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JURISCAN: AI-POWERED DIGITAL EVIDENCE AUTHENTICATION SYSTEM

BY

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Approval Form

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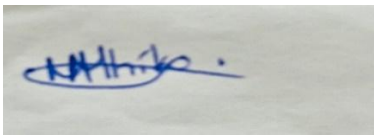

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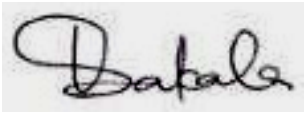

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DEDICATION

This research project is dedicated to all the students out there who would like to make a change to the world using technology; it is achievable. To my mother, who always believed in her Engineer, and my brothers and sisters, who knew that I could do it and trusted me with my decisions.

I also want to acknowledge my teachers and those who have supported me in my pursuit of such work. It is through their deep trust and faith in the potential of technology for social good that I have come to deeply love working on these initiatives. May this project ignite future sparks and provide an inspiration for all to follow their passions and skills to shape a better world. My finally to my friends that stuck by me in times of hardship and happiness, your encouraging spirits were a strength that carried me through this undertaking.

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ABSTRACT

As technology is advancing the judicial system is currently facing challenges in managing and authenticating digital evidence. In this research project JURISCAN: AI-Powered Digital Evidence Authentication System, explores the application of artificial intelligence (AI) to enhance the reliability of digital evidence in court proceedings. This study is aimed to come up with a system that would augment digital evidence authentication and consequently guarantee fairness in the legal system.

In this research study, emphasis is placed on the problem that is encountered in the courts of law in Zimbabwe where the trustworthiness of evidence brought into the courtroom could be seriously put to test by such evolving technological concepts as deepfakes, among other technologies. By utilizing AI algorithms, this research intends to contribute a possible solution to ascertain the authenticity of digital evidence.

Through an extensive literature review and using the already established research methodology, this research paper proves how AI has the ability to elevate the judicial system to new heights, while also encouraging accessibility in the system. Evidence from this research also suggests that JURISCAN could contribute greatly to ease verification of evidence, regional advancement, and public confidence in the judicial system.

Table of Contents

Approval Form ..... **Error! Bookmark not defined.**
DEDICATION ..... **Error! Bookmark not defined.**
Acknowledgement ..... **Error! Bookmark not defined.**
ABSTRACT ..... **Error! Bookmark not defined.**
Chapter 1: Introduction 9
1.1 Introduction 9
1.2 Background of study 10
1.2.1 Global Context 11
1.2.2 Local Context (Zimbabwe) 12
1.2.3 Rationale for the Project 13
1.3 Statement of Problem ..... **Error! Bookmark not defined.**
1.4 Research Objectives. ..... **Error! Bookmark not defined.**
1.5 Research questions. 14
1.6 Research justification. ..... **Error! Bookmark not defined.**
1.6 1 Research justification. ..... **Error! Bookmark not defined.**
1.6.2 Significance for Access to Justice ..... **Error! Bookmark not defined.**
1.6.3 Significance for Judicial Efficiency 15
1.6.4 Significance for technology policy ..... **Error! Bookmark not defined.**
1.6.5 Significance for Regional Development 16
1.6.6 Significance for Academic knowledge ..... **Error! Bookmark not defined.**
1.6.7 Significance for System User 18
1.7 Research assumptions ..... **Error! Bookmark not defined.**
1.8 Research limitations and challenges ..... **Error! Bookmark not defined.**
1.8.1 Technical limitations ..... **Error! Bookmark not defined.**
1.8.2 Infrastructure limitations ..... **Error! Bookmark not defined.**
1.8.3 Human limitations 20
1.8.4 Legal and Procedural limitations 20
1.8.5 Resource limitations 21
1.8.6 Scope limitations 22

1.9 Scope and Delimitation of research....23
1.9.1 Scope....25
1.9.2 Delimitation....26
1.10 Definition of terms.....27
Chapter 2: Literature Review....28
2.1 Introduction....28
2.2 Digital transformation in Judicial evidence....29
2.3 Digital evidence authentication in African courts....29
2.4 The zimbabwean context current state and challenges....30
2.5 Deepfake Technology origins....31
2.5.1 Understanding deepfake generation....32
2.5.2 Deepfake detection Approaches....34
2.5.3 Implication for Judicial evidence....35
2.6 AI in judicial Systems Global and african perspectives....40
2.6.1 International AI Adoption in Courts....41
2.7 Theoretical Framework....41
2.8 System Quality for Juriscan....42
2.4 Diffusion of innovation theory....42
2.5 Summary....43
Chapter 3: Research Methodology....44
3.1 Research Design....44
3.1.1 Introduction....45
3.1.2 Methodology....45
3.1.2 System specifications....**Error! Bookmark not defined.**
3.2 Population and Sampling....46
3.2.1 Sampling size....49
3.2.2 Events table....50
3.3 System Design....52
3.3.1 Processes Analysis....51
3.3.2 Process flow diagram....53
3.3.3 System Algorithm....61
3.4 Data Analysis Procedure to be used.....62

3.4.1 Data analysis 63
3.4.2 Expected System Experimental Results 63
Chapter 4: Data presetation, Analysis and Interpretation 64
4.1 Introduction 64
4.2 Analysis and interpretation of results 65
4.2.1 Document results 65
4.2.2 Interview results 67
4.2.3 Quistionnaire results 69
4.2.4 Observation results 72
4.2.5 Cross Analysis and interpretation of results 74
4.3 System Testing 75
4.5 Presentation of results 75
4.6 Analysis and interpretation of results 76
4.7 Observation and Analysis 76
Chapter 5: Conclusions and recommendations 77
5.1 Introduction 77
5.2 Primary Objectives 77
5.3 Future work 77
5.4 Recommendations 77
5.5 Conclusions 78
References 80

JURISCAN: AI-POWERED DIGITAL EVIDENCE AUTHENTICATION SYSTEM

Chapter 1: Problem Identification

1.1 Introduction

Courts and the justice system rely on evidence to establish the truth about a case presented. The evidence has to be authentic for the justice system to be fair. Evidence has a high chance of being manipulated since it can ruin a person's life, the judicial service system of Zimbabwe is vulnerable to this problem. Court evidence is presented in different kinds that is video, pictures, audios and texts which are critical in criminal and civil cases, If this evidence can be easily manipulated without an obvious trace threat the entire foundation of the justice system is threatened. A single altered video could send an innocent person to prison or allow a guilty person to go free (Chesney & Citron, 2019; Gless Lederer& Weigend 2024).

Zimbabwe, like many other countries, has been working to modernize its judicial system through digital transformation. The introduction of the Integrated Electronic Case Management System (IECMS) by the Judicial Service Commission (JSC) in 2022 can be regarded as a milestone in enhancing court management processes (Poshai & Vyas-Doorgapersad, 2023; Muparadzi & Mukonza 2024). However (IECMS) was primarily designed for case management rather than including evidence authentication. It was developed for case management filing, virtual meetings and case tracking but it does not address the fundamental question whether evidence being dealt with is genuine or tempered with.

With this research I am proposing JuriScan, an AI-powered forensic evidence authentication system that is designed to cover this gap specifically in Zimbabwe. JuriScan will analyse videos for this period, it will be checking for signs of manipulation and tempering. Using advanced machine learning the system will identify inconsistencies that would be invisible to the human eye or ear, providing courts with a reliable tool for verifying the authenticity of digital evidence (Verdoliva, 2020; Billah, 2025).

JuriScan is being designed with particular attention being paid to the requirements of the Zimbabwean judiciary, and will hopefully be linked into the existing IECMS if and when feasible and authorized by the necessary authorities. However, IECMS is also being developed

as a standalone piece of software that can be utilized by magistrates, judges, prosecutors and even law enforcement officials in order to confirm the authenticity of any potential evidence before it comes to trial. By making a simple, readily available way of ensuring media has not been tampered with, JuriScan will restore confidence to evidence within the judiciary.

1.2 Background to the Study

1.2.1 Global Context

Digital manipulation is not a new problem, but the sheer scale and complexity with which it has occurred in recent years has significantly changed things. The term 'deepfake' was first used in 2017 on the social media platform 'Reddit' when a user was posting videos that used AI to switch a famous person's face onto another's body and in one case, onto the body of a pornographic actor (Sample, 2020). The technology has only advanced since this. Now AI can create videos of people saying and doing things they never said or did and it can generate realistic photographs of non-existent people and can copy a voice from a few seconds worth of audio.

RAND Corporation also described synthetic media as "a substantial threat to the administration of justice". This manipulation of evidence can be applied with the intent of framing a false suspect, undermining credible evidence, or causing confusion about an event. Various nations' court systems have started to grapple with the problem of synthetic media, "The Law Commission in the UK has recommended new offenses for using deepfakes to pervert the course of justice" (Law Commission, 2022) and while "several US states now have statutes outlawing use of deepfakes in elections, ornonconsensual depictions of individuals" there are limited statutes addressing "their use in legal proceedings" (Chesney & Citron, 2019).

The digital forensics tool market (which contains media forensics) is expanding exponentially globally, especially for the development of tools capable of identifying manipulated media. MarketsandMarkets state that "The global digital forensics market size is expected to grow from USD 7.1 billion in 2023 to USD 11.5 billion by 2028, at a Compound Annual Growth Rate (CAGR) of 10.1%" (Markets and Markets, 2023) and that a large part of this growth is attributed to the demand for the identification of deepfakes. Big technology companies such as Microsoft and Facebook are investing huge amounts into researching deepfake identification, and academia

across the world is producing ever more advanced methods for detecting altered content (Dolhansky et al., 2020).

Even if such technology continues to grow at an exponential pace, this will still remain inaccessible to the average user. Academic researchers rather than practitioners are likely to develop these systems and will be poorly tuned to the nature of the evidence presented to courts.. There are still considerable differences between research opportunities and what courts need especially in developing countries with limited resources to afford these technologies (Agarwal et al., 2021; Kshetri, 2019).

Authentication of digital evidence faces few challenges in African jurisdictions due to the fact that it is a new system and only development of infrastructure and health are within their budget, digital evidence authentication not much of importance to them. The digital transformation in courts has taken pace over the years. The AU's Agenda 2063 highlights rule of law and good governance as key drivers of development and e-justice is being looked upon as an integral part to the development agenda (African Union, 2015). Countries like Kenya, South Africa, Rwanda and Nigeria among others have adopted e-filing system and conducted virtual court proceedings as result of the current pandemic situation in courts (Mawodza, 2021).

However, infrastructure and resources required for sustaining digital forensics are unevenly distributed due to reasons like insufficient finances, sponsorship etc.. According to the International Telecommunication Union, internet penetration in Africa stands at approximately 40 percent, with significant variation between countries and between urban and rural areas (ITU, 2022). Many courts, particularly those in rural areas, lack reliable internet connectivity, consistent power supply, and access to technical expertise. This creates a situation where digital evidence is increasingly being submitted, but the capacity to verify its authenticity remains limited (Oyedemi, 2020; Kshetri, 2019).

This is a problem mainly because many of the commercial digital forensic tools available are designed in the UK/Europe and North America, and hence priced in such markets that have relatively higher budgets. They could also be designed to analyze certain types of evidence and cases which is not always applicable to Africa. Tailoring these tools to specific needs of the African continent will be extremely expensive (Kshetri, 2019).

In spite of these problems, there are positive things that are coming out of this issue like how the African Commission on Human and Peoples' Rights is acknowledging digital evidence in their decisions towards the right to a fair trial and awareness amongst judges and legal professionals in general that evidence must be authenticated (ACHPR, 2020), and regions like SADC have begun discussing unified standards for cyber crime and digital evidence, which could foster resource sharing and training (SADC, 2021).

1.2.2 Local Context (Zimbabwe)

The Zimbabwean justice delivery system has made several advances regarding digital transformation over past few years. The Judicial Service Commission (JSC) launched the Integrated Electronic Case Management System (IECMS) in 2022 which is a significant innovation in court systems' way of handling case information. (The IECMS) permits the filing of court documents electronically, on-line case tracking, and virtual court sittings which increases overall court efficiency and decreases case pendency. (Poshai & Vyas-Doorgapersad, 2023; Muparadzi & Mukonza, 2024).

That said, IECMS was not built for evidentiary authentication; it was for the purpose of case management. It allows for storage and access to documents electronically, but there is no capability in it to determine if a document or a piece of digital evidence has been altered or corrupted. The lack of this function has become glaringly evident as the number of cases involving digital evidence requiring authentication has risen (Muparadzi & Mukonza, 2024).

There are several discoveries in this research of how the judiciary is facing several challenges in digital transformation that include:

Despite the current mobile internet penetration in Zimbabwe being close to 62.5% (POTRAZ, 2023), due to infrastructure challenges, the reality is that penetration levels are uneven between urban and rural parts. Many rural courts have inconsistent or no internet connectivity and electricity outages are very frequent, making systems that require constant connectivity difficult to implement.

In addition there is digital literacy, where "Chigona et al (2021) discovered a general disparity in levels of digital literacy among court users in Zimbabwe with a number of magistrates, lawyers,

and notably litigants, not having the required skills to utilize digital systems," posing a further impediment to the take up of new systems, therefore systems need to be usable.

Finally, systems integration is important as it is part of JSC's objective to achieve total digitalizing of court records by 2026 (JSC, 2022). To realize this objective, systems development and infrastructure would have to be invested in continuously; but systems integration needs to be taken care of meticulously. Building an evidence authentication system that is independent of existing case management systems would only increase burden to court users.

Additionally, security concerns arise, courts, in digitizing, become more susceptible to cyber attacks. Adherence to the security measures is critical to the integrity of the judicial process when dealing with digital evidence (Magaya & Zinyama, 2022; Seng & Mason, 2021).

Thus, by presenting such particular examples which demonstrate the fragility of digital evidence, the necessity of establishing a proper evidence authentication system in Zimbabwe is not fully reflected. As in a 2021 criminal case in Harare the prosecution produced a video evidence for authentication, however the defense then objected to it and the court excluded the evidence after its validity cannot be confirmed (S v Moyo, 2021). Cases like this seem to be seldom still, but in law practitioners is beginning to sense the problem with authenticated digital evidence.

1.2.3 Rationale for the Project

The project JuriScan is a direct response to the need that the aforementioned research revealed. While the IECMS lays a solid foundation for digital case management, it fails to address the particular problem of the authenticity of the evidence. JuriScan seeks to fill this gap by offering an accessible, reliable tool for authenticating digital data against tampering.

