Journal of Engineering Science | *Vol. XXXI, no. 4 (2024), pp. 84 - 94*
Fascicle *Electronics and Computer Science* *ISSN 2587-3474*
Topic *Electronics and Communication* *eISSN 2587-3482*

https://doi.org/10.52326/jes.utm.2024.31(4).06
UDC 004.522:811.135.1:621.865.8

ANALYSIS AND EVALUATION OF ROMANIAN VOICE COMMANDS FOR THE CONTROL OF MECHATRONIC SYSTEMS

Olesea Borozan *, ORCID: 0000-0003-1091-5506

Technical University of Moldova, 168 Ștefan cel Mare Blvd., Chisinau, Republic of Moldova
* Corresponding author: Olesea Borozan, *olesea.borozan@ia.utm.md*

Received: 10. 22. 2024
Accepted: 12. 05. 2024

Abstract. This paper focuses on the analysis and evaluation of voice commands for controlling mechatronic systems in exceptional situations. It highlights the role and benefits of mechatronic devices in modern society, emphasizing their use across various fields, from industrial process automation and infrastructure to consumer electronics and energy. Significant benefits of these devices, such as comfort, efficiency, and technological innovation, are outlined, along with the risks associated with their use, including short circuits and electro-mechanical failures. The research is directed towards integrating voice emotion recognition technologies into the control systems of household appliances to handle exceptional situations. Emotion recognition from speech, based on artificial intelligence and voice signal processing, is described as an interdisciplinary approach that combines audio processing, voice feature extraction, and machine learning. The objectives include developing effective techniques and methods to classify emotions and ensure the safe operation of devices. Research results show the potential of these techniques and technologies to transform interactions with mechatronic systems, offering innovative solutions for enhancing performance and reducing the risks associated with complex activities. The study opens new directions for integrating artificial intelligence into production processes and creating safer, more intuitive working environments.

Keywords: *industrial processes, robotic systems, human-machine interaction, natural language processing, voice recognition, emotional voice control, exceptional situations, neural network, emergency intervention.*

Rezumat. Lucrarea este axată pe analiza și evaluarea comenzilor vocale pentru controlul sistemelor mecatronice în situații excepționale. Sunt subliniate rolul și beneficiile dispozitivelor mecatronice în societatea modernă, subliniind utilizarea acestora în diverse domenii, de la automatizarea proceselor industriale și infrastructură până la electronica de consum și energetică. S-au scos în evidență beneficiile semnificative ale acestor dispozitive, precum confortul, eficiența și inovația tehnologică, dar și riscurile asociate exploatării lor, inclusiv scurtcircuitele și defectele electro-mecanice. Cercetările sunt orientate pe integrarea tehnologiilor de recunoaștere a emoțiilor vocale în sistemele de control ale dispozitivelor electrocasnice pentru a gestiona situațiile excepționale. Recunoașterea emoțiilor din vorbire, bazată pe inteligență artificială și prelucrarea semnalelor vocale, este descrisă ca o abordare interdisciplinară care combină procesarea audio, extragerea de caracteristici vocale și învățarea automată. Obiectivele includ dezvoltarea unor tehnici și metode eficiente care să clasifice emoțiile și să asigure funcționarea dispozitivelor în regimuri sigure. Rezultatele cercetării arată potențialul acestor tehnici și tehnologii de a transforma interacțiunea cu sistemele mecatronice, oferind soluții inovatoare pentru îmbunătățirea performanței și reducerea riscurilor asociate activităților complexe. Studiul deschide noi direcții pentru integrarea inteligenței artificiale în procesele de producție și pentru crearea unor medii de lucru mai sigure și mai intuitive.

