

DETECTION AND SYSTEMATIZATION OF SIGNS AND MARKERS OF MODIFICATIONS IN MEDIA CONTENT FOR THE DEVELOPMENT OF A METHODOLOGY TO ENHANCING CRITICAL THINKING IN THE ERA OF DEEPFAKES

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ABSTRACT

Modernity demonstrates a critical need for pedagogical support and the development of a methodology to enhance critical thinking in the face of escalating misinformation and advanced media manipulation, mainly through deepfake technology. The paper focuses on creating a comprehensive framework for detecting manipulated content and identifying indicators such as pixelization, unnatural expressions, etc. With attention to international and Ukrainian efforts, the work advocates for ongoing research adapted to evolving technologies to improve media literacy programs in combating emerging forms of misinformation.

Problem statement. The problem is the urgent need for a comprehensive methodology that fosters critical thinking skills to combat disinformation and manipulation of artificially reproduced media content, particularly in the context of emerging technologies like deepfakes. The challenge involves assessing existing pedagogical approaches, addressing gaps, and equipping both learners and educators to navigate the complexities of the digital age. Digital transformation, in general, and the spread of artificial intelligence for media generation, in particular, are irreversible processes in the modern world, so the urgent issue, given the challenges of the digital economy and the needs of the digital society, is to find forms, methods, and means of shaping the critical thinking of citizens to counteract manipulation and disinformation by synthetically reproduced media content. It is essential to develop a database with systematically organized materials categorized based on identified markers for the subsequent creation of training materials to solve the outlined issues.

Materials and methods. A comprehensive approach was employed, combining general (systemic, instrumental, and functional approaches, dialectical and comparative analysis, synthesis, and systematization for the study of pedagogical, scientific-technical, and methodological literature), specific (observation and analysis of educational practices), and general-logical methods (extrapolation, induction, and deduction for formulating conclusions) in scientific research to solve the tasks set in the study. This allowed for the examination of the current state, evaluation of the practical results of implementing the developed methodology for critical thinking formation, and identification of priority avenues for improving education in the context of the strategy to enhance media literacy and critical thinking among the population and science. The study aimed to determine priority pathways within the framework of the development of methodology of critical thinking and pedagogical support to counteract disinformation and manipulation of artificially reproduced media content and to characterize its potential scientifically. The development of critical thinking and pedagogical support to counteract disinformation and manipulation of artificially reproduced media content requires the following materials analysis: scientific-technical literature (materials offering a scientific understanding of the technical aspects related to media content creation, modification, and reproduction), methodological literature (guides and methodologies focused on developing educational frameworks and strategies to enhance critical thinking in the context of media literacy), synthetically reproduced media content (media content, especially in the context of emerging technologies like deep fake to identify modification markers).

Results. The study is devoted to analyzing, identifying, and systematizing markers and signals for identifying media manipulation to create a database for the methodology in the form of methodological cards. A comprehensive database with classification is being developed, focusing on methodological interactive cards with 66 curated cases of deepfakes and synthetically reproduced media (in Ukrainian). This initiative aims to provide educators, researchers, and learners with a versatile resource for understanding the challenges posed by manipulated media..

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Conclusions. In response to the escalating threat of disinformation and advanced media manipulation, there is a critical need to develop a robust methodology for enhancing critical thinking skills. The study highlights global concerns about false information, mainly through deepfake technology, jeopardizing public trust and enabling psychological manipulation. Future research should consider revising media literacy programs to elevate citizens' critical thinking in the face of evolving digital landscapes and the increasing capabilities of artificial intelligence in generating media content.

KEYWORDS: Deepfake Technology; Artificial Intelligence; Generative Images; Misinformation; Media Literacy; Critical Thinking; Digitalization; Information Warfare; Public Awareness; Synthetic Media Content.

ВИЯВЛЕННЯ ТА СИСТЕМАТИЗАЦІЯ ОЗНАК І МАРКЕРІВ МОДИФІКАЦІЙ У МЕДІАКОНТЕНТІ ДЛЯ РОЗРОБКИ МЕТОДОЛОГІЇ ДЛЯ ПІДВИЩЕННЯ КРИТИЧНОГО МИСЛЕННЯ В ЕРУ ДІПФЕЙКІВ

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АНОТАЦІЯ

Сучасність демонструє критичну потребу в педагогічному супроводі та розробці методології, яка підвищить критичне мислення в умовах зростаючого обсягу дезінформації та вдосконаленої медіаманіпуляції, особливо через застосування технології deepfake. У роботі акцентується увага на створенні комплексної структури для виявлення маніпульованого контенту, виявлення ознак, таких як пікселізація та ненатуральні вирази тощо. Зосереджуючи увагу на закордонних та українських зусиллях, робота підтримує проведення постійних досліджень, адаптованих до технологій, які розвиваються, для вдосконалення програм медіаграмотності для протидії новим формам дезінформації.