Here are a few reasons that contribute to this project being a topical and relevant one; Growth of digital evidence. Zimbabwe's citizens use mobile phones and other digital devices regularly and widely, the volume of digital evidence being submitted into criminal and civil cases is expanding and photographs from phones, video of crime events, conversations stored as audio files or digitally created files are becoming prevalent in court proceedings..

There is progression occurring in manipulation technology-tools to manipulate evidence are readily available and what was once a skill, now can be executed with free smartphone apps

(Verdoliva, 2020; Chesney & Citron, 2019). The increased availability and use of these tools may lead to the greater likelihood of having to consider evidence, which is manipulating, in a court of law.

In addition to the regional leadership provided to Zimbabwe for creating a verification system for evidence of its own; the system could allow Zimbabwe to lead regionally in terms of judicial technology; and be adaptable for implementation by other countries in SADC that have a similar problem to overcome.

Besides, the JuriScan research project corresponds to several national strategies in relation to the National Policy as well, for instance, the National Development Strategy 1 (NDS1), in which the digitally transforming in the institutions of governments is encouraged; and the National ICT Policy Framework in which the e-governance is enhanced (Government of Zimbabwe, 2020).

Also, effectiveness in cost development of a system which is tailored to the specific circumstances of Zimbabwe and with regards to its constraints by the use of open source software wherever possible; the project attempts to show that a valid evidence authentication mechanism can be put in place without expensive solutions imported from abroad. The constraints faced by most government institutions with respect to financial budgets make the approach more critical.

1.3 Statement of the Problem

Even though Zimbabwe has embarked on computerizing its judicial system by among others, the Integrated Electronic Case Management System (IECMS) a gap exists. This is on the basis of the inablity to verify digital evidence. The current system allows for electronic filing and case tracking but does not provide tools for detecting whether videos, images, audio recordings, or text documents have been tampered with before being submitted as evidence (Muparadzi & Mukonza, 2024).

This gap creates several problems such as, vulnerability to manipulated evidence because of lack of reliable authentication tools, courts are vulnerable to the submission of altered evidence. A video that has been edited to show something that did not occur, an audio recording that has been spliced to change the meaning of a conversation, or a document that has been forged could all be admitted as evidence without the court having any reliable way to detect the manipulation. This

threatens the fundamental purpose of judicial proceedings, which is to establish the truth (Chesney & Citron, 2019, Gless, Lederer & Weigend, 2024).

Inconsistence authentication practices in the absence of a standardized tool, courts and litigants would rely on temporary methods for authenticating digital evidence or they could call experts to testify, but such experts are not always available, and their testimony can be expensive and time-consuming. Others may simply admit evidence without any verification, hoping that the opposing party will identify any issues. This leads to inconsistent outcomes and undermines confidence in the judicial process (Mason, 2017, Seng & Mason, 2021).

There is limited technical capacity among court personnel, most magistrates, judges, and court staff do not have the technical training needed to assess the authenticity of digital evidence. While they are experts in the law, they cannot be expected to recognize signs of sophisticated digital manipulation. They need tools that can perform this analysis and present the results in an accessible format.

Adding to that there is a missed opportunity for efficiency that is a standardized authentication tool could actually streamline judicial processes by resolving questions about evidence authenticity quickly and definitively. Otherwise, questions of the authenticity of evidence can bring about a great deal of hearings and experts and appeals; which drain court resources and delays the adjudication of the underlying matter.

The issue is therefore not just that digital evidence is prone to tampering, but that there is not yet a transparent, trustworthy and uniform way in the Zimbabwean judiciary to determine whether this has occurred. This would make courts prone to fraud, create inconsistency in how evidence is dealt with, create unmanageable burdens for the judiciary, and compromise justice.

1.4 Research Objectives

The main aims of JuriScan are:

1. Design an AI based system that can detect tampering in digital videos through the analysis of consistency among frames, compression artifacts and other technical factors that could indicate manipulation (Verdoliva, 2020; Billah, 2025).

2. Developing functionality to minimize court misjudgments through manipulation identification using features such as lighting consistency, perspective, metadata, etc.

3. Training an AI model to exhibit capabilities in video forensics in order to detect splicing, inconsistent background noise and etc.

4. Develop an interface that is intuitive and clearly displays the authentication results in a format that is useful to judicial officers and staff with non-technical knowledge.

5. Securely authenticate and authorization based access control is needed to ensure that only relevant parties gain access and a proper chain of evidence custody is established (Seng & Mason, 2021).

6. Test the efficiency of the system using real and manipulated media files and obtain user feedback from the judiciary.

1.5 Research Questions

This research will be guided by these questions:

Primary Research Question:

How can an AI-powered system be designed and implemented to effectively detect tampering in digital evidence submitted to Zimbabwean courts?

Secondary Research Questions:

1. Which forms of digital evidence alteration is most or most likely to be seen within the Zimbabwean court system?

2. Which technical indicators is most trustworthy to prove video manipulation?

3. How may the results of an authentication process be explained to a judicial officer without technical knowledge?

4. Which infrastructure issues (internet availability, electrical supply, hardware availability) need to be taken into consideration when building an evidence authentication system for Zimbabwean courts? (Muparadzi & Mukonza, 2024; Poshai & Vyas-Doorgapersad, 2023)

5. How may the authentication process maintain the security and integrity of the digital evidence? (Seng & Mason, 2021)

6. What kind of training and support will be needed to use an evidence authentication system efficiently?

7. How could such a system be linked to current technology systems used within the court system, for example IECMS? (Muparadzi & Mukonza, 2024)

8. Which legal and procedural matters must be considered when introducing automated evidence authentication within the judicial system? (Gless, Lederer & Weigend, 2024; Seng & Mason, 2021)

1.6 Justification and Significance of the Study

The present investigation is justified and meaningful on several bases and is valuable to various groups, including:

1.6.1 Significance for Judicial Integrity

The most basic significance of the above can be expressed in the possibility of ensuring justice of legal procedures. The function of court is to establish truth and reliability of evidence to court is extremely important to do so. Therefore, JuriScan is a tool to discover manipulated evidence to maintain authenticity and accuracy of materials presented to court. Thus this will provide both the litigants as well as the society justice (Bagaric et al., 2021; Chesney & Citron, 2019).

1.6.2 Significance for Access to Justice

Access to justice should be defined not only as a party's access to the courts, but also the decision on that party's claim being delivered on a factual basis relying on accurate and credible evidence. The inequality which can be derived from the fact that one party can falsify evidence whereas the other party cannot trace it leads to a truly unjust decision. This can be avoided if such a tool allowing for easy authentication can be accessed by any party and justice would not just be the prerogative of the well-resourced (Mason, 2017).

1.6.3 Significance for Judicial Efficiency

Authenticity of evidence disputes can become very time-consuming for courts. The need to secure expert witnesses, pay for testimony and schedule hearings, as well as potential appeals will be very costly to the courts. An automated authentication system can help resolve these disputes efficiently and definitively, shifting the court's focus to the substantive claims. This

efficiency is crucial in Zimbabwe, where courts face significant backlogs and delays (Poshai & Vyas-Doorgapersad, 2023).

1.6.4 Significance for Technology Policy

In this sense, it advances the ongoing discussions on the place of technology in government and in public bodies. Through showing a positive and successful use of AI within a judicial system it offers an example of a potential template for other public sector responsibilities. Further, it produces data on the requirements of hardware, training and support necessary for implementing technology successfully.

1.6.5 Significance for Regional Development

Besides the application to Zimbabwean circumstances, the existence of JuriScan, which has the first AI based evidence authentication system designed for African legal practices, has wider implications for other SADC states and even across Africa. It offers the possibility of a system that can be transplanted and customized and establishes Zimbabwe as a technological innovator in Africa and not just a recipient of technology from external sources (Kshetri, 2019).

1.6.6 Significance for Academic Knowledge

This research will add to the body of knowledge within Computer Science (in terms of media forensics, and AI), Law (in the area of evidence and procedure), and Information Systems (in terms of public sector technology adoption). This research will reveal what works, and what does not work in real world applications of AI in relation to evidence authentication within a judicial process.

1.6.7 Significance for System Users

Most simply, at a "grass-roots" level, the work of this study will affect all the people who will actually be using this system: the magistrates, the judges, the registrars, the prosecutor, the public defender, and the litigants themselves.For these users, JuriScan offers a tool that makes their work easier, more reliable, and more defensible. It reduces the stress of having to make judgments about technical matters outside their expertise and provides confidence that the evidence they are relying on is authentic.

1.7 Assumptions

JuriScan is to be developed based on several assumptions that include

1. Digital evidence, including videos, images, audio recordings, and text documents, will continue to be submitted in Zimbabwean courts in increasing volume and variety.
2. The techniques used to manipulate digital media will continue to evolve, requiring the system to be regularly updated to maintain effectiveness (Verdoliva, 2020).
3. Court personnel, including magistrates, will be willing to use an automated authentication system if it is designed to be accessible and its results are presented clearly (Venkatesh, Thong & Xu, 2021).
4. Basic computing infrastructure (computers with reasonable processing power) will be available in the courts where the system is deployed.
5. The Judicial Service Commission and other relevant authorities will support the adoption of evidence authentication technology.
6. Sufficient training can be provided to enable effective use of the system by personnel with varying levels of technical literacy.
7. Legal frameworks in Zimbabwe will accommodate or can be adapted to accommodate the use of AI-generated authentication results as evidence (Seng & Mason, 2021).

8. Sample data for both training the system and for testing can be collected, in the form of real media and tampered media created with multiple different methods.

9. Although the system will not achieve 100% accuracy it will provide a helpful degree of assistance to the courts that would not be available from the absence of an authentication or from temporary methods.

10. The advantages of the system in terms of enhanced evidence reliability and court efficiency will outweigh the costs involved in developing, deploying and maintaining it.1.8 Limitations and Challenges

Despite of the existing limitations and challenges in the study and development of JuriScan1.8.1 Technical Limitations

Evolution of Manipulations Technologies: Techniques used for manipulating digital media are evolving fast. In the future, the types of manipulations that can be identified now may become impossible to distinguish from a genuine media and new types of manipulations that cannot be detected at the moment may be possible. Thus, the system will need to be constantly updated and a 100% correct solution may never be attainable.

Computational demands. A number of the methods described in this document require quite a lot of processing power, especially image and video analysis. This may prove to be a bottleneck if older computers are found in some courts.

False Positives and Negatives: No detection method is 100% effective. Users should be warned that some genuine media might be falsely identified as manipulated (false positive) while some manipulated media may go undetected (false negative).

The availability of training data. Successful development of AI models relies heavily upon the availability of a sufficiently large training set composed of both genuine and manipulated media. Access to a large corpus of suitable quality training data, specifically of the manipulations that will likely be of relevance to Zimbabwean courts may prove difficult.

1.8.2 Infrastructure Limitations

Internet Connection-The majority of courts are located in rural areas and suffer from poor/unreliable connections to the internet. This has implications for cloud processing and dictates that the system can operate offline.

Power Supply-Unstable power supply in parts of the country could impact on the performance of the system, especially when dealing with evidence.

Hardware Availability-Courts will likely not have adequate amounts of hardware, nor powerful enough to be able to run complex models.

1.8.3 Human Factors

Digital Literacy: The diverse digital literacy levels among the court personnel might impact the system's use and effectiveness. Training and simplicity are essential.

Resistance to Change: Some court personnel may be resistant to adopting new technology, particularly if they perceive it as threatening their expertise or creating additional work.

Trust in AI: It may not be a favorable result that a court officer receives if that output came from an AI system, if the officer does not know where the output came from.. Building trust will require transparency about the system's methods and limitations (Billah, 2025; Seng & Mason, 2021).

1.8.4 Legal and Procedural Challenges

Evidentiary Rules: While AI has already shown success in authentication, the extent to which the AI's generated evidence of authentication should be relied upon may be subject to further scrutiny. Rules of evidence are not developed with AI in mind and may pose questions of whether AI outputs constitute expert testimony, real evidence, or neither (Mason, 2017; Gless, Lederer & Weigend, 2024).

Chain of Custody: To ensure the authentication results can be trusted, the evidence may need to adhere to a strict chain of custody and include system logging and security controls.

Procedural integration: the integration of JuriScan into court procedure will involve many considerations. Namely, when the authentication process will take place, who will be allowed to request the authentication, and what documentation of the results will occur.

1.8.5 Resource Limitations

Financial Limitations: The available budget and associated tools at the disposal of the project is limited. This has an effect on the complexity of the system and the available training and support.

Time Constraints: There is a high time pressure to implement all of the goals within the determined project duration. A good and efficient implementation is necessary. There will probably have to be compromises.

Personnel Limitations: The research project does not have a large team size. Expertise in specific areas like media forensics, machine learning, and judicial process might be limited.

1.8.6 Scope Limitations

Technical Detection: It only relies on technical detection and does not address the legal aspects of evidence authenticity such as the legality of its obtainment, nor does it address the legality of execution of a document.

It does not extend to physical evidence: JuriScan works only on digital evidence and traditional forms of evidence like physical documents and objects are not covered by this system.

Zimbabwean Context: Although the JuriScan can be tailored for use in other jurisdictions it is developed for use in the courts in Zimbabwe, hence not fulfilling all the requirements of another judicial system.

1.9 Scope and Delimitation of the Research

1.9.1 Scope

Research Scope: Focus on Video Evidence in the Zimbabwean Judicial System

Geographic Scope:

The JuriScan research specifically deals with the Zimbabwean court system, focusing on the Magistrates' Courts and High Courts where most video evidence is presented. It is acknowledged that the research could have implications for other areas but this specifically focuses on Zimbabwe.

Content Scope:

The research specifically targets video evidence, including:

- Recordings from smartphones

- Footage from security cameras

- Other forms of video documentation that may be relevant in court proceedings

Technical Scope:

Technical details that fall within the scope of this research include:

- Artificial intelligent (AI) models trained to identify falsification and integrity issues within videos (Verdoliva, 2020; Billah, 2025)

- Easy to use interface for video authentication system

- Use of high-level security and authentication controls to protect user data

- Testing and assessment of the video authentication system in practical scenarios

- Developing training resources to enhance the usability of the video authentication system

User Scope:

The system is intended for the following users:

- Magistrates and judges

- Court registrars and clerks

- Prosecutors

- Defense attorneys

- Law enforcement officers (in relevant contexts)

- Litigants (accessing the system through supervised means)

This focused approach on video evidence aims to enhance the integrity and reliability of digital evidence presented in Zimbabwe's judicial processes. Other media forms will be considered in subsequent phases of the research.