Cuvinte-cheie: *proces industrial, sistem robotic, interacțiune om-mașină, procesarea limbajului natural, recunoașterea vorbirii, control emoțional vocal, situații excepționale, rețea neuronală, intervenții de urgență.*

1. Introduction

Modern society cannot be imagined without the presence of various electro-mechanical devices, which serve to automate different fields of human activities. These devices are found everywhere: in systems for the automation of technological, industrial, and robotic processes [1]; in transportation and infrastructure to ensure the functionality of vehicles and transport systems [2]; in medical equipment to provide precise and efficient diagnosis and treatment [3]; in consumer electronics represented by household appliances [4]; in energy and environmental sectors, where they are used for the production and distribution of energy, as well as in environmental protection equipment [5], and so on.

Household appliances (such as electric and gas stoves, coffee makers, vacuum cleaners, blenders, irons, water heaters, etc.) play a particularly significant role in modern society, as they are omnipresent in their operation and bring a range of benefits and conveniences. These devices use electrical and mechanical technology to perform various household functions, transforming people's lifestyles into one of maximum comfort and efficiency. Some of the most important benefits offered by these appliances include comfort and efficiency, time and energy savings, connectivity and automation, diversity, and innovation. Through continuous innovation and technological development, these devices have secured a dominant place in modern society [6].

Alongside the benefits brought by household appliances, these devices can also pose certain risks to human life and health, such as fires and short circuits, electric shocks, explosions, mechanical failures, etc. All of these risks can be prevented by following proper usage and maintenance guidelines. However, during the operation of household appliances, exceptional situations may arise in which these devices can negatively impact health or present a risk to human life [6, 7]. In such cases, it is essential to have mechanisms in place to intervene in their operation by stopping or switching them to a maximum safety mode.

It is evident that emerging situations trigger an immediate response in the human body through emotions, including vocal emotions, which can be identified and used for emergency interventions in the functionality of household appliances. Emotions play a significant role in the communication process. They influence voice tone, speech rate, intonation, and other aspects of verbal expression. Tone and intonation can convey emotions such as happiness and joy, as well as fear, anxiety, or sadness. Negative emotions can also impact the rhythm and speed of word pronunciation, making speech unclear or difficult to identify [8].

Speech emotion processing and recognition [9–12] is an interdisciplinary field of research focused on identifying and interpreting the feelings and emotional states expressed in a person's vocal discourse. In the first stage, the vocal signal is processed to eliminate noise and extract relevant features. This process may include signal filtering, sound level normalization, and segmenting the speech into analysis intervals. In the second step, vocal signal features are extracted to capture emotion-related information, including fundamental frequency, intensity, rhythm, pitch, pauses, and other aspects of voice modulation. In the third step, the extracted features are used to build emotion recognition models, which can be based on machine learning techniques such as neural networks, support vector machines, or supervised learning algorithms. These models are trained on a dataset labeled with emotions to learn the characteristic patterns of various emotional states. In the fourth step, the emotion recognition models are evaluated using separate datasets and adjusted according to their performance. This evaluation and adjustment process may involve optimizing model parameters or applying performance enhancement techniques, such as adding supplementary features or using natural language processing techniques [13,14].

Speech emotion processing and recognition is a rapidly evolving field of research that involves a wide range of techniques, technologies, and methods to identify and interpret emotions expressed in human vocal discourse. These technologies have the potential to significantly enhance human-machine interaction and contribute to the development of more responsive and intuitive systems. Speech emotion recognition has a wide array of practical applications in fields such as voice-assisted technology, speech recognition technology, discourse analysis, mental health, and human-machine interaction [15,16].

This paper presents the results of research conducted in the design of control systems for electro-mechanical devices based on vocal emotions in emergency situations. The research objectives are focused on: developing a mechanism for identifying and analyzing vocal emotions that will highlight vocal characteristics according to emotional state in emergency situations; developing a model and algorithm for emotion recognition and classification in emergency contexts, based on vocal signal processing and artificial intelligence; integrating emotions into the control systems of household electro-mechanical devices; selecting and justifying keywords expressed in exceptional situations; and evaluating and validating the results.

