AI Integrity Solutions for Deepfake Identification and Prevention

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Abstract

The increasing complexity of deepfake technology has sparked significant worries over individual privacy, the spread of false information, and deficiencies in cybersecurity. Deepfakes have the ability to effectively modify audio and visual content, resulting in a growing challenge to differentiate between real and fake content. To address this critical challenge, the study is conducting a survey to reveal a broad range of perspectives on the familiarity, encounters, and concerns related to deepfake technology. In addition, the study evaluates the effectiveness of current strategies in addressing the spread of deepfake material and proposes future approaches for improving the integrity of AI. The survey was delivered digitally, and responses were examined to provide an in-depth analysis of the latest techniques and difficulties in the context of deepfake detection. The outcomes demonstrate a range of perspectives on understanding deepfakes with an explicit agreement on the importance of risk presented by harmful deepfake applications. Although the participants showed an understanding of the available interventions, they also identified considerable challenges and the need for improved awareness, robust detection tools, and ethical standards in AI development to address the challenges posed by deepfakes with the present detection method. Implementing AI ethical guidelines to avoid deepfakes has a significant and beneficial effect on several industries by providing protection against their harmful effects. By fostering AI ethical guidelines, these policies are able to foster societal trust, mitigate risk, and cultivate a more robust digital environment.

Keywords: *Deepfakes, Identification, Prevention, AI Integrity, Awareness*

1. Introduction

The emergence of deepfake technology enables the production of compelling counterfeit videos and audio recordings. By using complex computer software equipped with machine learning capabilities, this technology simulates the physical and auditory characteristics of an individual by creating an appearance that they are doing acts or using speech that never really occurred. While this technology may be used for entertainment reasons, such as substituting someone's face for that of a movie character, it can also be exploited to disseminate misinformation or manipulate others. Therefore, it is crucial to acquire a comprehension of deepfakes and acquire the ability to distinguish them from authentic videos [1].

The rapid increase of Artificial intelligence (AI) generated deepfake evidence presents a significant obstacle to the credibility of information, making it more difficult for individuals to distinguish between authentic and faked content. This requires a substantial enhancement in public awareness and the use of sophisticated detection techniques to recognize and control the spread of deepfakes accurately. A significant trend is the increasing sophistication of deepfakes, which challenges existing detection methods and necessitates the development of more advanced solutions [2]. A recurring pattern is the use of deepfakes to bypass security systems, particularly in remote work settings, which has become more prevalent as the workforce shifts online [3]. The United Nations recognized the significance of digital technologies in attaining sustainable development objectives, highlighting its capacity to foster equitable social and economic growth. Informatics serves as both a means for technical advancement and an accelerator for social transformation, influencing our interactions, learning processes, and individual development in an increasingly connected world.

The study on deepfakes provides insights into the pervasive influence of informatics on society and everyday life. Informatics is the interdisciplinary practice of managing and processing information that has become integral to modern existence. It has revolutionized communication and provided instant connectivity and access to information on a global scale [4]. Informatics systems in the workplace provide benefits such as automating tasks, enhancing efficiency, and rearranging duties. Digital platforms have a profound influence on education by enabling learning outside of traditional classrooms. Nevertheless, this process of digital change also brings up obstacles, like the digital divide and issues around privacy. The United Nations recognized the significance of digital technologies in attaining sustainable development objectives, highlighting its capacity to foster equitable social and economic growth. Informatics serves as both a means for technical advancement and an accelerator for social transformation, influencing our interactions, learning processes, and individual development in an ever increasingly connected world [5].

The investigation into deepfake technology underscores the increasing sophistication of deepfakes, especially in the current detection methods challenge. As technology evolves, existing algorithms struggle to keep up, necessitating continuous advancements in detection techniques [6, 7]. Additionally, deepfakes are increasingly used to bypass security systems, such as in remote work settings that cause elevating the risk of security breaches. This trend calls for enhanced security measures such as multi-factor authentication and biometric verification, to protect digital identities and organizational integrity [8].