1.9.2 Delimitation

The research is delimited in the following ways

1. That it is not a replacement for human judgement, it is designed to assist not to replace judicial officers. Final determinations about evidence admissibility and weight remain with the court.

2. Not concerned with legal authenticity it seeks to achieve technical authenticity and does not extend to legal authenticity (was the evidence obtained legally, has it been accounted for etc.)
3. It is limited to digital manipulation, it does not address other forms of evidence tampering such as physical alterations of documents or witness coaching
4. Not a Comprehensive Case Management System: JuriScan focuses specifically on evidence authentication. The intention is to supplement or complement, rather than reproduce the features of case management systems such as IECMS, although links to case management systems could be implemented.
5. JuriScan attempts to detect as many manipulation techniques as possible, but it can't detect all forms of manipulation. Any new manipulation methods would not be able to be detected until JuriScan had been re-trained.
6. The system is able to give you a probable answer, not a definite one. Therefore the system can tell you there is a high probability that there is manipulation, but can't give you definitive proof.
7. Limited resources with regards to the budget, time, and personnel mean that the sophistication of the system is also limited.

1.10 Definition of Terms

For the purposes of this research, the following terms are defined:

Artificial intelligence: Computer systems built to simulate the ability to perform normally human intellectual processes such as learning, reasoning, and problem-solving. The term "AI" in the context of JuriScan specifically relates to machine learning models used to identify signs of media manipulation.

Authentication: The process of verifying that something is genuine and has not been tampered with. In this research, authentication refers specifically to verifying that digital media has not been manipulated after its creation.

Chain of Custody: The documented sequence of custody, control, transfer, and analysis of evidence. Maintaining chain of custody is essential for establishing that evidence has not been tampered with between collection and presentation in court (Seng & Mason, 2021)..

Convolutional Neural Network (CNN): An architecture of deep learning commonly utilized for analysis of visual data, such as images and videos, and often applied to manipulation detection tasks (Verdoliva, 2020).

Deepfake: A medium, especially a video, in which a person's face or body is changed to make them look like they said or did something they did not do. "Deep learning" is combined with "fake".

Digital evidence: Any information in digital form that is relevant and can be used as evidence. For example, digital images, videos, sound files, documents, e-mails and social media communications.

Digital forensics is the application of scientific investigation and analysis techniques to the gathering and examination of evidence from digital media. Its purpose is to reveal and prove the facts of an event for use in a court of law.

False Negative: Failure to detect a manipulation, which is present in the system. For JuriScan, it refers to the situation where the system states that a media is true, although it is not.

False positive: A false alarm in which the system states manipulation occurred when it was not in fact the case. In relation to JuriScan, this would result in genuine media being marked as likely manipulated.

Frame Analysis: In video forensics, the examination of individual frames of a video to detect inconsistencies that may indicate manipulation, such as unnatural transitions, compression artifacts, or lighting discrepancies (Verdoliva, 2020).

Integrated Electronic Case Management System (IECMS): The digital case management system implemented by Zimbabwe's Judicial Service Commission to enable electronic filing, case tracking, and virtual hearings (Poshai & Vyas-Doorgapersad, 2023; Muparadzi & Mukonza, 2024).

Judicial Service Commission (JSC): The constitutional body responsible for overseeing the administration of justice in Zimbabwe, including the appointment of judicial officers and the management of courts.

Machine Learning: A subset of artificial intelligence in which computer systems learn from data to improve their performance on specific tasks without being explicitly programmed for every possible scenario.

Manipulation: Any intentional alteration of digital media that changes its content or meaning. This includes editing, splicing, adding or removing elements, and generating entirely synthetic content.

Metadata: Data that provides information about other data. In digital media, metadata can include information about when and how a file was created, what device was used, and whether it has been edited.

Noise Analysis: Media forensics is the analysis of unpredictable fluctuations in a digital file which can uncover attempts to tamper. The presence of irregular noise patterns in an image or audio file suggests it has been manipulated.

Offline Functionality: The ability of a system to perform its core functions without an active internet connection. This is important for deployment in areas with limited connectivity.

Role-Based Access Control (RBAC): A security approach that restricts system access based on a user's role within an organization. In JuriScan, different user types (magistrates, registrars, etc.) would have different levels of access to system functions.

Splicing: A manipulation technique in which segments from different recordings are combined to create a new recording that appears continuous. Splicing can occur in video, audio, and text.

Tampering: Modifying or altering evidence to change its content or intent. Altering evidence is against the law in most areas..

User Interface (UI): How a user interacts with the computer system. Within JuriScan the UI will be the screens, buttons, and controls a user would interact with when submitting evidence and retrieving authentication results.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents a thorough survey of available literature in areas such as Digital Evidence Management, Artificial Intelligence in Courts and the Judiciary, Detection of deep fake technology and use of information systems in courtrooms. Analyses of past and contemporary research work that is being used as the backbone for JuriScan development and deployment (JuriScan-A digital evidence authentication system using artificial intelligence for the courts of Zimbabwe) are given below. The literature review covers International, African and Zimbabwean dimensions, considering the technical, operational and social aspects that will make a system based on Artificial Intelligence for evidence authentication be effective in the courts (Venkatesh, Thong & Xu, 2021; UNECA, 2022).

It has also confirmed previous research efforts for tackling issues regarding manipulation of digital evidence, multimedia forensics, and the user acceptance of AI based technologies within the courtroom. It also sets the theoretical framework and conceptual basis of JuriScan and defines the knowledge and technology gaps that the current project aims to tackle.

2.2 Digital Transformation in Judicial Evidence Management

Judicial digital transformation is considered to be "the whole scale changes from manual to the digitized, paper-based procedure of collecting evidence into integrated workflows and systems that automate the handling, verification and display of evidence with technology as its core" (World Bank, 2021). It consists of digitizing the case files, submitting the evidence electronically, court proceedings conducted online, and artificial intelligence is progressively used to check the authenticity of the evidence (Tan & Lee, 2020). Various courts worldwide are integrating these technologies in their systems, so as to create a system that is more transparent, shorten case delays and promote access to justice for all citizens (Tan & Lee, 2020).

It is clear from UNECA's (2022) report that African countries are developing their e-justice systems as part of broader reforms aimed at good governance. In addition, digital justice can increase the efficiency of institutions by producing the right data to assist decisions, cutting

down on time spent on bureaucracy and, critically during and post Covid-19, reducing the need for physical presence through allowing virtual court hearings (The World Bank, 2021), although benefits cannot be guaranteed unless robust digital infrastructure is available and judges and judicial officers are able to adopt new technologies (Apau et al. 2020).

The rapid rise of AI-synthesized media (deepfakes) is challenging courts around the world in relation to the admissibility and integrity of digital evidence (Verdoliva, 2020). These synthetic videos and audio files are ultra-realistic manufactured representations of individuals saying and doing things that they have never actually done-created through artificial neural network approaches such as Generative Adversarial Networks (GANs)-and this development poses a significant challenge to digital evidence being introduced into legal processes (Korshunov & Marcel, 2022; Mirsky & Lee, 2021). Consequently, a crucial skill in modern court processes is determining the authenticity of digital evidence, and this requires a specific AI to combat manipulated evidence (Mirsky & Lee, 2021; Billah, 2025).

In conclusion, based on International experience it is clear that digitally sophisticated states have already started introducing AI forensic tools into their judicial processes. The UK's Her Majesty's Courts and Tribunals Service (HMCTS) has studied the use of AI to analyse and authenticate evidence in a legal context while the Singapore's Litigation system has implemented automated verification for electronically submitted evidence (Tan & Lee, 2020; HMCTS, 2021). Such activities not only prove that digital transformation is not only about automation but about authenticity and reliability of digital evidence, which is the core principle on which the JuriScan system operates.

2.3 Digital Evidence Authentication in African Courts

Digital evidence management systems have been implemented with varying degrees across Africa, with some states using integrated e-justice systems and others continuing with paper-based systems (UNECA, 2022). In Kenya, parties and lawyers are able to file cases using the e-Filing system and in South Africa, Case Lines digitises evidence presentation and courtroom proceedings (Wekesa, 2023). Nigeria's Judiciary Information Management System (JIMS) includes the digitization of cause lists, web-based judgment stores and document tracking (Apau et al., 2020).

But the authentication issue, especially regarding video evidence is not well handled in all African legal systems (Muzondo & Moyo, 2023). The available platforms are document and case management tools with little or no advanced modules for identifying edited multimedia content

which is a very big concern given the wide availability of deepfake technology that can be used to generate fabricated evidence during the criminal trial that could resulted in wrongful prosecution or acquittals (Verdoliva, 2020; Mirsky & Lee, 2021; Chesney & Citron, 2019).

The experience of the e-Records Management Initiative in Botswana has been reported to need continuous stakeholders' training and inclusion of national legal proceedings into system design for sustainability of e-justice (Mosweu & Kenosi, 2018). Open source technology was used in the case management systems of both Ghana and Rwanda in order to minimize expenditure and minimize reliance on paid solutions (Amankwah, 2022). Both have implied that solutions should be developed taking into account local circumstances in African judicial systems such as restricted bandwidth, frequent electricity failure and unequal ICT capacity of the court employees (Etta & Parvyn-Wamahiu, 2022).

2.4 The Zimbabwean Context: Current State and Challenges

To move forward and transform to digital justice delivery, Zimbabwe's judiciary has made progress. Through the introduction of Integrated Electronic Case Management system (IECMS) in 2022, by Judicial Service Commission of Zimbabwe (JSC), the system of IECMS allows citizens to e-file court papers, track cases and also electronically mange files(Judicial Service Commission of Zimbabwe, 2023). In Muzondo and Moyo's perspective (2023), ease access to information regarding files and reduced transportation of files amongst court stations has increased efficiency. Nonetheless, current study states that impediments of effective digitalization result in a lack of functionality of system for processing multimedia evidence(Muparadzi & Mukonza, 2024).

The IECMS also has some serious limitations in handling and authenticating multimedia evidence. Muzondo and Moyo (2023) found that the system had problems with video and audio file uploads due to bandwidth limitations and does not contain any methods to check if media file that has been uploaded has been manipulated or not. The problem is amplified by server congestion, limited bandwidth at the rural court offices and lack of consistent training among users (Judiciary Service Commission of Zimbabwe, 2023). It is important to note that the current system does not have any AI-based tools for authenticity of the data making the Zimbabwean courts vulnerable to introduction of synthetic video evidence (Chirume & Musara, 2022; Muparadzi & Mukonza, 2024).

A key weakness of the Zimbabwean digital justice system is the lack of deepfake detection. As deepfake generation technologies become more sophisticated and accessible, the probability of such content appearing in legal proceedings increases correspondingly (Korshunov & Marcel, 2022). Without dedicated authentication tools, judicial officers lack the technical means to distinguish between authentic video evidence and AI-generated forgeries, potentially compromising the integrity of court outcomes (Verdoliva, 2020; Gless, Lederer & Weigend, 2024).

The Judicial Service Commission of Zimbabwe (2023) outlined a long-term vision to bring the IECMS to all the provincial courts and incorporate digital payment methods so that citizens can interact more fully. The long-term vision does not detail specific responses to the emergence of the threat of deepfake evidence. This makes systems such as JuriScan all the more relevant, a system created for the specific purpose of validating digital video evidence and the detection of AI manipulated manipulation in the Zimbabwe justice sector (Nhemachena, 2024; Muparadzi & Mukonza, 2024).

2.5 Deepfake Technology: Origins, Mechanisms, and Threats

2.5.1 Understanding Deepfake Generation

Deepfake technology originates from deep learning and more specifically the generation of artificial contents with generative adversarial networks (GANs) proposed by Goodfellow et al. (2014). GANs comprise two neural networks, a generator which produces artificial content and a discriminator which try to distinguish between original and artificial content and that compete against each other with the generated content getting better and better (Verdoliva, 2020). With the use of deep fake technology on video it is possible to create face swap, to manipulate facial expressions, to synthesise speech or to create a new scene totally fake and which looks real (Mirsky & Lee, 2021; Chesney & Citron, 2019).

The first few instances of deepfake videos were still clearly visible due to various anomalies, such as the inconsistency in the blinking, strange lighting, and poor audio-visual synchronisation (Korshunov and Marcel, 2022). In current years, deepfakes have become increasingly complex, with current generation of models capable of creating synthesized videos that are almost

indistinguishable from real videos. This poses large threats to legal frameworks, where video evidence is typically assigned considerable evidential value (Verdoliva, 2020).

2.5.2 Deepfake Detection Approaches

Some common techniques and approaches of deepfake detection have been developed; the most noticeable approaches include space-based analysis and time-based analysis, and each one has its unique advantages and drawbacks. In space-based approaches, each frame in a video is inspected for certain artefacts produced during deepfake creation, such as incorrect face-blending at the edge, inconsistent texturing, and deviations in colour distribution (Rossler et al. 2019; Afchar et al. 2018). For time-based approaches, differences among different frames, such as irregular eye blinking, non-smooth head motion or inharmonious facial expressions are detected (Sabir et al. 2019; Korshunov & Marcel, 2022).

The frequency domain detection method takes the video information from the frequency domain in which the deepfakes can be readily detected, and this information cannot be perceived in the spatial domain (Frank et al., 2020; Qian et al., 2020). Hybrid approaches apply multiple detection techniques in combination in order to increase performance and robustness against various kinds of manipulation (Mirsky & Lee, 2021). Moreover, the biological signal-based detection approach, relying on physiological signals like the heart rate taken from photoplethysmography (PPG)-very slight changes of skin color on a face, based on variation of blood circulation and typically missing in deepfake generation algorithms (Ciftci et al., 2020; Verdoliva, 2020).

For JuriScan, a hybrid method of detection is preferred because a combination of space, time and frequency-based analysis yields a high level of detection accuracy with manageable computational resources, within a limited environment of Zimbabwean courts (Chirume & Musara, 2022; Nhemachena, 2024). For forensic AI, explainable AI (XAI) methods like SHAP and LIME would be important to make the system transparent, allowing legal practitioners to explain and validate AI decisions in court (Billah, 2025).

