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**НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ
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**“MUHANDISLIKDA SUN'IY INTELLEKT VA
RAQAMLI INNOVATSION
TEKNOLOGIYALAR: ZAMONAVIY
YECHIMLAR VA ISTIQBOLLAR”
MAVZUSIDAGI
XALQARO ILMIY-AMALIY ANJUMAN
MATERIALLARI**



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TOSHKENT MENEJMENT VA IQTISODIYOT INSTITUTI

"MUHANDISLIKDA SUN'IY INTELLEKT VA RAQAMLI INNOVATSION TEXNOLOGIYALAR:

ZAMONAVIY YECHIMLAR VA ISTIQBOLLAR" MAVZUSIDAGI

XALQARO ILMIY-AMALIY ANJUMAN MATERIALLARI

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МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ РЕСПУБЛИКИ

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МЕЖДУНАРОДНАЯ НАУЧНО-ПРАКТИЧЕСКАЯ КОНФЕРЕНЦИЯ НА ТЕМУ

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“Muhandislikda sun’iy intellekt va raqamli innovatsion texnologiyalar: zamonaviy yechimlar va istiqbollar” Xalqaro ilmiy-amaliy anjuman tezislar to‘plami. 2026-yil 21-may.

Ushbu to‘plamda – “Muhandislikda sun’iy intellekt va raqamli innovatsion texnologiyalar: zamonaviy yechimlar va istiqbollar” Xalqaro ilmiy –amaliy anjuman ishtirokchilarining tezislarini keltirilgan. Anjuman kun tartibiga kiritilgan masalalar dolzarb bo‘lib, u yalpi ma’ruzalar va amaliy zamonaviy muhandislik ta’limida raqamli transformatsiya va sun’iy intellekt, muhandislik yechimlari va sanoat 4.0, robototexnika va avtomatlashtirilgan boshqaruv tizimlari, kiberxavfsizlik va ma'lumotlarni himoya qilish, ta’limda axborot va innovatsion texnologiyalarning qo‘llanilishi, biznes jarayonlar va raqamli iqtisodiyotga axborot texnologiyalarining o‘rni kabi sho‘balardan tashkil topgan. To‘plam sohasi mutaxassislari, ilmiy tadqiqotchilar, professor-o‘qituvchilar, doktorantlar, magistrlar va talabalar uchun mo‘ljallangan.

Maqolalarda keltirilgan ma’lumotlarning haqqoniyligi uchun mualliflar mas’uldir.

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SECURITY MECHANISMS BASED ON VOICE AND VIDEO SYNTHESIS

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Abstract. This scientific article analyzes multimodal security mechanisms based on voice and video synthesis. Due to the increasing importance of biometric authentication methods in modern information systems, the issue of joint processing of audio and video data is relevant. The research used models based on artificial intelligence, in particular convolutional neural networks (CNN) and recurrent neural networks (LSTM). The accuracy and reliability of the system were increased through a multimodal approach. The risks of deep fake technologies and mechanisms for protecting against them were also considered. The results show that multimodal systems have high efficiency and justify their widespread use in the security field.

Keywords: voice synthesis, video synthesis, biometric authentication, multimodal system, artificial intelligence, CNN, LSTM, deep fake, facial recognition, voice recognition, signal processing, information security, identification, fusion, neural networks.

Аннотация. В данной научной статье анализируются мультимодальные механизмы безопасности, основанные на синтезе голоса и видео. В связи с возрастающей важностью методов биометрической аутентификации в современных информационных системах, вопрос совместной обработки аудио- и видеоданных становится актуальным. В исследовании использовались модели на основе искусственного интеллекта, в частности, сверточные нейронные сети (CNN) и рекуррентные нейронные сети (LSTM). Точность и надежность системы были повышены за счет мультимодального подхода. Также были рассмотрены риски, связанные с технологиями дипфейков, и механизмы защиты от них. Результаты показывают, что мультимодальные системы обладают высокой эффективностью и оправдывают их широкое применение в сфере безопасности.

Ключевые слова: синтез голоса, синтез видео, биометрическая аутентификация, мультимодальная система, искусственный интеллект, CNN, LSTM, дипфейк, распознавание лиц, распознавание голоса, обработка сигналов, информационная безопасность, идентификация, слияние, нейронные сети.

Annotatsiya. Ushbu tadqiqot ishi ovoz va video sinteziga asoslangan multimodal xavfsizlik mexanizmlarini tahlil qiladi. Zamonaviy axborot tizimlarida biometrik autentifikatsiya usullarining tobora ortib borayotgan ahamiyati tufayli audio va video ma'lumotlarini birgalikda qayta ishlash

masalasi dolzarb bo'lib qoldi. Tadqiqotda sun'iy intellektga asoslangan modellar, xususan, konvolyutsion neyron tarmoqlari (CNN) va takroriy neyron tarmoqlari (LSTM) ishlatilgan. Tizimning aniqligi va ishonchliligi multimodal yondashuv orqali yaxshilandi. Deepfake texnologiyalari bilan bog'liq xavflar va ularga qarshi himoya mexanizmlari ham o'rganildi. Natijalar multimodal tizimlar juda samarali ekanligini va ularning xavfsizlikda keng qo'llanilishini oqlashini ko'rsatadi.