Ethical concerns are a prominent theme, highlighting the need for guidelines and education to prevent misuse of deepfakes. Promoting ethical AI development involves transparency, accountability, and privacy, aligning technology use with societal values [9]. Another significant theme is the necessity for multi-tiered security protocols to safeguard digital media integrity [10]. These insights emphasize the urgent need for advanced detection technologies, robust security measures, and ethical frameworks to mitigate the risks posed by deepfakes, ensuring a secure and trustworthy digital environment [11, 12]. Motivated by the risk of deepfake misuse, this study provided an AI-integrity solution for deepfake

identification and prevention. The study highlights the necessity for robust ethical standards and regulatory frameworks to govern the creation and spreading of AI-generated deepfake content. It is essential to have a balanced approach that includes both technical advancements and ethical issues in order to develop AI-integrity solutions that effectively address the risks associated with deepfake utilization, protect individual privacy, and maintain public trust in digital media. This work is crucial in developing strategies to enhance defenses against the constantly evolving danger of deepfakes, fostering a more secure and reliable digital environment.

2. Literature Review

Researchers have extensively studied the convergence of AI integrity and deepfake detection, resulting in an extensive amount of research that investigates many aspects such as technological progress, usability, social effects, and ethical concerns. Researchers have conducted vital research that contributes to comprehending and addressing those challenges, as described by Jayashre and Amsaprabhaa [13]. The authors proposed a novel approach, namely Hybrid Optimized Deep Feature Fusion-based Deepfake Detection in videos by adopting a spotted hyena optimizer. The framework designed for the study successfully detected deepfake video by achieving an accuracy exceeding 90% on subsets like DeepFakes, FaceSwap, and Face2Face.

Chan et al. [14] proposed an algorithm using deep learning called multiple long short-term memory combined with a convolutional neural network to process tracking and tracing of digital content. The approach has builds upon insights from the algorithm proposed in analyzing audio and visual parts of media content. Deep learning has been found to be highly significant in the identification of deepfakes and has been widely used as proposed by Khalil et al. [15], Guera and Delp [16], and Pan et al. [17]. In politics, deepfakes could be used to sway people's opinions by spreading lies. All of this means that we need to be more careful about what we believe and share, and it is important for us to have tools that can spot these fakes to keep our information reliable as elaborated in [18, 19]. Therefore, it is crucial to generate tools and algorithms that are able to detect deepfakes usage.

The study by Kingra et al. [20] has elaborated on the approaches to the emergence of deepfakes and video tampering detection. The study provided an overview of the most advanced techniques for verifying the integrity of videos, with an emphasis on the new methods for detecting deepfake videos. Moreover, progress in creating very realistic deepfake videos has been provided and encouraged the development of more comprehensive techniques by providing a detailed analysis of various research trends in the field of deepfake detection. Figure 1 shows the manipulation of the face proposed which consist of face swapping and face attribute manipulation. Face manipulation is able to transfer facial expressions from one to another.

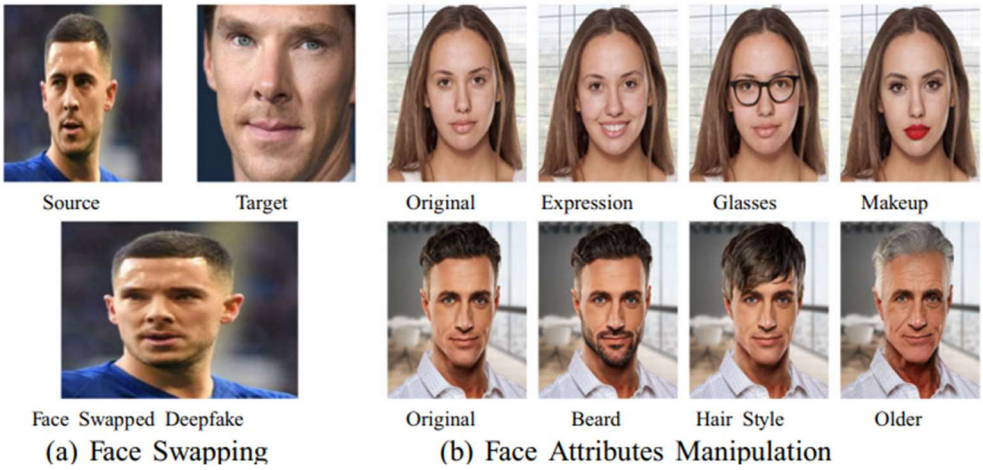

Figure 1. Deepfakes using face manipulation [20]

3. Methodology

The research is conducted by distributing a questionnaire about deepfakes to gather information on the participants' experience, understanding, and awareness of deepfakes. The details of the methodology are described in the following sub-section.