Постановка проблеми. Проблемою є термінова необхідність у комплексній методології, яка розвиває навички критичного мислення для протидії дезінформації та маніпуляціям штучно відтвореними медіаматеріалами, особливо в контексті нових технологій, таких як deepfakes. Виклик полягає в оцінці існуючих педагогічних підходів, вирішенні прогалин та забезпеченні навчальних закладів та вчителів інструментами для навігації в складнощах цифрової ери. Цифрова трансформація загалом та поширення штучного інтелекту для генерації медіа, зокрема, є невідворотними процесами в сучасному світі, тому термінове питання, враховуючи виклики цифрової економіки та потреби цифрового суспільства, - знаходження форм, методів та засобів формування критичного мислення громадян для протидії маніпуляціям та дезінформації з боку медіаматеріалів, які відтворюються штучно. Для вирішення окреслених проблем є необхідним напрацювання бази даних з систематизованими матеріалами з категоризацією за виявленими маркерами для подальшого створення тренінгового матеріалу.

Матеріали та методи. Для вирішення завдань, поставлених у дослідженні, застосовано комплексний підхід, який об'єднує загальні (системний, інструментальний та функціональний підходи, діалектичний та порівняльний аналіз, синтез та систематизація для вивчення педагогічної, науково-технічної та методологічної літератури), спеціфічні (спостереження та аналіз навчально-виховної практики) та загально-логічні методи (екстраполяція, індукція та дедукція для формулювання висновків) у науковому дослідженні. Це дозволило досліджувати поточний стан, оцінювати практичні результати впровадження розробленої методології формування критичного мислення та визначати пріоритетні шляхи удосконалення освіти в контексті стратегії підвищення медіаграмотності та критичного мислення серед населення та науки. Робота мала на меті визначити пріоритетні напрямки в рамках розробки методології критичного мислення та педагогічної підтримки для протидії дезінформації та маніпуляціям зі штучно відтвореними медіаматеріалами та науково характеризувати її потенціал. Розробка методології критичного мислення та педагогічної підтримки для протидії дезінформації та маніпуляцій зі штучно відтвореними медіаматеріалами потребує наступних матеріалів: науково-технічна література (матеріали, що пропонують наукове розуміння технічних аспектів, пов'язаних із створенням, модифікацією та відтворенням медіаматеріалів), методична література (посібники та методології, спрямовані на розробку навчальних рамок та стратегій для підвищення критичного мислення в контексті медіаграмотності), штучно відтворені медіаматеріали (медіаматеріали, особливо в контексті нових технологій, таких як deepfake, для виявлення ознак модифікації).

Результати. Дослідження присвячене аналізу, визначенню та систематизації ознак та сигналів для ідентифікації медіаманіпуляції з метою створення бази даних для методології у вигляді методичних карток. Розробляється комплексна база даних із класифікацією, зосереджена на методичних інтерактивних картках із 66 керованими випадками дипфейків та синтетично відтворених медіа (українською мовою). Ця ініціатива має на меті надати педагогам, дослідникам і учням універсальний ресурс для розуміння викликів, які створюють маніпульовані ЗМІ.

Висновки. У відповідь на загострену загрозу дезінформації та вдосконаленої медіаманіпуляції є критична необхідність термінового розроблення міцної методології для розвитку навичок критичного мислення. Дослідження підкреслює глобальні турботи щодо хибної інформації, особливо через технологію deepfake, яка піддає сумніву громадську довіру та уможливорює психологічну маніпуляцію. Майбутні дослідження повинні бути спрямовані на перегляд програм медіаграмотності для підвищення критичного мислення громадян у зоні зростаючих можливостей штучного інтелекту у генерації медіаматеріалів.

КЛЮЧОВІ СЛОВА: технологія deepfake; штучний інтелект; генеративні зображення; дезінформація; медіаграмотність; критичне мислення; цифровізація; інформаційна війна; громадська освіта; штучно відтворені медіаматеріали.