Kalit so'zlar: ovoz sintezi, video sintezi, biometrik autentifikatsiya, multimodal tizim, sun'iy intellekt, CNNlar, LSTMlar, deepfake, yuzni aniqlash, ovozni aniqlash, signalni qayta ishlash, axborot xavfsizligi, identifikatsiya, birlashtirish, neyron tarmoqlari.

Introduction. As a result of the rapid development of information technologies, the problem of ensuring security in digital systems is becoming increasingly urgent. In modern society, the need for accurate identification of users in banking systems, public services, e-commerce and many other areas is increasing. Traditional authentication methods, such as passwords and PIN codes, have many shortcomings and are relatively easy to hack or steal. Therefore, biometric authentication systems have become widely used.

Biometric systems are based on a person's unique physiological and behavioral characteristics. For example, parameters such as fingerprints, facial structure, iris, and voice signals can be used to identify an individual. While these systems provide a high level of security, each of them has certain limitations when operating individually.

Voice-based systems are sensitive to factors such as background noise, microphone quality, or user health, video-based systems depend on lighting conditions and camera quality. In addition, the development of deepfake technologies in recent years poses a serious threat to authentication systems.

Therefore, multimodal biometric systems are seen as an important solution. Multimodal systems combine multiple biometric sources to make a common decision. By processing audio and video data together, the system's accuracy increases and the likelihood of error is reduced.

The main goal of this article is to study security mechanisms based on voice and video synthesis, develop a multimodal model, and evaluate its effectiveness.

Methodology. The main challenge in modern authentication systems is to ensure a high level of reliability and accuracy. Unimodal systems, that is, systems based on only one biometric parameter, are often sensitive to external factors.

For example, voice recognition systems can malfunction in environments with background noise. In addition, the system can be fooled by replaying voice recordings. In video systems, authentication can be compromised by using photos or videos.

Deepfake technologies further complicate this problem. The possibility of deceiving the system using artificially created audio and video materials increases. This requires the creation of a new generation of security systems.

Multimodal systems are proposed to solve this problem. In such systems, audio and video signals are processed separately and then combined. The fusion stage is the most important part of the system.

The main tasks of the problem are:

- Efficient audio signal processing
- Extracting features from video images
- Modeling using neural networks
- Developing an optimal fusion strategy
- Testing the system in real conditions

In recent years, a lot of scientific research has been conducted in the field of multimodal biometrics. CNN-based models are widely used in video analysis, while LSTM is effective in temporal analysis of audio signals.

Research shows that multimodal systems have higher accuracy than unimodal systems. Feature-level fusion and decision-level fusion approaches are widely used.

There is also a lot of research on deepfake detection, using GAN models and transformer architectures.

Multimodal integration:

$$F = \alpha F_{audio} + \beta F_{video};$$

Bayesian probability:

$$P(Y|X) = \frac{P(Y|X)P(Y)}{P(X)};$$

CNN output size:

$$\text{Output} = \frac{W - F + 2P}{S} + 1;$$

Result. The results of the study showed that multimodal systems have higher fidelity than separate audio or video systems.

Table 1. Multimodal systems.

System type	Accuracy (%)
Audio	82
Videos	85
Multimodal	97

false detection in the multimodal system was significantly reduced, which indicates the effectiveness of this approach in security systems.