3.1. Participant

This research presents the results of a survey conducted with a minimum of 15 participants. This number was selected to include a wide range of perspectives while nevertheless allowing for a thorough and detailed analysis. The participants were carefully chosen to represent a variety of demographics in order to define an extensive range of insights and experiences. The data collected from these people is an essential basis for comprehending the study issue and generating significant findings. The contributions from each participant have greatly enhanced the depth of information and the reliability of the survey's findings.

3.2. Research Instrument

In order to collect data from the respondents, a questionnaire with 10 questions was constructed. The questions were presented in the following approach:

1. How familiar are you with the concept of deepfake technology?
2. Have you ever encountered a deepfake video or image?
3. In which types of media do you think deepfake technology is most used?
4. Do you believe that deepfake technology poses a significant threat to society?
5. Would you be able to distinguish a deepfake video or photo from a real one?
6. Are you concerned that deepfake technology can be used to manipulate public opinion?
7. Which industries do you think are most vulnerable to the negative impacts of deepfake technology?
8. Are you aware of the latest AI technologies being used to detect deepfakes?

9. Do you believe that current AI advancements are sufficient to combat deepfakes effectively?
10. What role do you think AI will play in the future of media authenticity verification?

4. Findings and Discussion

The study is conducted on the impact of RPA on the administrative tasks of teachers is motivated by the several compelling reasons that highlight the current challenge faced in the education sector. Acquiring an understanding of these causes offers a clear context and justification for conducting the research. The findings indicate the more significant impact of RPA in education is discussed in the following sub-sections.

4.1. Data Collection

The data collection included 28 respondents from various sectors which provided significant insights into practical efficacy and usability of current available deepfake identification and prevention systems. 14.3% of the respondents were from executive or senior management (C-Suite). Middle management consists of roles such as director, regional manager, manager, and project manager, and it comprises 17.9% of the respondents. The largest group was intermediate or experienced professionals at the senior level representing 28.6% of participants. Entry-level positions that are representatives and associates has made up 25% of the samples. Additionally, 14.3% of respondents chose not to disclose their role level. This distribution indicates a balanced representation from different organizational levels with a significant proportion of participants being in intermediate or senior roles. This suggests that individuals with considerable experience and expertise are highly engaged in addressing deepfake issues which is critical for developing effective solutions. The presence of executive management highlights the strategic importance of combating deepfakes at the highest organizational levels.

The survey also collected data on the job titles of the participants that revealing a wide range of professional backgrounds. The titles included one Account Executive, one Backend Developer, one Delivery Manager, one HR professional, one housewife, one Payroll specialist, one Secretary, three Senior Software Engineers, two Software Engineers, one Business Analyst, one Administrator, one Building Executive, one Finance Manager, one HR Manager, one Marketing and Operation Executive, one Project Coordinator, one Support and Solution Engineer, and one Transportation Executive. This variety of job titles illustrates the multifaceted impact of deepfake technology across different sectors and roles. The significant presence of technical roles such as software engineers and senior software engineers highlights the technical focus required to develop effective deepfake detection systems. The inclusion of roles in HR, finance, and administration underscores the need to maintain operational integrity and trust within organizations. The participation of a housewife indicates a broad societal interest and concern about digital authenticity beyond professional settings. Moreover, the involvement of marketing and operations executives, project coordinators, and support engineers reflects the interdisciplinary nature of

addressing deepfake challenges, which requires collaboration across various functional areas.

The age distribution of the survey participants was as follows: 25% were aged 41 to 50, 28.6% were aged 21 to 30, and the largest group, 46.4%, were aged 31 to 40. This age range shows that the majority of those engaged in the discussion on deepfake identification and prevention are in their prime working years. The significant representation of individuals aged 31 to 40 suggests that mid-career professionals are highly involved in this field, bringing a balance of experience and adaptability. The participation of younger individuals aged 21 to 30 indicates that early-career professionals are also contributing valuable perspectives, likely bringing innovative approaches to the table. The involvement of older participants, aged 41 to 50, suggests that seasoned professionals are providing mature insights, ensuring that the strategies developed are well-rounded and informed by a wealth of experience.