INTRODUCTION

Problem statement. To investigate the current state and problems of the Deepfakes, as well as to present the results of the study and the effectiveness of the implementation of the methodology for the formation of critical thinking of citizens. In the contemporary landscape marked by the proliferation of disinformation and the sophisticated manipulation of media content, there exists a pressing need for the formulation and implementation of a robust methodology aimed at nurturing critical thinking skills. The challenge lies in developing a comprehensive pedagogical framework that not only equips individuals with the ability to discern manipulated media content but also addresses the evolving landscape of artificially reproduced content, such as deepfakes. This necessitates a thorough examination of existing pedagogical, scientific-technical, and methodological approaches to identify gaps and formulate an effective strategy. Additionally, understanding and mitigating the impact of disinformation on educational practices and broader societal contexts is crucial. The problem at hand, therefore, centers on devising a methodology that not only empowers learners with critical thinking skills but also provides educators with the tools and support needed to navigate the challenges posed by the manipulation of media content in the digital age.

Analysis of recent research and publications. Numerous foreign scientists such as Anwar S., Anwer M., Banihirwe A., Bates M., have studied the technologies of synthetic reproduction of mediacontent with the help of modern ICT and artificial intelligence Milanova M. and others. Foreign scholars such as Aldwairi M., Alwahedi A., Anderson K. E., Atodiresei C.-S., Tănăselea A., Iftene A., Figueira A., Oliveira L. and others, have studied the manipulation of the media with the help of falsified visual content. Among domestic scholars, who viewed various aspects of the issue of the role of media and media education in modern educational space, presented significant achievements Ivanova V., Isaeva O., Mokogoz O., Naidionova L., Onkovich G., Cherepovsky N., Thaninin N., Kozak T. et al.

In recent times, the rise of false information has become a serious concern for public discourse, human society, education, and democracy (Borges et al., 2019; Qayyum et al, 2019; Chemerys et al, 2021a,b,c; Chemerys & Ponomarenko, 2023; Chemerys & Kardashov, 2022; Chemerys, 2023). Fake news refers to deliberately created news-style content with the aim of deceiving the public (Aldwairi & Alwahedi, 2018; Jang & Kim, 2018). This misleading information spreads through social networks, crossing geographical boundaries and potentially affecting millions of users (Figueira & Oliveira, 2017). The growing popularity of video content highlights the need for strategies that promote critical thinking among the public to verify the authenticity of media and news, especially with new technologies allowing highly convincing manipulation of visual information (Anderson, 2018). We are currently in an era marked by digital disinformation and information warfare, involving orchestrated campaigns of false information to influence public opinion (Anderson, 2018; Qayyum et al., 2019; Zannettou et al., 2019). Recent technological advancements have simplified the creation of visual content through the use of "Deepfake" technology, resulting in the production of hyperrealistic visual content through face swaps that are nearly indistinguishable from authentic material (Chawla, 2019; Maras & Alexandrou, 2019). Deepfake technology has the potential to generate various types of content, such as humor, pornography, or political videos, wherein individuals seem to say things without their consent, with their images and voices manipulated (Day, 2019; Fletcher, 2018). Importantly, Deepfake technology poses a significant threat due to its ability to create counterfeit visual content for purposes including political sabotage, manufacturing evidence for legal proceedings, spreading terrorist propaganda, facilitating blackmail, manipulating financial markets, and disseminating fake news (Maras & Alexandrou, 2019). Due to the psychological characteristics of a person, after seeing with one's own eyes, trust is instilled, which creates a basis for manipulation of consciousness through misinformation by means of synthetically reproduced mediacontent using deepfake technology and others.

Objective: To study the current state and problems of combating "dipfakes" to identify signs and markers of modifications in media content to create a database of training cards for the methodology of critical thinking and pedagogical support to counteract disinformation and manipulation of artificially reproduced media content of citizens.

THEORETICAL GROUNDS OF THE STUDY

To strengthen the fight against misinformation, the European Commission will focus its efforts on revising the Code of Practice on Disinformation in the system of regulation of obligations and accountability of Internet platforms in accordance with the future Digital Services Act. In general, the European Commission aims to introduce tools that would increase the responsibility of the media and the beneficiaries of information campaigns for the dissemination of misinformation. Urgency of the problem is confirmed by a number of normative and legislative documents aimed at regulating measures to ensure national information security and the right to access reliable information. The main requirements for the introduction and development of information, telecommunications and media technologies in Ukraine are contained in the Strategy for the Development of the Information Society in Ukraine (2013). In order to counter hybrid threats and spread misinformation in Ukraine approved and implemented the cyber security strategy of Ukraine for 2021-2025 "Safe cyberspace - the key to successful development of the country"; National Security Strategy of Ukraine and the Law of Ukraine "On National Security" (2020). In particular, on July 15, 2021, representatives of state authorities of Ukraine and the delegation of foreign states to the OSCE discussed the fight against misinformation and information security, during which the best world practices of protecting society from the harmful effects of misinformation and other hybrid tools were discussed. In particular, a number of foreign regulations have been formulated, such as the Code of European Union Practice Regarding Disinformation (2018), and the European Commission has adopted a "Joint Framework on Counter-Hybrid Response". a European Union response, 2016).