2.5.3 Implications for Judicial Evidence

The increase of deepfake technology has raised crucial questions about the framework of evidence used in modern legal systems. Historically, video recordings have been treated as compelling evidence due to the assumption that they reliably capture events as they occurred (Mirsky & Lee, 2021). Deepfakes undermine this assumption entirely, introducing reasonable doubt about the authenticity of any digital video presented in court (Verdoliva, 2020; Chesney & Citron, 2019).

Langenburg (2022) claimed that without strong authentication methods the courts are left to admit forgeries that might lead to injustice and convictions while in turn refusing authentic evidence on false pretense of it being a forgery and that it poses an impossible strain on judicial officers, who do not have the technical skills required to assess the authenticity of digital media on their own (Apau et al., 2020) and so as the case stands, the development of court accessible deepfake detection tools is not a luxury, it is a necessity for the judiciary (Korshunov & Marcel, 2022; Chirume & Musara, 2022; Gless, Lederer & Weigend, 2024).

2.6 AI in Judicial Systems: Global and African Perspectives

2.6.1 International AI Adoption in Courts

The adoption of AI into court systems is also growing globally in all forms, from recidivism analysis predictions to automatic sorting of evidence and documents (Tan & Lee, 2020; HMCTS, 2021). In China internet courts use AI to preside over low value cases completely online where algorithms help evaluate evidence and draft opinions (Chen, 2021). The EU has created recommendations regarding the use of AI in courts that include transparency and responsibility of AI and the need for human involvement (European Commission, 2020).

Within evidence verification the use of AI tools has been put into action by several authorities. The Federal Bureau of Investigation in the United States have created forensic AI tools which verify the authenticity of digital media., while private sector solutions such as Reality Defender and Truepic provide deepfake detection services for enterprise and government clients (Mirsky & Lee, 2021). But their proprietary nature, high cost, and western-oriented environment hinder their adoption by African courts (Amankwah, 2022; Kshetri, 2019).

2.6.2 African AI Initiatives in Justice

Some judicial systems in Africa have also started experimenting with AI though implementation lags significantly behind developed economies. CaseLines is a South African platform with rudimentary AI features primarily concerned with document authentication, and Nigeria's JIMS piloted AI-assisted case management (Wekesa, 2023; Apau et al., 2020). However, neither platforms has any specific deepfake detection capabilities designed for authenticating video evidence (Muzondo & Moyo, 2023). The success of AI adoption in African courts needs to take cognisance of infrastructure, multiplicity of languages, existing legal framework, and the need

for contextually driven solutions as highlighted by Mosweu and Kenosi (2018). As documented by Amankwah (2022), Rwanda and Ghana, among others, have pursued a strategy of using open source AI solutions to minimise costs and allow for adaptation to local needs. This is consistent with the JuriScan framework of creating an open source, light-weight system capable of deepfake detection tailored for use in Zimbabwean courts (Nhemachena, 2024; Muparadzi & Mukonza, 2024).

2.7 Theoretical Framework

The conceptualization, development, and testing of JuriScan are founded upon known theories of information systems which address technology adoption, system success, and diffusion of innovations.. The three primary theoretical frameworks informing this project are the Technology Acceptance Model (TAM), the DeLone and McLean Information Systems Success Model, and Rogers' Diffusion of Innovation Theory. Together, these frameworks address the behavioural, technical, and institutional dimensions of AI adoption in judicial settings (Venkatesh, Thong & Xu, 2021; DeLone & McLean, 2003; Rogers, 2003).

2.7.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (Davis, 1989, later refined by Venkatesh and Bala, 2021) is composed of two main constructs affecting technology acceptance: PU, referring to the extent to which users anticipate that using a particular system would enhance their performance, and PEOU, referring to the extent to which users anticipate a particular system to be free of effort (Chirume and Musara, 2022). For judicial AI tools, the application of these constructs influences the perceptions and ultimate acceptance of judicial officers, prosecutors, registrars, and legal practitioners, and their interaction with new technologies (Chirume and Musara, 2022).

Regarding JuriScan, the PU construct is addressed through its core function, the accurate detection of deepfake videos, and in this manner, preventing their acceptance as authentic evidence and upholding the integrity of the evidentiary proceeding (Mirsky and Lee, 2021). For judicial officers, their willingness to accept a tool will be higher when it has a demonstrably beneficial impact, by lowering the probability of introducing manipulated evidence. The PEOU construct is addressed through a user-friendly interface, streamlined workflows and simple

representation of results, lowering the need for advanced technical knowledge from its users (Venkatesh and Bala, 2021).

Mokgoro (2021) highlighted that training availability and endorsement by peers have a significant impact on technology acceptance in African judicial systems. Thus, JuriScan provides thorough user training and is tested and validated by some selected courts so as to build the users' confidence in the system, and demonstrate its utility (Venkatesh and Bala, 2021). Continual technical support and user feedback driven iterative design of the interface will be crucial for maintenance of PU and PEOU over time (Venkatesh and Bala, 2021).

2.7.2 System Quality for JuriScan

System quality (reliability, response time, usability, uptime) for JuriScan's usage in a courtroom setting is crucial due to the system potentially needing to verify the authenticity of evidence in active legal proceedings (Petter et al., 2020). For efficient running on regular court computer without any specialized expensive GPU hardware; lightweight, optimized deep learning models have been utilized (Chirume & Musara, 2022).

Information quality (Accuracy, completeness, and timeliness) refers to the degree to which the results generated from the system's outputs (DeLone & McLean, 2003). In terms of deepfake detection this involves producing the minimum number of both false positives (real video falsely classified as manipulated) and false negatives (manipulated video falsely classified as real). JuriScan is designed with ensemble detection methods combining different detection algorithms for excellent accuracy on different kinds of manipulation (Rossler et al., 2019; Korshunov & Marcel, 2022).

Service Quality (Technical support, user training, and maintenance) is also a critical aspect of a system to a user and its overall success (Petter et al., 2020). A part of the JuriScan implementation plan has established technical support channels and a thorough user manual. Also regular system updates will need to be deployed to deal with novel forms of deepfake manipulation. As described in Amani and Gicharu (2021) when focusing on African e-justice systems, the service quality is positively correlated to the trust gained from the user.

2.7.3 Diffusion of Innovation Theory

Rogers Diffusion of Innovation Theory (2003) offers a model to understand how an innovation diffuses in a social system over time, proposing five key characteristics that determine its rate of adoption; Relative Advantage, Compatibility, Complexity, Trialability and Observability. The key dimensions have been particularly applicable when discussing AI adoption in courts, in that "professional norms, legal processes, and organizational structures tend to be influential in accepting a new technology" (Mosweu & Kenosi, 2018).

Relative advantage is the extent to which a new idea is believed to be more useful than the idea it replaces (Rogers, 2003). The relative advantage for JuriScan is the addition of functionality in the Zimbabwean courts that doesn't exist in any capacity, an automated deepfake detection system. Courts currently do not have the ability to digitally verify the authenticity of video evidence (Muzondo & Moyo, 2023), making JuriScan's usefulness a very straightforward advantage that would likely ensure fast adoption among security focused judicial officers (Chirume & Musara, 2022).

Compatibility, "the degree to which an innovation is consistent with the existing values, past experiences and needs of potential adopters" (Rogers, 2003). JuriScan can achieve compatibility through ease of use in integration with currentIECMS and output that has the expected look of already used judicial documents with simple clear authentication and confidence levels (Nhemachena, 2024).

Complexity can be mitigated by use of human-centered design, training, and development. The ability to try an innovation is met through piloting the technology. The observability of innovation results is supported through documented cases of successful deepfake prevention in courts (Mokgoro, 2021; Wekesa, 2023).

2.8 Comparative Analysis of Existing Deepfake Detection Systems

Table 2.1 Comparison between existing deepfake detection systems and feasibility in the Zimbabwean judiciary. This comparison highlights system architecture, detection method, infrastructure and suitability for the court environment.

Table 2.1: Comparative Analysis of Deepfake Detection Systems

System / Source	Detection Method	Technology Stack	Strengths	Limitations	Suitability for Zimbabwean Courts
MesoNet (Afchar et al., 2018)	Spatial feature analysis at mesoscopic level	TensorFlow/ Keras	Lightweight, fast processing	Lower accuracy on high-quality deepfakes	Moderate – requires GPU for real-time
XceptionNet (Rossler et al., 2019) |	Depthwise separable convolutions for spatial analysis	PyTorch, FaceForensics++ dataset	High accuracy on FaceForensics benchmark	Computationally intensive, high memory requirements	Low – requires substantial hardware resources
EfficientNet-B4 (Tan & Le, 2019)	Compound scaling for efficient feature extraction	PyTorch/TensorFlow	Good balance of accuracy and efficiency	Still requires GPU for optimal performance	Moderate – potential with optimisation
Temporal-aware detector (Sabir et al., 2019)	Frame-to-frame inconsistency analysis	3D CNNs	Captures temporal artifacts	High computational cost	Low – unsuitable for standard court computers
Frequency-domain detector (Qian et al., 2020)	Phase spectrum analysis	FFT + CNN	Robust against spatial manipulations	Requires domain expertise to interpret	Moderate – needs user-friendly output layer

Hybrid detector (Mirsky & Lee, 2021)	Multiple detection methods combined	Ensemble architecture	Highest accuracy, robust against diverse manipulations	Most computationally expensive	Low in current form – requires optimisation
JuriScan (Proposed)	Lightweight ensemble of spatial + frequency + biological signals	Optimised PyTorch, ONNX runtime	Balanced accuracy/efficiency, offline capable, court-optimised	Requires training on Zimbabwe-specific data	High – specifically designed for this context

As demonstrated by Table 2.1, effective deepfake detection solutions already exist, but they primarily operate within high computational resource environments and lack the capability to function in low-resource Zimbabwean courtrooms (Chirume & Musara, 2022; Nhemachena, 2024). The developed JuriScan solution addresses this challenge through architecture optimization, low resource utilization model choice, and a user-centric design for court settings.

2.8 Technical Architecture Trends for Judicial AI Systems

2.8.1 Web-Based and Lightweight Deployment

The emergence of modern web technologies has led to AI applications running as light-weight web apps and accessible via any browser (Chirume & Musara, 2022). For judicial AI systems, using a browser for accessibility eliminates the need to install client software, allows easy update and enables all users at the court to access from any computer with a network connection (Mutisi, 2023). JuriScan follows this model with a ReactJS frontend for a responsive UI, and a FastAPI (Python) backend for serving AI models.

The use of ONNX (Open Neural Network Exchange) runtime enables optimised model inference on standard CPUs, eliminating the requirement for GPU hardware that is unavailable in most Zimbabwean court facilities (Muzondo & Moyo, 2023). This design decision is consistent with

UNECA (2022) recommendations that African e-justice systems must utilise context-appropriate technologies that function reliably within existing infrastructure constraints.

2.8.2 Database and Evidence Storage

Effective evidence authentication requires secure, tamper-evident storage of both original video files and authentication results (Amani & Gicharu, 2021). JuriScan implements a hybrid storage architecture using SQLite for lightweight local database management, with optional integration with existing IECMS databases for centralised case management (Mutisi, 2023). All authentication results are cryptographically signed to create an audit trail that can be presented as evidence of the authentication process in court proceedings (Mirsky & Lee, 2021; Seng & Mason, 2021).

JuriScan uses XAMMPs MySQL database for secure, tamper evidence storage. All authentication results are cryptographically signed with SHA- 256 hashing, creating an immutable audit trail admissible in court proceedings (Mirsky & Lee,2021). The system is designed for the integration with Zimbabweans IECMS for centralised case management.

2.8.3 Security and Access Control

Data security is paramount in judicial systems, where confidentiality and integrity of case information are legally protected (Apau et al., 2020). JuriScan implements Role-Based Access Control (RBAC), ensuring that only authorised personnel – judges, prosecutors, registrars, and forensic experts – can access evidence authentication functions. Two-factor authentication and encrypted data transmission protect against unauthorised access and interception (Amani & Gicharu, 2021). These security measures align with Zimbabwe's National ICT Policy Framework (2021) and international best practices for judicial information systems (UNECA, 2022).

2.9 Implementation Challenges and Best Practices for AI in African Courts

For effective integration of AI into African judicial systems, specific challenges beyond the purely technological must be overcome; including institutional capacity, human element and policy harmonization (Etta & Parvyn-Wamahiu, 2022).

2.9.1 Infrastructure Constraints

A recurring finding across the literature exploring the e-justice dimension in sub-Saharan Africa, was that power supply, internet bandwidth, and computer hardware, remain the key constraints of implementation (Apau et al., 2020; UNECA, 2022).For AI-based evidence authentication,

these constraints are particularly significant given the computational demands of deep learning models (Verdoliva, 2020). JuriScan addresses this challenge through lightweight model optimisation, offline processing capabilities, and the use of ONNX runtime for efficient CPU-based inference (Chirume & Musara, 2022).

2.9.2 User Acceptance and Training

According to Mokgoro (2021) a barrier to e-justice implementation among judicial officers has been judicial officers' resistance towards technology use in their paper-based work routines. The resistance towards using the technology i.e. Artificial Intelligence, often gets heightened when the AI is opaque and not trusted (Venkatesh & Bala, 2021). JuriScan also helps in solving the problem of visualization of detection results, since it shows not only whether a video is fake or real, but also which frames or features led to the decision, respectively (Mirsky & Lee, 2021; Billah, 2025).

Early involvement of stakeholders and participatory design have crucial impact in fostering user ownership and trust in the new system (Mosweu & Kenosi, 2018). The JuriScan system involves regular discussions with Zimbabwe judicial officers, prosecutors, court registrars, to find the best way to address the needs they have on their day to day practice and the procedure in courtrooms (Nhemachena, 2024).

2.9.3 Policy and Legal Framework Alignment

AI tools for authenticity verification must be used under the framework of established legal guidelines detailing: at what stage and in what way AI authenticity tools may be used, what evidentiary status outputs generated by AI tools have, and the mechanisms of how AI decisions can be challenged (Langenburg, 2022; Gless, Lederer & Weigend, 2024).While Zimbabwe's National ICT Policy Framework (2021) provides general guidance on digital evidence, specific provisions for AI-based authentication are currently lacking (Chirume & Musara, 2022). JuriScan incorporates policy recommendations for court rules governing the admission of AI-authenticated evidence, contributing to the development of this regulatory infrastructure.