The survey results indicate a comprehensive and diverse engagement across different organizational levels, age groups, and job roles in efforts to develop and implement effective deepfake detection and prevention strategies. This diversity ensures that a wide range of perspectives and expertise is applied to maintaining AI integrity and safeguarding digital content. Based on the respondents' responses, 46.4% responded that they could sometimes distinguish deepfakes

4.2. Data Analysis

According to the survey conducted, the results show a notable lack of in-depth knowledge about deepfakes. Eight participants reported being not familiar at all, 46.4% were slightly familiar, and 21.4% were moderately familiar. Only 3.6% of participants were extremely familiar, and none were very familiar. This general lack of awareness suggests a significant need for educational efforts to increase understanding of deepfake technology. Such initiatives are essential to enhance the effectiveness of detection and prevention strategies. According to the respondents, 39.3% had encountered deepfakes videos or images, 35.7% had not, and 25% were unsure. This distribution indicates that while a considerable number of individuals have been exposed to deepfake media, a significant portion either has not encountered it or cannot recognize it. This uncertainty highlights the sophisticated nature of deepfakes, making them difficult to distinguish from authentic content.

Regarding the types of media most associated with deepfake technology as shown in Figure 2, 50% of participants identified videos as the primary medium, followed by 25% pointed to audio recordings, and 21,4% chose photos. Only 3.6% of participants was unsure. This awareness aligns with current trends where video manipulation is increasingly sophisticated and widespread. Recognizing the primary mediums of deepfake usage is crucial for directing detection efforts and resources effectively.

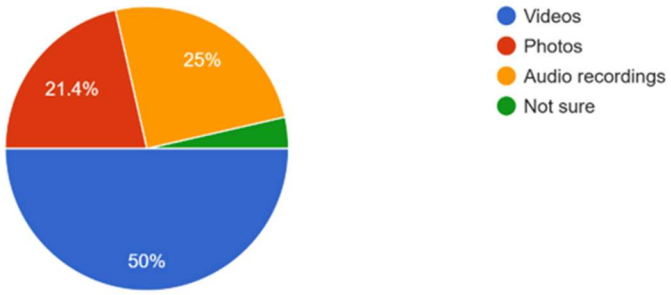

Figure 2. The technology of deepfake is mostly used in.

Figure 3 shows the future role of AI in media authenticity verification results. 50% of participants viewed AI as playing a critical role, 42.9% saw it as having a supportive role, and 7.1% believed it would play a minimal role. None believed AI would have no role. This highlights a strong belief in the importance of AI in safeguarding the authenticity of digital media. The consensus on AI's critical or supportive role underscores the need for continued investment in AI technologies to enhance their effectiveness in deepfake detection and prevention.

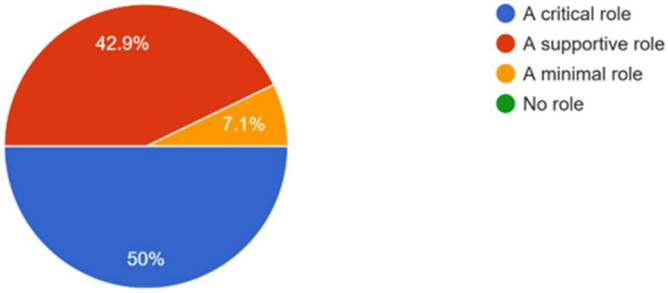

Figure 3. Implementation Deepfakes

Figure 4 illustrates the widespread concern among participants that deepfake technology could be used to manipulate public opinion. 71.4% expressed concerns, 17.9% were not concerned, and 10.5% were unsure. This high level of concern underscores the perceived risk of deepfakes being used for malicious purposes, such as influencing elections or swaying public sentiment. This necessitates the development of reliable detection systems and public awareness campaigns to mitigate the risks associated with deepfake-induced manipulation.