Modern Ukrainian educational practice has begun the active implementation of the course of media education and media literacy in educational institutions (letter of the MES of Youth Sports of Ukraine No. 1/9 of March 29, 2013). "On the introduction of the study of the course" Fundamentals of media literacy in educational institutions"). Leading ideas and formulations of the problem of introducing media literacy in Ukrainian society are currently being actively developed within the project "Study and distinguish: Information Media Literacy", implemented by the Council for International Research and

Exchanges (IREX) with the support of the Embassy of the United States of America and the Embassies of the United Kingdom and Ukraine, in partnership with the Ministry of Education and Science of Ukraine and the Ukrainian Press Academy.

Most domestic studies, despite their undoubted significance and practical value, cover the issue of misinformation in the media through text or verbal messages, bypassing the precedents of falsification of visual information, namely video and photo content, or covering this issue superficially and insufficiently.

The applied problem of the project is determined by the need for a comprehensive approach to the study of modern Ukrainian media landscape on the subject of misinformation by means of synthetically reproduced mediacontent, meaningful and structured analysis of results to develop scientifically sound methodology for critical thinking and psychological and pedagogical support of society (Chemerys, 2024). Research of their psychological influence on society for the development, practical application, testing and scaling of tools that form and develop the skills of critical thinking of society to counteract information manipulation by means of synthetically reproduced mediacontent.

Within the project, testing of the system of development of critical thinking and psychological and pedagogical support to counteract misinformation and manipulation of synthetically reproduced mediacontent will be carried out in a mixed (face-to-face) form.

METHODS OF RESEARCH

To solve the tasks set in the research, a comprehensive approach was employed, combining general (systemic, instrumental, and functional approaches, dialectical and comparative analysis, synthesis, and systematization for the study of pedagogical, scientific-technical, and methodological literature), specific (observation and analysis of educational practices), and general-logical methods (extrapolation, induction, and deduction for formulating conclusions) in scientific research. This allowed for the examination of the current state, evaluation of the practical results of implementing the developed methodology for critical thinking formation, and identification of priority avenues for improving education in the context of the strategy to enhance media literacy and critical thinking among the population and science. The study aimed to determine priority pathways within the framework of the development of methodology of critical thinking and pedagogical support to counteract disinformation and manipulation of artificially reproduced media content and to scientifically characterize its potential.


RESULTS OF THE RESEARCH

The growing concern over the erosion of public trust in visual content has underscored the urgent need for the development of critical thinking skills. This imperative arises as a crucial defense against the pervasive threat of misinformation within the realm of visual media, emphasizing the pivotal role of fostering a robust level of critical thinking for ensuring societal resilience against cyber threats. This is particularly pertinent to counteracting the detrimental impact of misinformation on the sustainable development of Ukraine. It is noteworthy that even high-quality deepfakes, extensively employed in the film industry and advertising, fall short in achieving complete naturalness or realism. The subtlest deviations from natural appearance and behavior can evoke anxiety and aversion in viewers, a phenomenon known as the uncanny valley effect.








Consequently, when scrutinizing a suspicious video, particular attention should be directed towards the primary object of manipulation, typically the face. To establish a comprehensive database of methodological materials, an exhaustive examination of existing markers of image tampering was conducted. This meticulous study aimed at identifying and cataloging the distinctive signs indicative of manipulated visual content. By leveraging this research, we seek to contribute to the development of effective tools and strategies for discerning synthetic media, further fortifying the foundation of critical thinking in our society.

To create the database with methodological materials, we conducted a thorough study of existing markers of image tampering (Table 1).