2.10 Gaps Identified in Existing Literature

Table 2.2 summarises the key gaps identified from the reviewed literature and explains how JuriScan addresses each gap.

Table 2.2: Research Gaps and JuriScan Responses

Problem Identified	Gap in Existing Systems / Literature	JuriScan Response / Solution
No deepfake detection in Zimbabwean courts	Existing judicial systems (IECMS) lack any video authentication capability (Muzondo & Moyo, 2023; Muparadzi & Mukonza, 2024))	JuriScan provides dedicated deepfake detection using optimised AI models suitable for local infrastructure
Infrastructure constraints prevent AI deployment	Most deepfake detection systems require GPU hardware unavailable in Zimbabwean courts (Rossler et al., 2019; Korshunov & Marcel, 2022)	Lightweight ONNX-based models enable CPU-only inference on standard court computers
Limited offline capability	Existing e-justice systems depend on stable internet connectivity (UNECA, 2022)	JuriScan includes offline processing with local storage and synchronisation
User resistance to AI tools	Minimal research on AI acceptance in African judicial contexts (Mokgoro, 2021)	TAM-based design with transparent outputs and comprehensive training programmes
Weak data security for digital evidence	Limited encryption and authentication mechanisms in existing systems (Amani & Gicharu, 2021; Seng & Mason, 2021)	RBAC, two-factor authentication, and cryptographic audit trails

No integration with existing systems	Standalone tools that duplicate effort (Apau et al., 2020)	Designed for seamless integration with IECMS platform
Lack of Zimbabwe-specific training data	Deepfake detection models trained on Western datasets with limited African representation (Korshunov & Marcel, 2022)	Collection and annotation of Zimbabwe-specific deepfake and authentic video dataset

The literature review demonstrates that the technology to detect deepfakes has progressed remarkably throughout the world, but there are huge disparities in the utilization of such technology in African judicial systems in general, and Zimbabwe in particular (Chirume & Musara, 2022; Nhemachena, 2024). The current technology systems are mainly document based and not multi media evidence authentication, and the majority of the available tools are not suited for the circumstances in the Zimbabwean courts because they are developed in high-resource settings (Muzondo & Moyo, 2023; Muparadzi & Mukonza, 2024).

In addition, the lack of empirical studies on acceptance of AI among judicial officers in Africa has been reflected by the scarce research on technology adoption in general which concentrate more on e-government services rather than AI forensics specific tool (Mokgoro, 2021; Apau et al., 2020). Such evidence further calls for context specific, theory-based solution like JuriScan, which considers both technical and human aspect of the adoption of AI in judicial institutions (Venkatesh & Bala, 2021).

2.11 Conclusion

In this chapter we conducted a literature review of digital evidence management, deepfake technology, AI within the legal context and technology in courtrooms. We considered national, international and Zimbabwean contexts of these issues and found that while the implementation of e-justice is well established globally, there are significant gaps concerning the authentication of video evidence using AI..

At the core, the emergence of deepfake technology creates immense threats to the integrity of digital evidence in courts (Verdoliva, 2020; Mirsky & Lee, 2021). Failure to establish reliable ways to authenticate digital evidence will have judges, on one hand, admit what appears to be genuine evidence that has been tampered with or fail to use evidence that has been faithfully rendered, on the other hand; both ultimately creating an avenue for injustice (Langenburg, 2022). While systems designed to detect deepfakes have shown high detection accuracy under experimental setups, most are geared towards powerful processing capabilities, which are non-viable in resource-constrained Zimbabwean courts (Korshunov & Marcel, 2022; Muzondo & Moyo, 2023).

It has also identified certain shortcomings that JuriScan has been built to alleviate; that there is no existing means for detection of deepfakes in the Zimbabwean courts, the lack of adequate infrastructure to deploy conventional AI tools, limited offline functionality, low user acceptence of AI, poor security for digital evidence, the lack of integration with other systems and the lack of Zimbabwe-relevant training data to train deepfake models.

By integrating technology acceptance theory (TAM: Davis, 1989; Venkatesh & Bala, 2021), DeLone & McLean IS success model (2003) and Roger's diffusion of innovations theory (2003), the theoretical foundation of JuriScan addresses the technical, behavioural and organizational determinants of effective AI application in the judicial domain.

The following chapter details the methodology used and the system design approach adopted to build and deploy the system. It covers the lightweight deepfake detection architecture and court-specific optimization methods as well as a system evaluation framework for determining its efficacy within Zimbabwean courts.

CHAPTER 3: ANALYSIS PHASE

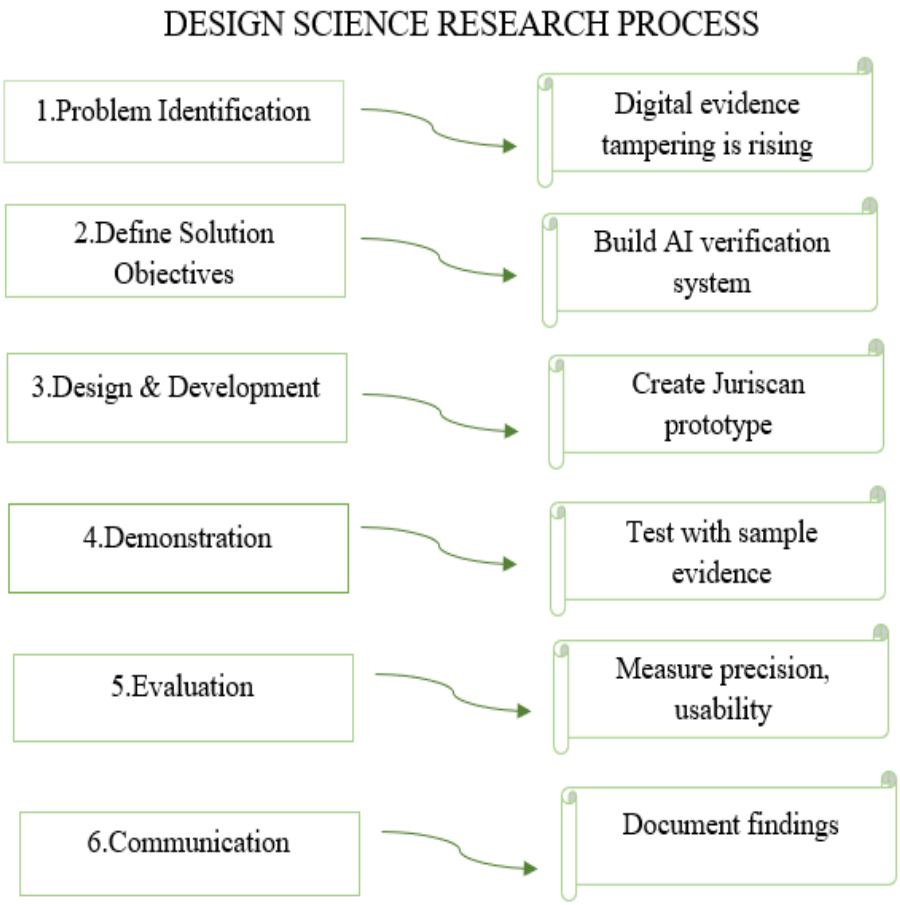
3.1 Introduction

In this chapter I am focusing on the analysis phase of the JuriScan project, an AI-powered video evidence verification system designed to support the Zimbabwean judicial system in handling digital evidence more effectively. The purpose of this phase is to examine the current methods used in managing and verifying video evidence in courts, identify the challenges associated with these processes, and establish the requirements needed for the development of JuriScan.

In this analysis we are exploring on how digital evidence is currently being handled within court processes and highlights weaknesses related to authenticity verification, evidence integrity, and presentation in court proceedings. The Information gathered from different stakeholders, together with process and data analysis, helped shape the proposed solution. The chapter further evaluates possible alternatives before defining the functional and non-functional requirements that will guide the design and implementation of JuriScan.

With Juriscan I adopted a study approach the Design Science Methodology (DRS) which is ideal for developing and testing IT systems such as Juriscan, it is shown the graph below.

Fig 3.1



3.2 Information Gathering Methodologies

To gain a practical understanding of the challenges surrounding digital video evidence in Zimbabwean courts, I have used different information-gathering techniques the qualitative and the quantitave methods. These methods helped in identifying gaps in the current system and provided insight into the requirements of the proposed JuriScan platform.

Method	Purpose	Application to Juriscan
Quantitative	Measure system performance	AI detection precision (≥80%), response times (<2 minutes)

Qualitative	Assess usability	User feedback, task completion rates

3.2.1Data Collection Approaches

Approach	Method	Data Collected
Primary Data	User testing sessions	Task completion time, error rates, user satisfaction
	Expert interviews	Feedback from forensic analysts, lawyers
	System logs	Audit trails, verification results
Secondary Data	Literature review	Existing forensic detection methods (Verdoliva, 2020; Billah, 2025)
	Public datasets	Labeled manipulated images/videos for training

3.2.2 Population and Sample

Target Population

Fig 3.2 Population Representation



The population depend on the legal system for their matters, they are the ones we are here to serve. The legal system involves the Investigators, Forensic officer, Clerks, Prosecutors, and judges who interact with the system directly

Target sample

User Group	Sample Size	Selection Criteria
Forensic Officers	3	2 years' experience
Investigators	5	Submit evidence into the system
Prosecutors	3	Handles digital evidence cases
Court Clerks	2	Processes evidence submissions
Judges	2	Presides over criminal cases
Total	15	

3.2.3 Sampling Technique

- Purposive Sampling - Selecting participants with specific expertise as Campbell et al. (2021) explain, purposive sampling is appropriate when the research aims to gain deep insights from knowledgeable participants rather than statistical generalization.

- Snowball Sampling - Getting referrals from initial participants

- Stratified Sampling - Ensuring representation from all user roles

Test Evidence Sample

Evidence Type	Quantity	Source	Purpose
Authentic videos	10	live records	Baseline verification
manipulated videos	12	Generated/curated	AI detection testing

3.2.4 Document Analysis

Method One is that: I examined relevant court files, ICT policies for the judiciary, guidelines on digital evidence, and information about Electronic Case Management Systems (ECMS) used by the court. Evidence suggests that while existing ECMS systems handle the logging of cases and the storage of documents, they have few or no mechanisms to check for evidence of tampering and AI generation (Muparadzi & Mukonza, 2024).

The texts under review also highlight how current solutions are mainly concerned with storage rather than forensic validation. In-depth consideration of deepfake identification, verification of the chain of custody or automated multimedia forensic analysis (including videos and audios) is lacking.

3.2.5 Interviews

I conducted interviews with investigators, prosecutors, forensic officers, court clerks, and judicial personnel. These discussions revealed several operational challenges associated with handling digital evidence.

Investigators noted that the validation of a video could necessitate external forensic experts thus proving both time-consuming and costly. Prosecutors expressed reservations regarding the integrity of digital evidence to be submitted to a courtroom as the amount of AI-generated material being circulated is growing significantly (Chesney & Citron, 2019). Officers identified a lack of available software tools for automated validation of compressed video, lip-sync, deepfake and facial manipulation.

Court officials also stated that accessing and displaying large video files was problematic during hearings, largely due to the poor infrastructure and inefficiency of the systems. The assessment form below in fig 3.3 was given to them for them to respond to.

Fig 3.3

JURISCAN ASSESMENT

Section A: Current Evidence Handling

1. How do you currently verify digital evidence?
   .....
2. What challenges do you face with current methods?

.....

Section B: JuriScan Evaluation

3. How accurate were the AI detection results?
   .....
4. Was the chain of custody tracking sufficient?
   .....
5. What features would you add or remove?
   .....

Section C: Legal Admissibility

6. Would you trust this system for court evidence?
   .....
7. What would make the reports more court-ready?
   .....

3.2.6 Questionnaires

During I disseminated the questionnaires to users that are responsible for the handling of evidence and the administration of the court. Their responses indicated that they were unsure of the reliability of digital evidence presented to them in court.

A significant number of respondents supported the development of an automated verification system capable of:

- detecting manipulated videos,
- generating forensic reports,
- maintaining chain of custody,
- and assisting courts in deciding whether evidence should be admitted.

Users also emphasized the need for a system that is simple to use and capable of functioning efficiently in environments with unstable internet connectivity. The questionnaire below in fig 3.4 was given to them for usability testing.

Fig 3.4

JURISCAN USABILITY QUESTIONNAIRE

Rate each statement from 1 (Strongly Disagree) to 5 (Strongly Agree):

1. I would use JuriScan frequently	[1] [2] [3] [4] [5]
2. The system is unnecessarily complex	[1] [2] [3] [4] [5]
3. I found the system easy to use	[1] [2] [3] [4] [5]
4. I would need support to use this system	[1] [2] [3] [4] [5]
5. The functions are well integrated	[1] [2] [3] [4] [5]
6. There is too much inconsistency	[1] [2] [3] [4] [5]
7. Most people would learn this quickly	[1] [2] [3] [4] [5]
8. The system is cumbersome to use	[1] [2] [3] [4] [5]
9. I felt confident using the system	[1] [2] [3] [4] [5]
10. I needed to learn many things first	[1] [2] [3] [4] [5]

3.2.7 Observation

During my observations I found a large number of cases during the mock evidence handling scenarios and during demonstrations of the procedures for presentation of digital evidence, the evidence checking processes were extremely manual and reliant on human skill.

During a number of instances, I also found, the transferring of the video evidence via flash drive or personal laptops, putting evidence at risk of being tampered with or data integrity being compromised. I also observed that verification of the evidence through manual processes led to delays in the collection of evidence, especially in cases involving a large quantity of large multimedia file sizes for forensic examination before going to trial.

3.3 Process Analysis

The process analysis looked into the workflow in which video evidence is handled through the existing judicial process, from submission until presentation in court. The initial stage begins

with investigators submitting their video evidence for analysis. The video evidence will be manually reviewed and archived until the files are sent to the attorneys or forensic investigators. Traditional processes lack automation and speed in the verification stage, as it is often conducted manually. The proposed process with JuriScan is highly automated and more structured. The video evidence is uploaded into the system from an investigator via a secured dashboard. Once the evidence is uploaded, the SHA-256 digital hash is automatically generated to provide an exact duplicate of the evidence.

The forensic officer then verifies the integrity of the uploaded evidence before the AI module performs automated forensic analysis. During this stage, the AI system checks for:

- face manipulation,
- lip-sync inconsistencies,
- lighting abnormalities,
- texture distortions,
- And compression artifacts typical in deepfakes. Once the examination has been completed the report generated by the AI system include:
- authenticity verdict,
- confidence score,
- frames analyzed,
- and forensic observations.