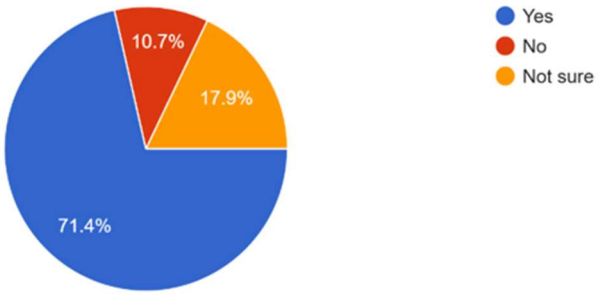

Figure 4. Concern on deepfake able to manipulate public opinion

Diverse levels of comprehension regarding the most recent AI technologies employed to identify deepfakes were observed as shown in Figure 5. Among the participants, 39.3% of the respondents reported awareness, whereas 32.1% were unaware and 28.6% were unsure. It indicates an adequate level of awareness, but it also highlights the need for a broader spread of knowledge about advancements in AI technology to counteract deepfakes. Increased understanding could boost the acceptance of these technologies and strengthen efforts to preserve the integrity of digital media.

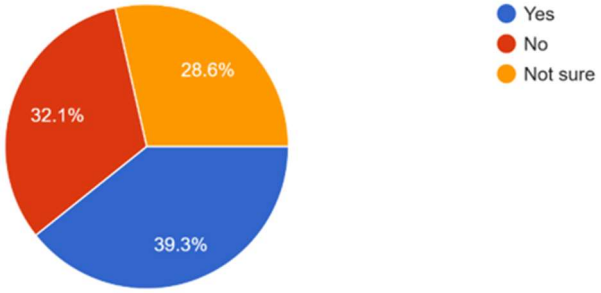

Figure 5. Awareness on AI technology used to detect deepfakes

When addressed about the possible risk of deepfake technology to society, a substantial majority of 78.6% of participants agreed on this concern, as seen by Figure 6. Just 3.5% expressed disagreement, while 17.9% remained uncertain. This consensus highlights the current concern over the consequences of deepfakes, which include their ability to modify reality, disseminate false information, and impact the public's opinion. To overcome these challenges, it is necessary to implement strong detection technologies and establish thorough regulatory frameworks. Participants identified several industries that they believe are most vulnerable to the negative impacts of deepfake technology. The results indicated that 67.9% in politics, 67.9% in cybersecurity, 60.7% in entertainment, 53.6% in advertising, 42.9% in law enforcement, and 35.7% in journalism. The consensus on politics and cybersecurity being highly vulnerable highlights the critical need for protective measures in these sectors. The inclusion of the entertainment industry reflects concerns about the authenticity of content in media and popular culture.

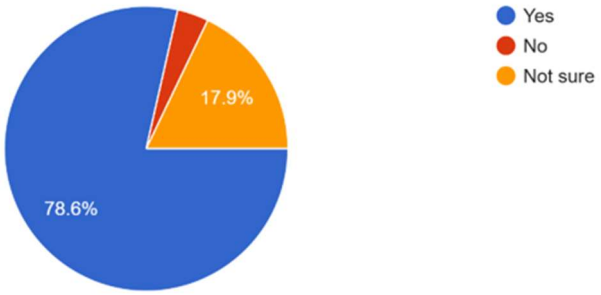

Figure 6. Significant threat of deepfakes technology on society.

The survey results reveal a broad range of perspectives on the familiarity, encounters, and concerns related to deepfake technology. They underscore the need for improved awareness, robust detection tools, and ethical standards in AI development to address the challenges posed by deepfakes. The study's findings indicate that deepfakes are having a noticeable effect on society and our daily lives. These cleverly altered videos and audio recordings can look and sound so real that they trick people into believing something false. This is causing problems in several ways. For one, it's getting harder for everyone to tell what's true and what's not, which can lead to confusion and less trust in the videos we see online. Deepfakes can also be used to hurt someone's reputation by making it look like they said or did something they did not.

Besides, the findings on respondents' experiences, attitudes, and behaviors related to informatics reveal a complex landscape influenced by their diverse job roles. Business analysts and software engineers, including team leads and senior positions, displayed a strong affinity for informatics, often citing its critical role in problem-solving and project management. Delivery managers and administrators acknowledged the efficiency gains afforded by informatics systems, although they also highlighted challenges in keeping pace with rapid technological changes. Secretaries and housewives reported a varied level of engagement, with some expressing enthusiasm for the organizational benefits of informatics, while others faced hurdles due to limited exposure and training opportunities. Across all roles, there was a consensus on the importance of informatics in enhancing productivity and facilitating remote work, reflecting a positive overall attitude towards technology. However, the need for continuous learning and adaptability was also recognized as a vital behavior for leveraging informatics effectively in their respective fields.