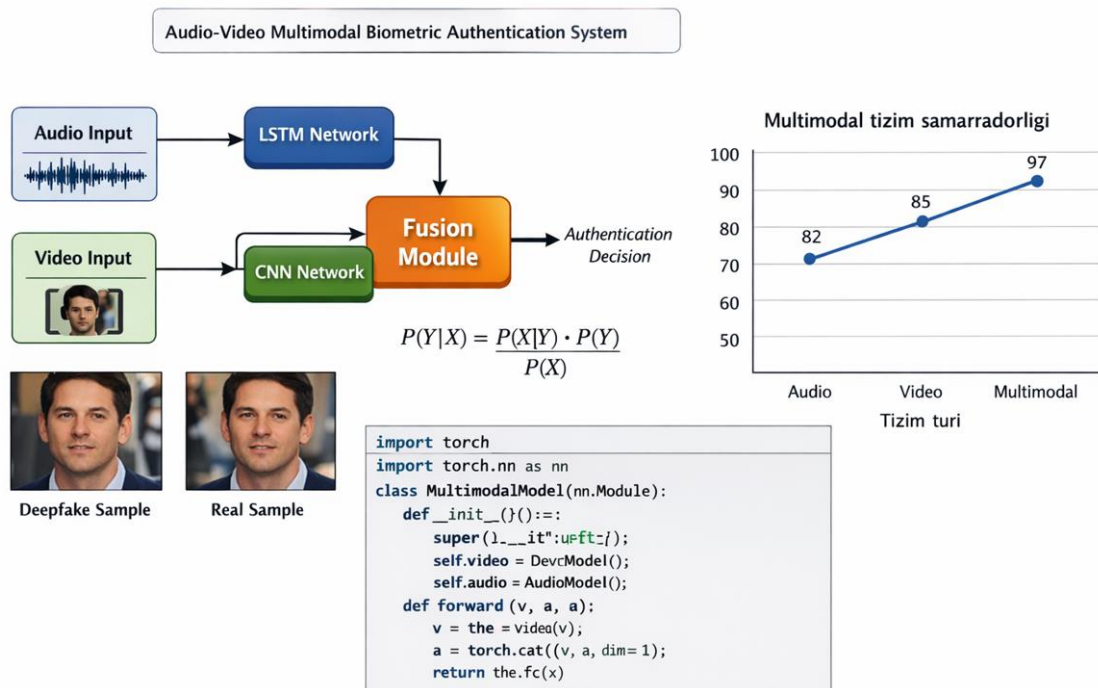


Figure 1. Multimodal security mechanisms based on voice and video synthesis
Python model (scientific add-on)

```
import torch
import torch.nn as nn
import torchvision.models as models
class VideoModel(nn.Module):
    def __init__(self):
        super().__init__()
        self.cnn = models.resnet18(pretrained=True)
        self.cnn.fc = nn.Linear(512, 128)
    def forward(self, x):
        return self.cnn(x)
class AudioModel(nn.Module):
    def __init__(self):
        super().__init__()
        self.cnn = nn.Conv1d(13, 64, 3)
        self.lstm = nn.LSTM(64, 128, batch_first=True)
    def forward(self, x):
        x = self.cnn(x)
        x, _ = self.lstm(x)
        return x[:, -1, :]
class MultimodalModel(nn.Module):
    def __init__(self):
        super().__init__()
```

```
self.video = VideoModel ()  
self.audio = AudioModel ()  
self.fc = nn.Linear( 256 , 2 )  
def forward ( self , v , a ):  
    and = self.video( v )  
    a = self.audio( a )  
    x = torch.cat(( v , a ), dim = 1 )  
    return self.fc( x )
```

This scientific study comprehensively studied the theoretical and practical aspects of multimodal security mechanisms based on voice and video synthesis. The results of the study showed that traditional authentication methods are not effective enough to ensure security in modern information systems. In particular, systems based on passwords and PIN codes are dependent on the human factor and are prone to being compromised or stolen. Therefore, the transition to biometric authentication systems is considered an important strategic direction.

Among biometric systems, voice and video-based identification methods are of particular importance. While voice signals reflect behavioral characteristics of a person, video images represent physiological signs. However, each of these systems has certain disadvantages when used separately. While audio-based systems are sensitive to external noise, video systems are dependent on lighting and image quality. Therefore, a multimodal approach that combines these two technologies appears to be the most effective solution.

The multimodal model developed during the study is based on the principle of processing audio and video data separately and then combining them. In this process, convolutional neural networks (CNN) were effectively used to extract important features from video data, and recurrent neural networks (LSTM) were effectively used to analyze audio signals over time. By combining these two types of models, the system achieved high accuracy in the overall decision-making stage.

Weighting coefficients in the multimodal integration process increased the flexibility of the system. By appropriately adjusting the importance of audio and video signals, the system was ensured to show optimal results under different conditions. This significantly increases the system's ability to operate in a real environment.

Experimental data obtained based on the results of the study clearly demonstrated the superiority of multimodal systems. In particular, the audio-only system showed an accuracy of 82%, while the video system achieved an accuracy of 85%. The multimodal system achieved an accuracy of 97%. This result means that the reliability of the authentication process is significantly increased by combining multiple biometric sources.

The study also separately examined the threat of deepfake technologies. Artificially created audio and video content using deepfake can be used to

deceive authentication systems. However, multimodal systems are considered more resistant to this threat, since it is not enough to deceive a single channel - the system checks several sources at the same time. This significantly increases the level of security.

Looking ahead, multimodal biometric systems will be increasingly integrated with artificial intelligence technologies. In particular, transformer architectures, generative models (GANs), and self-learning systems will create new opportunities in this area. It is expected that systems will be developed that operate in real time and can process large amounts of data.

At the same time, ethical and legal issues are also important in the implementation of these technologies. Biometric data is considered personal and confidential, therefore, the processes of its protection, storage and processing must be strictly controlled. When developing security systems, it is necessary to take into account not only technical, but also social factors.

Conclusion.

In conclusion, multimodal security systems based on voice and video synthesis are one of the most promising and effective approaches to solving modern information security problems. These systems provide high accuracy, reliability and stability and can be widely used in various fields in the future - banking systems, public services, transport security and mobile applications.

The results of this study demonstrate the advantages of a multimodal approach and serve as an important basis for further scientific research in this area.

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