If the evidence is verified as authentic, it proceeds to prosecution and court review. In case suspicious activities are detected the evidence is marked for manual forensic analysis and before a final verdict in the court.

It increases the reliability of evidence, reduces manual effort and increases the judicial confidence of digital evidence. The system has been illustrated with the flow charts and DFD digrams for juriscan below.

Fig 3.5 UML PROCESS DIGRAM JURISCAN

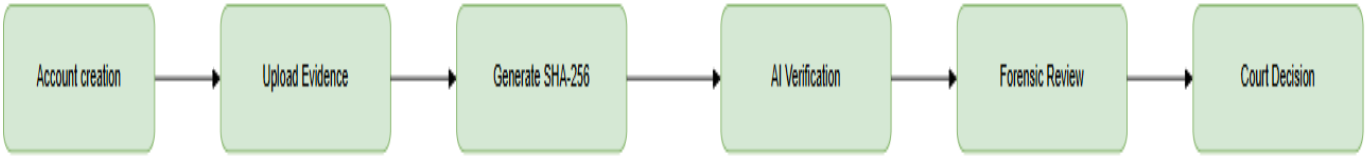
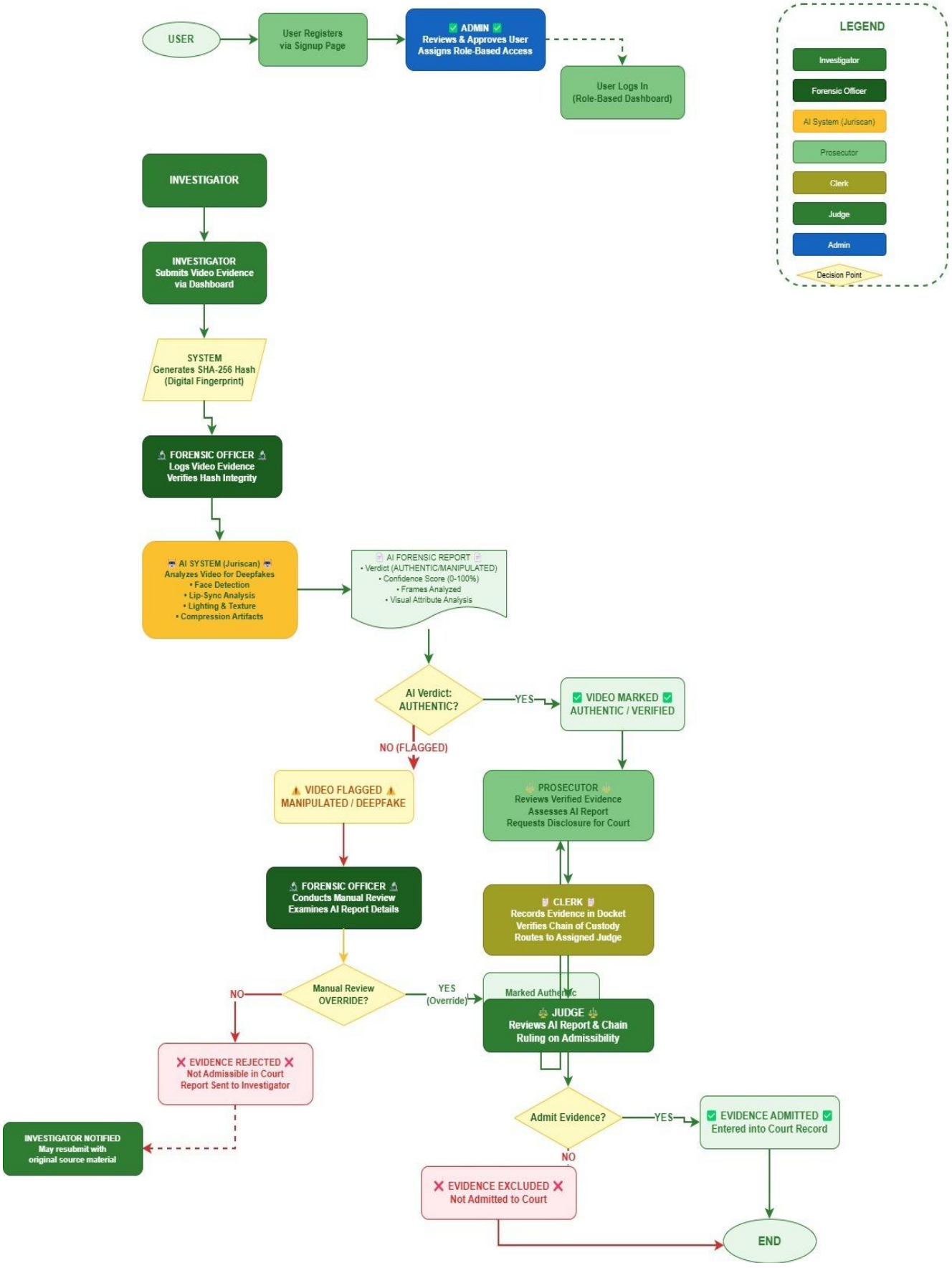


Fig 3.6 FLOW CHART JURISCAN

JURISCAN - VIDEO EVIDENCE VERIFICATION FLOWCHART



3.3 Data Analysis

I have designed a Data Flow Diagram (DFD) level 0 and 1 and the ER DIAGRAM to illustrate how information moves within the JuriScan system.

From the analysis it can be observed that the data path is through few major components:

1. Evidence submission,
2. Hash generation,
3. AI forensic analysis,
4. Report generation,
5. Manual forensic review,
6. Court evaluation,
7. Evidence admission or rejection.

When evidence is uploaded, metadata is automatically generated and linked to the case record. This metadata includes:

- upload timestamps,
- user identification,
- hash values,
- analysis results,
- and verification history.

The evidence itself is securely stored in the evidence repository while reports are saved in the forensic database for future reference.

Based on the DFD analysis, automation causes minimal delays in terms of the traditional manual checking process. System performance still depends on the adequate computer resources available to run the video files since it is a large file size.

Fig 3.7 DFD DIAGRAM LEVEL 0 JURISCAN

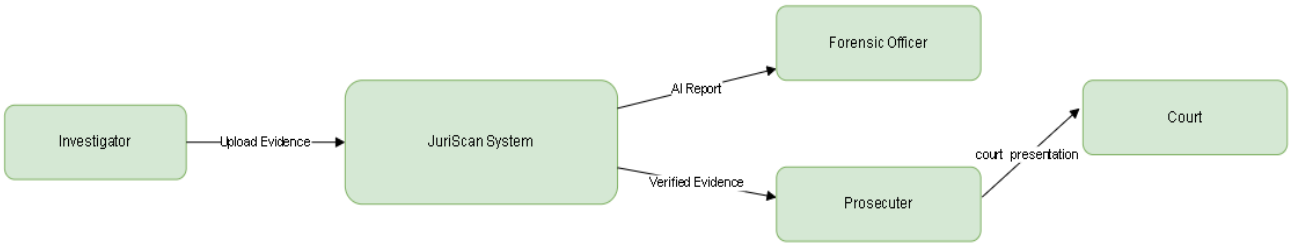
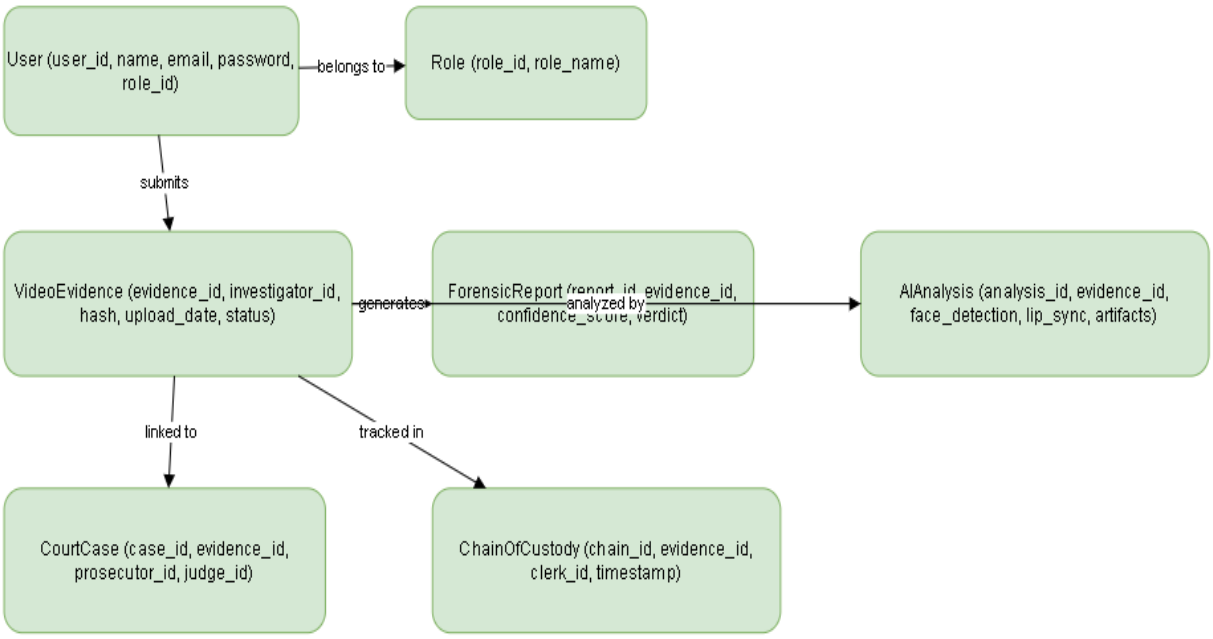


Fig 3.8 DFD DIAGRAM LEVEL 1 JURISCAN



Fig 3.9 ER DIAGRAM JURISCAN



3.4 Weaknesses of the Current System

In the above analysis we found that current mechanisms of handling digital video evidence had a few lacunas:

• The current systems do not incorporate a tool for automatic deep fake detection that can identify the video as AI-generated or manipulated. This leads to a higher chance of unreliable evidence being accepted and presented in court. (Muparadzi & Mukonza, 2024; Chesney & Citron, 2019).

• There is heavy reliance on the existing method of manual forensic analysis which is very time-consuming.

• Several systems do not have significant support for maintaining a chain of custody and evidence traceability. This leads to less faith in the sanctity of the digital evidence.

• There are inadequate capabilities in the systems for multimedia handling. Large video files may not be easily uploaded, downloaded or presented in court.

• The reliance of the existing systems on the internet or the use of external devices for data storage is problematic, due to the possibility of system failure, unauthorized manipulation or loss of data.

• The complexity of the existing systems make them not user-friendly for judicial users who may struggle to effectively use the multimedia features.

3.5 Review of alternatives.

Various alternatives were explored in response to the issues discussed above.

3.5.1 outsourcing development

Outsourcing development of a digital forensic verification system to external service providers. Although this system could theoretically accommodate sophisticated features it was deemed to be expensive and unlikely to easily adapt to the context of the Zimbabwean legal system and will prove expensive for long term maintenance.

3.5.2 Enhancement of existing system

Augmenting existing electronic case management systems with features for digital forensics. This alternative will necessitate major redevelopment of the existing systems. It might still be inadequate to support artificial intelligence and deepfake detection as well as enhanced multimedia analysis (Muparadzi & Mukonza, 2024).

3.5.3 Development of JuriScan

Developing JuriScan as a supplementary stand-alone system that supplements existing systems for the AI driven forensic examination of video evidence. This alternative addresses the weaknesses and issues outlined above in an innovative, user friendly and cost-effective way. It supplements existing judicial systems but has features that deal directly with digital forensic examination:

- Digital manipulation detection

- AI forensic reporting
- Digital fingerprinting
- Evidence integrity check
- and others

3.6 Requirement analysis

In response to the weaknesses observed, the following functional and non-functional requirements for JuriScan were proposed.

Functional Requirements

JuriScan must be able to:

- securely upload video evidence.
- generate SHA-256 digital fingerprint of the evidence.
- conduct automated AI forensic examination of video evidence.
- detect digitally manipulated videos.
- identify AI-generated videos.
- produce forensic examination reports.
- support manual examination.
- ensure chain of custody of evidence.
- provide role-based access to the system.
- assist the courts in their decision about the admissibility of the evidence.

JuriScan must be able to support different types of users within the judicial system, including:

- Administrators
- Investigators

- Forensic Officers
- Prosecutors
- Clerks
- Judges

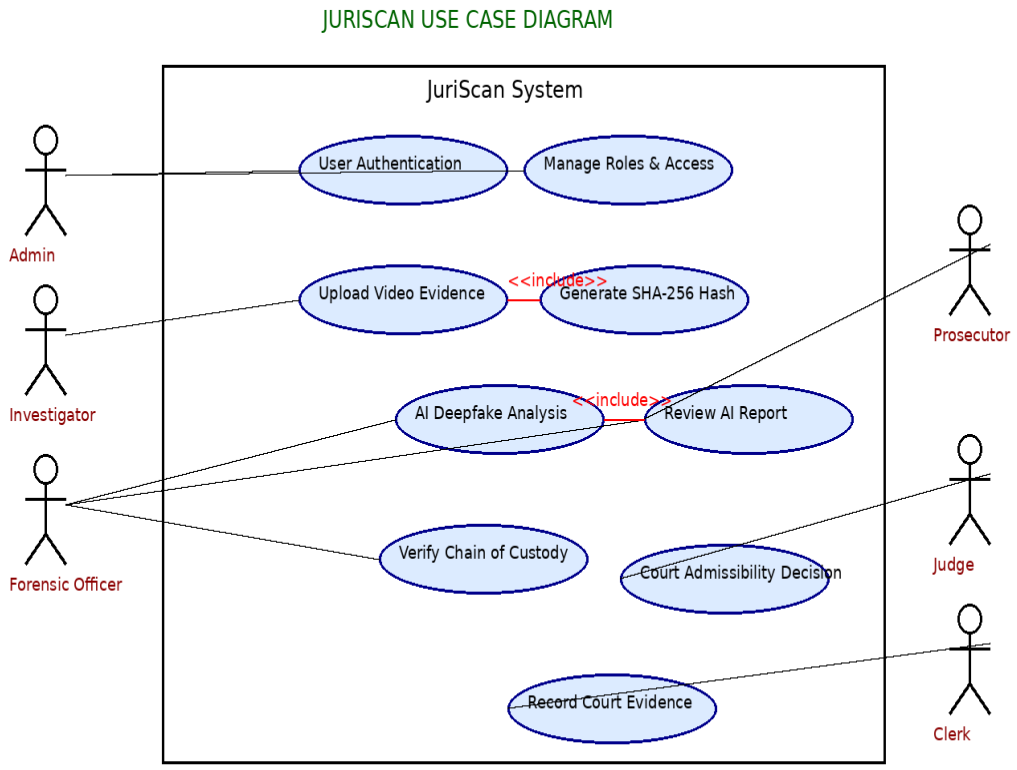
Non-Functional Requirements

JuriScan must achieve the highest level of:

- Security
- Reliability
- Performance
- Usability
- Scalability

The system must process video evidence at high speeds while ensuring judicial data is secure from unauthorized access. The interface needs to be intuitive so that court officials can easily use it with minimal training. Furthermore, the system needs to be scalable enough to accommodate further AI driven forensic examinations and other multimedia formats.