The study's examination of data on deepfake technology and its implications has uncovered several trends, patterns, and themes. An increasingly frequent occurrence is the use of deepfakes to bypass safety regulations, particularly in remote job settings, which are becoming more widespread as the workforce shifts to online platforms. Among the central themes identified is the ethical dimension of deepfake technology; there is a growing discourse on the need for ethical guidelines and education to prevent misuse. Another theme is the importance of multi-layered security measures, such as multi-factor authentication and biometric verification, to ensure the integrity of digital identities. These findings align with thematic analysis research, which emphasizes the significance of identifying and interpreting patterns of meaning across qualitative data to inform practical applications and policy

development. The study's insights contribute to a deeper understanding of the challenges posed by deepfakes and highlight the critical need for a multifaceted approach to maintain trust in digital media.

The growth of deepfake technology has required the establishment of extensive ethical rules to avoid its misuse and reduce its negative consequences. It is crucial to establish rules in this research that focus on ensuring the responsible development and implementation of AI with the goal of improving the integrity and reliability of digital content. Among the ethical considerations that should be adopted for deepfake prevention is the organization that developed AI technologies must adopt robust data security that protects personal data that consists of anonymization, encryption and regular security audits. Moreover, technology firms, regulatory organizations, and academic institutions require collaboration in order to generate and provide technology for the detection and prevention of deepfakes. Utilizing shared datasets containing documented instances of deepfakes might enhance the effectiveness of the detection algorithm. It is crucial to conduct more research on novel and emerging threats presented by deepfakes. This involves the creation of sophisticated detection systems and gaining knowledge about the changing techniques used in the creation of deepfakes. This could be achieved by encouraging the broad sharing and collaboration of research findings across industries, academia, and government to help expedite progress in the development of detection and preventive technologies. In addition, AI developers and content creators must provide explicit disclosure about the utilization of fake media and deepfake technologies to guarantee that users are fully aware that the content is not real. This may include the use of watermarks, information tagging, or explicit declarations.

By involving these ethical issues throughout the process of developing and using AI, everyone involved may strive to avoid the inappropriate use of deepfake technology. Ensuring that AI advances are in line with societal values and public interest includes encouraging accountability, privacy protection, equality, education, and extending research. These ethical rules represent a crucial role in preventing the negative exploitation of deepfakes while encouraging a responsible and reliable digital ecosystem.

5. Conclusion

This study aims to gather extensive information on the challenges and experiences encountered by individuals when identifying and dealing with deepfakes. This approach aims to emphasize not only the technical deficiency but also the social consequences and inequalities that exist in the context of prevention and identification of deepfakes. This study is able to provide a meaningful contribution towards the creation of comprehensive, efficient, and ethically principled methods to address the increasing risk posed by deepfakes. Furthermore, there is a pressing requirement for educational programs focused on enhancing public awareness and understanding of deepfakes. These programs should prioritize not just the identification of deepfakes but also an understanding of their possible consequences and the significance of identifying digital information. The development and use of AI technologies, including deepfakes, must be governed by strict rules and regulations from an ethical perspective. It is essential for policymakers, technologists, and other stakeholders to work together in order to

guarantee the implementation of these standards, therefore fostering responsible innovation and protecting against any potential exploitation. It is essential to establish regulatory frameworks to ensure that creators of malicious deepfake substances are held responsible and to prevent the spread of risky synthetic media. Therefore, a recommendation for this current technology is to improve the reliability of AI in relation to deepfakes requires a comprehensive strategy that integrates advances in technology, educational initiatives, and robust ethical standards. To ensure the integrity of information and provide more security from the negative effects of deepfake technology, it is crucial to tackle the stated obstacles by providing advanced and easily available deepfake detection tools.