Table 1. Signs and markers of modifications in media content

Signs	Description	Samples
For static mediacontent		
High quality with perfect hair and skin	Unnatural perfection in visual elements like hair and skin, indicating potential manipulation	

Signs	Description	Samples	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Attention to body</p>	<p>AI struggles with basic anatomical features, such as counting fingers on a hand, due to challenges in understanding human anatomy and variations in hand images from different angles. This leads to random and inaccurate results, with hands appearing disproportionately sized, fingers too long, and joints bent unnaturally, unclear or multiple finger counts.</p>		
			
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Unreadable text</p>	<p>AI learn to recognize specific images, but do not analyze the content</p>		
For dynamic mediacontent			
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Unnatural facial expressions. Fuzzy inside of the mouth</p>	<p>Anomalies in facial expressions, especially during blinking, eyebrow, and lip movements. Imperfect representation of the oral cavity, affecting clarity of teeth and tongue images</p>		
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Excessive pixelation, defects, fuzzy and blurred image</p>	<p>Signs of manipulated visual content, including pixelation, defects, and blurred or duplicated elements</p>		 

Signs	Description	Samples
Blurry outlines, Flickering of the face	Indication of unclear or inconsistent boundaries in the visual content notice the flickering of the face (transitions between the face, neck and hair, which are not always organically combined with each other)	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Real</p>  </div> <div style="text-align: center;"> <p>DeepFake</p>  </div> </div>
Low video quality	Often used to conceal flaws in neural network operation	<div style="display: flex; justify-content: space-around;">   </div>
Differences in body type, hairstyle, voice.	Discrepancies between the replaced face and the original body, including variations in shadows, lighting, and skin tone. Face replacements are common, and mismatches in skin color and features may reveal manipulation	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>SOURCE: ZELENSKY UKRAINIAN PRESIDENTIAL PRESS OFFICE</p>  <p>REAL</p> </div> <div style="text-align: center;"> <p>SOURCE: TWITTER ORIGINAL VIDEO CREATOR: UNKNOWN</p>  <p>FAKE</p> </div> </div>
Realtime mediacontent		
Profile trick for safety	<p>Dipfake algorithms are not designed to create an image in profile simply because they don't need it - during a conversation it is customary to look at the person you are talking to. Therefore, a request to turn the neck 90° will destroy the realistic illusion.</p> <p>Or the appearance of an object between the camera and the face (for example, a hand)</p>	

Source: Own work

DISCUSSION

Based on the research, the following discussion topics encompassing different viewpoints can be identified. One perspective underscores the importance of integrating critical thinking and media literacy education into formal curricula at different educational levels. This proactive approach aims to equip individuals with the skills needed to discern and combat disinformation effectively. In future research, we consider the exploration of a multidisciplinary approach, involving collaboration among educators, technologists, psychologists, and policymakers. This collaboration is viewed as crucial for the development of

a comprehensive methodology that addresses the multifaceted challenges associated with disinformation and outlines prospects for expanding opportunities for both teachers and students. An important direction for future studies is seen in global collaboration to establish standardized frameworks for ensuring the coherence of critical thinking methodologies, recognizing the interconnected and dynamic nature of the digital landscape. To investigate the potential long-term societal impact of implementing the methodology, determining factors such as increased resilience to misinformation and the activation of civic engagement to preserve democratic principles is essential.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

In light of the contemporary proliferation of disinformation and the increasing sophistication of media manipulation, the urgency of developing a robust methodology for fostering critical thinking skills is evident. The analysis of recent research underscores the global concern over false information, notably through deepfake technology, which poses a serious threat to public trust and opens avenues for psychological manipulation. The tasks set in the research lies in addresses the evolving landscape of artificially reproduced content, particularly deepfakes but also creating a comprehensive pedagogical framework that not only equips individuals with the ability to discern manipulated media content. The theoretical grounds of the study reveal the global efforts to combat misinformation, with a focus on revising regulations and introducing tools to increase media responsibility. In Ukraine, legislative documents emphasize the importance of media literacy and information security in countering hybrid threats. The applied problem emphasizes the need for a comprehensive approach to studying misinformation through synthetically reproduced media content. The results highlight the crucial role of developing critical thinking skills to counter misinformation in visual media. While recognizing the challenges posed by high-quality deepfakes, the study identifies signs such as pixelization, blurry outlines, unnatural facial expressions, and differences in body type for their identification. Thorough testing of the methodology, focusing on markers of image tampering, has been conducted. Practical tools for recognizing deepfakes, including attention to visual details, sound synchronization, and playback speed, are crucial for safeguarding against online deception. The study underscores the need for continued research and adaptation of strategies to emerging technologies to ensure societal resilience against misinformation.

Further research should focus on revising existing media literacy training programmes to update and improve the level of critical thinking of citizens, taking into account digital transformation and the spread of artificial intelligence capabilities for generating media content. As further prospects are improvement of existing methodical material from a systematized database and formation of interactive methodological interactive cards; supplementing each case with learning resources for deeper research; complementing different scenarios, including applications in different industries, societal impacts, detection strategies, ethical considerations and legal implications; English translation.

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