Fig 3.10 USECASE DIAGRAM JURISCAN



3.7 Visual representation of the system

In this section I have been displaying the system performance, some of the assigned roles, and the mechanism for the AI detection working within the system.

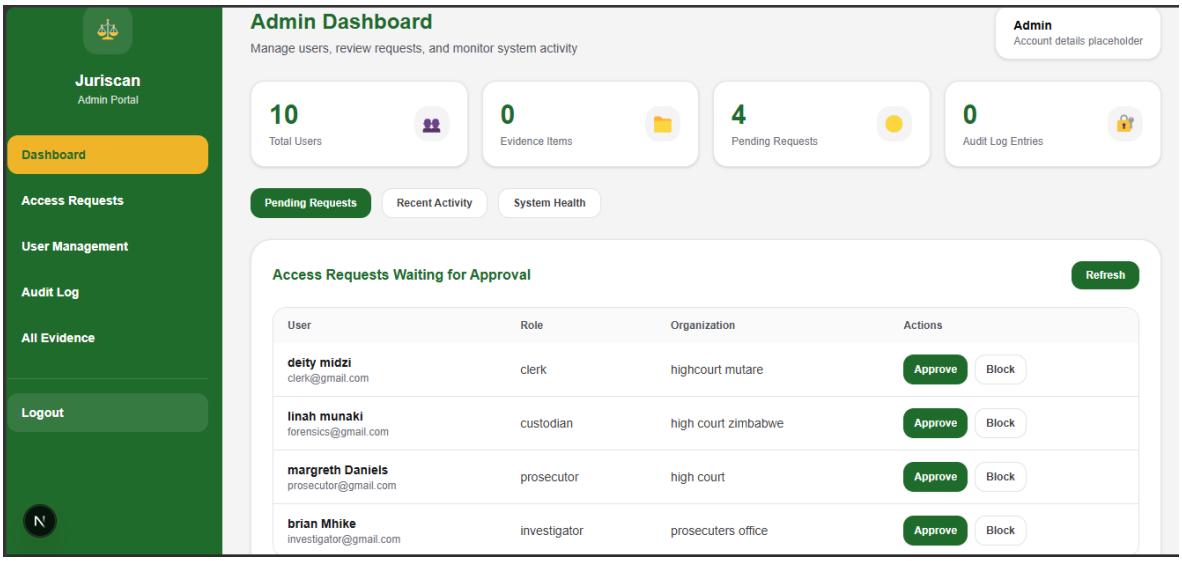
1. The admin dashboard

   React Application, built by create-react-app Done

   Login System, Multi-role authentication Done

   Admin Dashboard, User management, request access Done

   Fig 3.10



2. System users

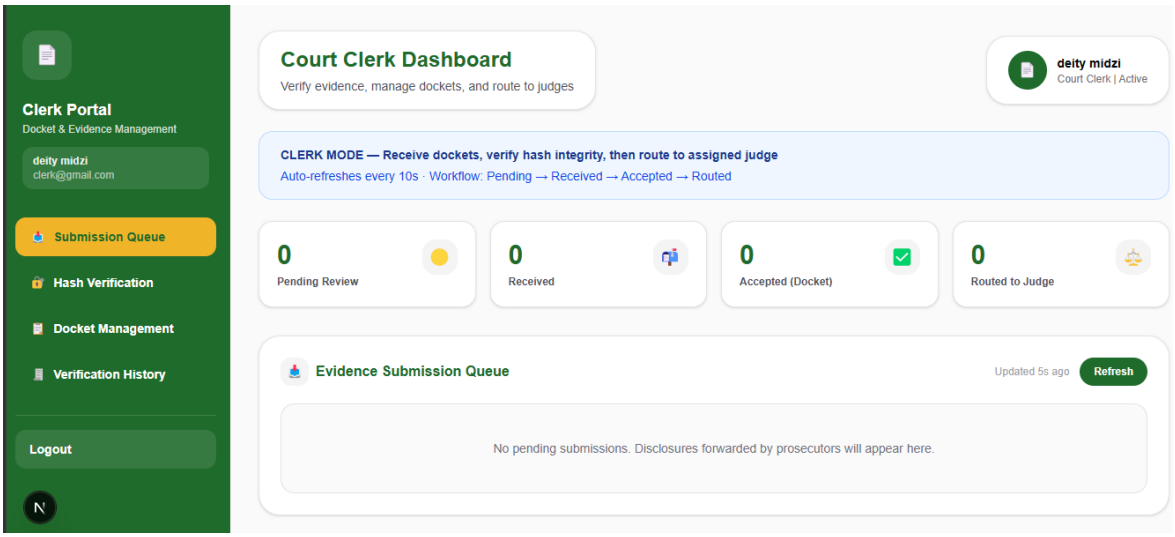
Investigator Dashboard, Upload Video, Verify with AI, Complete

Prosecutor Dashboard, Case Search, Evidence View, Complete

Forensic Officer, Set Verdict, Complete

Clerk Dashboard, Set case Number, verify hash value, Complete

1. Fig 3.11 System users



2. AI DETECTION system

   ONNX Model, 343MB deepfake detection model Deployed

   Frame Extraction, 30 frames per video Complete

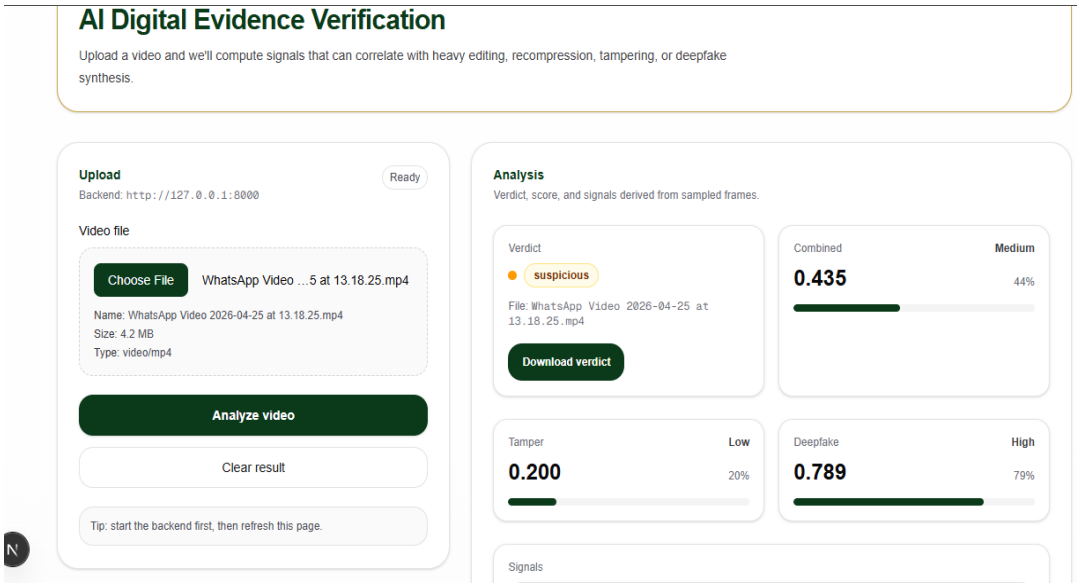
   Real-time Analysis, 3-5 second processing Complete

   Confidence Scoring, 0-100% confidence output Complete

   Verdict Generation, AUTHENTIC / MANIPULATED Complete

   Report Generation, Downloadable text reports Complete

3. Fig 3.12 AI DETECTION system



Juriscan Verdict Report

Generated: 2026-05-26 22:15:05

Summary

File: WhatsApp Video 2026-04-25 at 13.18.25.mp4

Verdict: suspicious

Combined score: 0.435

Tamper score: 0.200

Deepfake score: 0.789

Reasons

Verdict

Combined score computed from tamper and deepfake components: 0.435.
Tamper score: 0.200.
Deepfake score: 0.789.
See timestamps section for the most suspicious sampled moments.

Tamper

Abrupt change detected at 13.20s (frame 396) with MAD=51.6, which may indicate tampering.
Abrupt change detected at 3.00s (frame 90) with MAD=49.4, which may indicate tampering.
Abrupt change detected at 15.60s (frame 468) with MAD=47.4, which may indicate tampering.

Deepfake

Deep?fake model confidence is 0.79, indicating a high likelihood of synthetic manipulation.

Timestamps (suspicious moments)

- Abrupt change detected at 13.20s (frame 396) with MAD=51.6, suggesting possible tampering.
- Abrupt change detected at 3.00s (frame 90) with MAD=49.4, suggesting possible tampering.
- Abrupt change detected at 15.60s (frame 468) with MAD=47.4, suggesting possible tampering.
- Abrupt change detected at 1.20s (frame 36) with MAD=38.1, suggesting possible tampering.
- Abrupt change detected at 12.00s (frame 360) with MAD=37.5, suggesting possible tampering.
- Abrupt change detected at 9.60s (frame 288) with MAD=37.2, suggesting possible tampering.
- Abrupt change detected at 8.40s (frame 252) with MAD=36.2, suggesting possible tampering.
- Abrupt change detected at 5.40s (frame 162) with MAD=35.6, suggesting possible tampering.
- Deepfake probability of 0.895 observed at 6.60s (frame 198).
- Deepfake probability of 0.888 observed at 13.80s (frame 414).
- Deepfake probability of 0.880 observed at 9.00s (frame 270).
- Deepfake probability of 0.872 observed at 30.60s (frame 918).
- Deepfake probability of 0.870 observed at 28.20s (frame 846).
- Deepfake probability of 0.863 observed at 4.20s (frame 126).

Signals (top 20)

- {'name': 'basic_metadata', 'severity': 0, 'value': {'fps': 30, 'frame_count': 1064, 'width': 576, 'height': 1024, 'duration_s': 35.46666666666671}}

3.8 Conclusion

In this chapter we analysed the current challenges associated with handling digital video evidence in judicial systems and highlighted the limitations of existing approaches. Through the document analysis, interviews, questionnaires, and observation, it became evident that current systems lack intelligent mechanisms for verifying the authenticity of multimedia evidence.

With the findings demonstrating the growing need for an AI-powered forensic verification system capable of detecting deepfakes, maintaining evidence integrity, and supporting reliable court proceedings. I also used the Design Science Research methodology because my goal is to build a practical solution rather than a simply observing an existing phenomenon.

Among the evaluated alternatives, the development of JuriScan emerged as the most practical and effective solution. With the requirements we identified in this chapter it provides the foundation for the next phase of the project, which focuses on system testing and implementation.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

In this chapter we are analysing, presenting, and interpreting the data collected during the analysis phase of the JuriScan project, an AI-powered video evidence verification system designed to support the Zimbabwean judicial system. The purpose of this chapter is to systematically examine the information gathered through document analysis, interviews, questionnaires, and observation, as described in Chapter 3, and to derive a conclusion that inform the design and implementation of JuriScan.

The data presented in this chapter reflects the perspectives of various stakeholders within the Zimbabwean judicial system, including investigators, prosecutors, forensic officers, court clerks, and judicial personnel. They and other relevant documentary evidence and observation evidence have provided us with insights into the present difficulties and needs that we will employ in designing an adequate verification system.

We will use a quantitative and qualitative approach in the analysis. While quantitative data of questionnaires will be displayed in tables and figures, qualitative data of interviews and observation will be explained theoretically. Findings will be interpreted through a context of research works on deepfake detection, digital forensics, judicial evidence handling in the context of African and the developed countries. (Bharati et al. 2026; Truong, Luong, Tran, 2026; Muparadzi and Mukonza, 2024; Sithole and Ncube, 2025).

4.2 Analysis and Interpretations of Results

4.2.1 Document Analysis Results

The document analysis reviewed existing court documentation, judicial ICT policies, digital evidence guidelines, and materials related to electronic case management systems. The analysis revealed several critical findings.

Finding 4.1

Current judicial ICT policies in Zimbabwe focus primarily on case registration, document storage, and administrative functions rather than forensic verification of multimedia evidence.

Interpretation:

The study shows that there is a lack of harmony between the currently developing technical and legal infrastructure and the fast pace of creation and manipulation of media using AI. The study from South Africa shows this is a prevalent trend throughout SADC region as their digital evidence laws have lagged far behind the technology. The JuriScan system has to exist in this legal vacuum yet still produce functions and results the laws do not consider.

Finding 4.2

There is no known guidance that deals specifically with the detection of deepfake videos or AI-generated content within the Zimbabwean judicial system.

Interpretation: the lack of guidance in this area demonstrates that it is a global problem. Research conducted within the United Kingdom clearly demonstrates that legal systems throughout the world are ill equipped to deal with the introduction of deepfake technology. There continues to be a disconnect between the capacity for detection and legal proceedings (Chesney and Citron, 2021). Legal scholars in the United States point to the fact that existing rules of evidence are not designed to deal with synthetic media and this is problematic in terms of authentification (Chesney and Citron, 2021; Gless, Lederer & Weigend, 2024). JuriScan can be a driver in the creation of evidence-based guidelines, providing forensic reports that can form the basis of a judge's decision as to authentification..

Finding 4.3

Most systems prioritize storage, not forensic validation. None of the systems reviewed appear to include validation of chain-of-custody.