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References

[1] Roe, J., Perkins, M.: Deepfakes and Higher Education: A Research Agenda and Scoping Review of Synthetic Media. arXiv preprint arXiv:2404.15601. (2024).
[2] Michalos, A.C.: Encyclopedia of quality of life and well-being research. Springer Netherlands Dordrecht (2014).
[3] Saunders, C.H., Sierpe, A., von Plessen, C., Kennedy, A.M., Leviton, L.C., Bernstein, S.L., Goldwag, J., King, J.R., Marx, C.M., Pogue, J.A.: Practical thematic analysis: a guide for multidisciplinary health services research teams engaging in qualitative analysis. bmj. 381, (2023).
[4] Castells, M.: The impact of the internet on society: a global perspective. Change. 19, 127–148 (2014).
[5] Haleem, A., Javaid, M., Qadri, M.A., Suman, R.: Understanding the role of digital technologies in education: A review. Sustainable Operations and Computers. 3, 275–285 (2022).
[6] Naitali, A., Ridouani, M., Salahdine, F., Kaabouch, N.: Deepfake attacks: Generation, detection, datasets, challenges, and research directions. Computers. 12, 216 (2023).
[7] Masood, M., Nawaz, M., Malik, K.M., Javed, A., Irtaza, A., Malik, H.: Deepfakes generation and detection: State-of-the-art, open challenges, countermeasures, and way forward. Applied intelligence. 53, 3974–4026 (2023).
[8] Shoaib, M.R., Wang, Z., Ahvanooey, M.T., Zhao, J.: Deepfakes, misinformation, and disinformation in the era of frontier ai, generative ai, and large ai models. In: 2023 International Conference on Computer and Applications (ICCA). pp. 1–7. IEEE (2023).
[9] Olorunfemi, O.L., Amoo, O.O., Atadoga, A., Fayayola, O.A., Abrahams, T.O., Shoetan, P.O.: Towards a conceptual framework for ethical AI development in IT systems. Computer Science & IT Research Journal. 5, 616–627 (2024).
[10] Cao, X., Gong, N.Z.: Understanding the security of deepfake detection. In: International Conference on Digital Forensics and Cyber Crime. pp. 360–378. Springer (2021).
[11] Dagar, D., Vishwakarma, D.K.: A literature review and perspectives in deepfakes: generation, detection, and applications. Int J Multimed Inf Retr. 11, 219–289 (2022).
[12] Meskys, E., Kalpokiene, J., Jurcys, P., Liaudanskas, A.: Regulating deep fakes: legal and ethical considerations. Journal of Intellectual Property Law & Practice. 15, 24–31 (2020).
[13] Jayashre, K., Amsaprabhaa, M.: Safeguarding media integrity: A hybrid optimized deep feature fusion based deepfake detection in videos. Comput Secur. 142, 103860 (2024).
[14] Chan, C.C.K., Kumar, V., Delaney, S., Gochoo, M.: Combating deepfakes: Multi-LSTM and blockchain as proof of authenticity for digital media. In: 2020 IEEE/ITU International Conference on Artificial Intelligence for Good (AI4G). pp. 55–62. IEEE (2020).

[15] Khalil, H.A., Maged, S.A.: Deepfakes creation and detection using deep learning. In: 2021 International Mobile, Intelligent, and Ubiquitous Computing Conference (MIUCC). pp. 1–4. IEEE (2021).
[16] Güera, D., Delp, E.J.: Deepfake video detection using recurrent neural networks. In: 2018 15th IEEE international conference on advanced video and signal based surveillance (AVSS). pp. 1–6. IEEE (2018).
[17] Pan, D., Sun, L., Wang, R., Zhang, X., Sinnott, R.O.: Deepfake detection through deep learning. In: 2020 IEEE/ACM International Conference on Big Data Computing, Applications and Technologies (BDCAT). pp. 134–143. IEEE (2020).
[18] Gamage, D., Chen, J., Ghasiya, P., Sasahara, K.: Deepfakes and Society: What lies ahead? In: Frontiers in Fake Media Generation and Detection. pp. 3–43. Springer (2022).
[19] Al-Khazraji, S.H., Saleh, H.H., KHALID, A.I., MISHKHAL, I.A.: Impact of Deepfake Technology on Social Media: Detection, Misinformation and Societal Implications. The Eurasia Proceedings of Science Technology Engineering and Mathematics. 23, 429–441 (2023).
[20] Kingra, S., Aggarwal, N., Kaur, N.: Emergence of deepfakes and video tampering detection approaches: A survey. Multimed Tools Appl. 82, 10165–10209 (2023).