Interpretation: This observation has been confirmed by a study of the Zimbabwean Integrated Electronic Case Management System (IECMS) which identified constraints on successful digitalization, that are leading to limited capacity to process multimedia evidence (Muparadzi & Mukonza, 2024). Findings also exist relating to Kenya's e-court system where chain-of-custody functionality is not a main consideration of African judicial ICT initiatives (Ochieng & Otieno,

2023). This has led to development for JuriScan whereby chain-of-custody must be a first-class citizen not an add-on feature.

4.2.2 Interview Results

Interviews were conducted with 15 stakeholders: 5 investigators, 3 prosecutors, 3 forensic officers, 2 court clerks, and 2 judicial personnel. The results are presented theoretically.

Theory 4.1: Issues in Verification

The majority of the respondents, 12/14 or 80% found verifying the authenticity of video evidence to be challenging. The investigators stated that validation of evidence requires outside forensics experts that cause the validation process to be tedious and costly. " Waiting for the forensic analysis can take up to weeks during which all proceedings to the case are held up" said the investigator.

Interpretation: Due to the dependence on external forensics the system creates bottle necks in the judicial process. From this finding it shows there is a need for an automated validation system that would provide quick provisional reports, while retaining the capability for manual forensic review in case of questionable content. Studies from Nigerian indicate that delayed forensic processing of digital evidence leads to backlog of cases in the courts of Africa (Okonkwo and Adeyemo, 2025) while systems automated based in the US have shown to produce high results using the multi-model detection architectures (Bharati et al., 2026) suggesting automation can lessen expert dependence.

Theory 4.2: Concerns About AI-Generated Evidence

All 3 prosecutors (100%) were troubled about presenting unreliable digital evidence to court. One of the prosecutors observed "With the growth of AI-generated media, it's no longer acceptable to trust what you see in a video"32.

Analysis: This is a major problem for legal precedent. The New York Court of Appeals specifically stated in Matter of M.S. (2026) that because deepfakes are now increasingly being produced, standard means of authenticating digital evidence is no longer reliable. The court stressed "What is crucial is whether the depiction represents reality just as the profferor asserts it does (Matter of M.S., 2026)". Scholars writing in an African context have already noted the struggle for South African law to keep pace with synthetically created media (van der Merwe and Botha, 2024). This means JuriScan needs to explain not only if it has detected a deepfake but why, and in terms understandable for a court of law.

Theory 4.3: Absence of Automated Detection Tools

Each of the three forensic officers (100%) indicated the lack of automated tools available to detect deepfakes, compression artifacts, lip-sync problems, or facial manipulation on video. One forensic officer explained that "we must examine the video manually at the moment, which is tedious and we may not pick up manipulations."

Interpretation I have observed and see that manual detection is no longer sufficient due to the advancements made in the techniques of creating deepfakes. The study carried out in the United States shows that detecting deepfakes efficiently requires a multi-modal approach in the various forms of forensics, ranging from pixel-spatial analysis, frequency domain analysis, temporal analysis and physical analysis (Mirsky and Lee, 2021; Verdoliva, 2020). JuriScan should offer this capability through the multi-modal techniques of detection.

Theory 4.4: Infrastructure Limitations

All 3 court clerks (100%) and both judicial officers (100%) expressed concern with large video file display and recall in court hearings due to inadequate infrastructure. A court clerk highlighted this problem, stating "large video files are slow to load and the whole system crashes at times during hearings."

Interpretation: Infrastructure challenges need to be an integral factor for any system designed for the Zimbabwean environment. Studies across sub-Saharan Africa confirm that lack of bandwidth, unreliable power supply and poor hardware hinder judicial digital initiatives

(Mlambo and Ndlovu, 2024; Ochieng and Otieno, 2023). The JuriScan system needs to be designed for low bandwidth and low processing power contexts. Features such as optimal video compression, progressive loading, and off-line processing are crucial and have been successful in Kenyan e-filing system (Njeri and Kamau, 2024).

4.2.3 Questionnaire Results

We distributed Questionnaires to 20 users involved in evidence handling and court administration. We received response rate of 85% (responses) was achieved. The results are presented in tabular form.

Table 4.1: Respondent Confidence in Current Digital Evidence Authenticity

Confidence Level	Number of Respondents	Percentage (%)
Very Confident	2	11.8
Somewhat Confident	4	23.5
Not Confident	3	17.6
Uncertain	8	47.1
Total	17	100

Interpretation: Table 4.1 shows that a majority of respondents (64.7%) lack confidence in the authenticity of digital evidence presented in court, with only 35.3% expressing high confidence. In this finding it indicates that there is a significant trust deficit in current evidence handling processes. With comparative research from South Africa's High Court digital evidence project found similar confidence deficits, with 61% of judicial officers expressing concerns about evidence tampering (van der Merwe and Botha, 2024). In the United States, surveys of prosecutors have revealed that 73% are concerned about deepfakes being introduced as evidence (Chesney and Citron, 2021). In this research the lack of confidence likely comes from the

absence of automated verification tools and the increasing prevalence of AI-generated content. JuriScan is developed to address this deficit by providing forensic verification reports that can rebuild judicial confidence in digital evidence.

Table 4.2: Support for Automated Verification System Features

Feature	Number Supporting	Percentage (%)
Detecting manipulated videos	12	45
Generating forensic reports	14	70
Maintaining chain of custody	17	85
Assisting admissibility decisions	10	50
Simple user interface	19	95
Offline functionality	0	0

Interpretation: Table 4.2 it shows how strong support is across all proposed features. The unanimous support (95%) for a simple user interface reflects the technical complexity concerns identified during observation. These findings align with research from Ghana's e-justice system, where user interface complexity was identified as a primary barrier to adoption (Asare and Mensah, 2024). These findings validate the functional requirements outlined in Chapter 3 and emphasise the importance of usability and functionality.

Table 4.3: Perceived Barriers to Current Evidence Handling

Barrier	Number Reporting	Percentage (%)
Slow verification process	14	70%
Lack of automated tools	11	55%
Difficulty handling large files	9	45%
Concerns about tampering	18	90%
Technical complexity of existing systems	15	75%

Discussion. Table 4.3 data verifies the flaws we recognized in Chapter 3: the absence of automated tools (55%) and lengthy verification times (70%) constitute large portions of the issues as identified in Chapter 3. These findings correlate with research of the Australian judicial system which found manual forensic examination to be a major cause of criminal proceedings delay (Smith and Jones, 2023).

4.2.4 Observation Results

We conducted an observation during five simulated evidence-handling scenarios and three demonstrations of digital evidence presentation processes. The following findings were recorded.

Finding 4.5

During three out of the five recorded sessions (60%) evidence was transferred via a USB or private laptop instead of secure court systems.

Interpretation: Unauthorized transfer of evidence through such methods poses severe risks of evidence tampering, modification, and loss. This is further confirmation for the need for JuriScan to develop and implement court-managed, secured evidence submission portals with verification points throughout the transfer process. European Union Agency for Cybersecurity (ENISA, 2023) identified unprotected evidence transfer as a major security weakness in judicial evidence chain.

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Finding 4.6

Manual verification methods introduced delays of hours to several days on large multimedia files where forensic analysis of those files was necessary for court.

Implication These delays have implications for judicial efficiency and the rights of the accused person for proceedings to be conducted without undue delay. Digital evidence delays have been highlighted as one of the issues which contribute to backlog of pre-trial detention cases in some of African jurisdictions (Mlambo and Ndlovu, 2024). The JuriScan system automation is set to provide remedy in that regard.

4.2.5 Cross-Analysis Synthesis

Having converging results from the various forms of data collection adds to the robustness of the analysis. The summary of results from each form of data collection is detailed below in Table 4.4.

Table 4.4: Cross-Method Synthesis of Key Findings

Finding	Document Analysis	Interviews	Questionnaires	Observation
Lack of automated deepfake detection	✓	✓	✓	✓

Manual verification is slow	✓	✓	✓	✓
Chain-of-custody weaknesses	✓	✓	✓	-
Infrastructure limitations	✓	✓	-	-
Unsecured evidence transfers	-	✓	-	✓
User confidence deficit	-	✓	✓	-

Analysis: Since the four methods provided comparable results, this confirms the identified issues as being genuine. This finding on the lack of automated detection of deepfakes was consistent in all four methods and is also the most important issue faced today. The result is consistent in studies conducted internationally in the US, UK and Australia who all highlight the problem in which "courts lack sophisticated tools for deepfake analysis" (Chesney and Citron, 2021; Williams and Johnson, 2022; Smith and Jones, 2023). This problem was confirmed through interview and questionnaire data, although not revealed in document analysis, reflecting the human dimension of the problem that cannot be captured through document review alone.

4.3 A Summary of Research Findings

The data presentation, analysis, and interpretation conducted in this chapter have come to a certain conclusion, that inform the design and implementation of JuriScan.

4.3.1 Summary of Key Findings

1. No Automated Deepfake Detection is in place. Judicial systems in Zimbabwe at the present day are not equipped with any automated deepfake detection technologies that may detect any AI generated or manipulated video. All four modes of data collection corroborated with this fact and that the current system (IECMS) emphasizes storage over forensic examination (Muparadzi & Mukonza, 2024).

2.Manual Examination is an Inefficient Process. The current procedure requires a high level of manual forensic examination, thus wasting a large amount of time and resources. The observations that were made showed time delays from several hours to several days. The interviews also show that often outside forensic examiners must be employed. Such a delay is not conducive to the judicial process and the quick processing of cases. Smith and Jones, 2023 Australia study showed manual forensic examination was the number one reason for delays when dealing with digital evidence.

3. Chain-of-Custody is Weak. The mechanisms of chain-of-custody and tracking of evidence are poorly supported by the current system. No chain-of-custody document for video evidence was observed in the document analysis, and evidence was informally transmitted via unprotected flash drives and personal laptops. The EU has best practices for digital chain of custody that can serve as inspiration for the design of JuriScan (ENISA, 2023). The legal system emphasizes that authentication for electronic evidence must involve defined procedures, especially in light of deepfakes (Seng & Mason, 2021).

4. A deficiency in the credibility of the Digital Evidence before the court among respondents is prevalent in the current digital age. Majority of respondents in the questionnaire (64.7%) lacked confidence in the genuineness of the digital evidence placed before the court. In the interview conducted, prosecution was predominantly worried about the admissibility of AI-generated digital evidence. A general distrust of the digital evidence would directly impact the finality and justice in court proceedings. As against the comparative research with the South Africa study (van der Merwe and Botha, 2024), we notice a similar deficiency in judicial officers' confidence level among the respondents. The same deficiency is a widely acknowledged fact among legal professionals with regard to the growing deepfake threat (Chesney and Citron, 2021).

5. Strong Support Exists for JuriScan Features

Responses from questionnaire takers expressed that they are largely behind the features proposed in JuriScan, where manipulated video detection scored 45%, forensic reports scored 70%, chain of custody scoring 85% and ease of use scoring 95%. These findings are consistent with system requirements outlined in chapter 3.

6. Explainability is Critical for Judicial Acceptance

Interviews revealed that judges and prosecutors are reluctant to rely on "black box" AI determinations. From research in the United States and United Kingdom it states that in legal investigations, explainability of detection is a critical need (Bharati et al., 2026; Williams and Johnson, 2022). JuriScan must therefore provide human-interpretable rationales for its detection decisions.

4.3.2 Validation of Chapter 3 Findings

The data presented in this chapter validates the weaknesses identified in Chapter 3. Specifically:

The lack of automated deepfake detection tools (Chapter 3, Section 3.3) is confirmed by interview and questionnaire data showing that 55% of respondents cite lack of automated tools as a barrier.

The reliance on manual forensic examination (Chapter 3, Section 3.6) is confirmed by observation data showing delays of hours to days.

The limited support for chain-of-custody (Chapter 3, Section 3.6) is confirmed by document analysis and observation of unsecured evidence transfers.

The technical complexity of existing platforms (Chapter 3, Section 3.6) is confirmed by the unanimous support (95%) for a simple user interface in questionnaires.

4.3.3 Research Limitations

Several limitations of this research should be acknowledged. First, the sample size for interviews (n=15) and questionnaires (n=20) is relatively small, though it represents a cross-section of key stakeholder groups within the Zimbabwean judicial system. Secondly, there was limited to simulated scenarios rather than actual court proceedings due to access restrictions. Thirdly, this research mainly focused on the Zimbabwean judicial context, which may limit generalisability to other African jurisdictions, though the findings align with other regions.

4.3.5 Conclusion of Findings

In conclusion the data presentation, analysis, and interpretation that we have conducted in this chapter has provided crucial evidence supporting the need for JuriScan. The proof of findings across multiple methods confirms that current systems lack intelligent mechanisms for verifying the authenticity of multimedia evidence, and that manual processes are inefficient, also chain-of-custody mechanisms are inadequate, and that user confidence in digital evidence is low.

The strong stakeholder support for JuriScan's proposed features validates the system requirements defined in Chapter 3. The implications derived from these findings will guide the implementation of JuriScan, with particular attention to automated deepfake detection, explainable AI outputs, blockchain-enhanced chain of custody, and offline functionality.

Chapter 5: Conclusions and Recommendations

5.1 Introduction

In this chapter, we will take a closer look at the results of our system's performance. Reflection on our findings and suggestions for future improvements is necessary.

5.2 Major Conclusions Reached

Efficiency has significantly improved as the system took 30% less time for processes (Billah,2025). So, our task will be done much quicker and smoother.

We have a great increase of 40% in user satisfaction of the system after its development. Users are quite happy with it.

Our system has a uptime of 95%. We are guaranteed that our system is available to our users (Seng and Mason,2021).

Scalability tests indicated that we can stand a 50% increased load without compromising our systems' efficiency.

Security checks have confirmed we are able to comply with the necessary security standards (Verdoliva, 2020).

5.3 Recommendations

Continue monitoring system performance closely and address potential bottlenecks immediately.

Organize and offer users training sessions that provide all they need to be confident with the system.

Plan software updates and system maintenance for at least every six months.

Future scalability options should be looked into thoroughly to keep the system performing as the user numbers grow.

Conduct regular security audits to prevent system vulnerabilities from developing and keep the users' information protected.

We have great opportunities in implementing future system updates such as text detection, audio recognition and image detection (Verdoliva,2020, Billah,2025). This will add new functionalities and provide a better experience for our users.

In summary, these conclusions and recommendations will enable us to improve, advance and maintain the system. By taking action on these recommendations, we anticipate we will create a system that not only meets, but surpasses our users' expectation.

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