2. Statement of the Research Problem

The objectives of the conducted research are aimed at identifying technical and technological solutions that will enable the integration, identification, interpretation, and utilization of vocal emotions in the control process of electro-mechanical devices, particularly household appliances, in exceptional or emergency situations to enhance their effectiveness and safety. By identifying and interpreting emotions expressed in the user's vocal discourse, the devices are programmed to respond appropriately to manage crisis situations or prevent potential risks. Thus, an innovative approach is proposed to improve the performance and safety of electro-mechanical devices, enhancing their functionality and response in emergency situations, critical conditions, or under stress.

In line with the defined objectives, the focus of this work is the development of advanced vocal emotion recognition technology and its integration into the control systems of electro-mechanical devices, particularly ubiquitous household appliances, with the aim of enabling more intuitive and efficient interactions between the user and the device.

3. Synthesis Functional Diagram of the Control System

The functional diagram for controlling electro-mechanical devices in exceptional situations based on vocal emotions is presented in Figure 1. The functional diagram includes the following components:

User – the person using the electro-mechanical system, who in normal operation can engage in discussions without emotions, but in emergency situations pronounces specific words related to the exceptional situation that will trigger the device to switch to a heightened safety mode. ***MK*** – microphone for perceiving sound waves and converting them into electrical signals. ***AM –*** amplifier of the electrical signals. ***Filter*** – a filter to exclude noise from the electrical signals caused by sounds generated by the user. ***ADC*** – Analog-to-Digital Converter synchronized with the frequency of the sound waves generated by the user. ***ANN*** – Artificial Neural Network adjusted to identify words and vocal emotions, generating control signals for the operational mode of the electro-mechanical device. ***EMD*** – Electro-mechanical device equipped with a safety system based on vocal emotions.

This diagram highlights the integrated flow of components that work together to analyze vocal emotions and adjust the device's operation accordingly to ensure safety in critical situations.

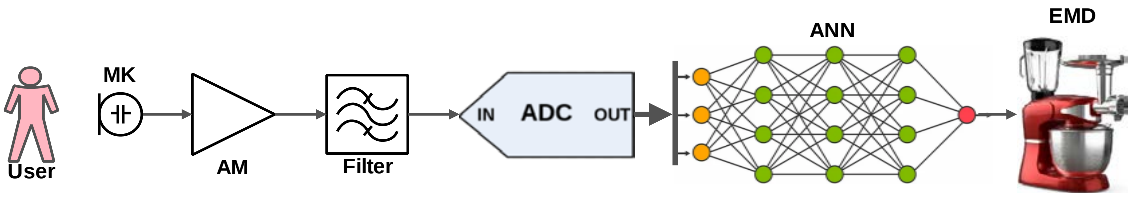


Figure 1. The functional diagram of the emotional voice control system.

4. Analysis and Evaluation of Words Pronounced by Humans in Exceptional Situations

Emotions in speech are pivotal in human communication, significantly shaping how messages are conveyed and understood. They add depth and context to words, influencing their interpretation by the receiver, whether it's another human, a machine, or an AI-powered robot. Emotions enrich spoken language, offering nuanced meanings and facilitating more effective interactions. By studying how emotions are expressed, perceived, and interpreted in speech, several critical scenarios and implications can be identified for enhancing human-to-human and human-machine communication:

The tone of voice can convey a range of emotions, such as joy, anger, fear, or dread, significantly impacting how the message is received. The speaker's emotional state influences the listener's perception and interpretation of the message, adding layers of meaning beyond the words themselves.

A message delivered with enthusiasm, happiness, or joy can elicit a positive response, whereas one expressed with sadness or disappointment is more likely to evoke feelings of compassion and empathy.

A tone that is aggressive or defensive can strain relationships, whereas a supportive tone has the potential to deepen emotional bonds and foster stronger connections.

Speech infused with emotions can be a powerful tool to influence or persuade the recipient's decision-making process.

- In human interactions, emotions conveyed through speech enrich communication by adding depth and nuance, enabling a more precise understanding and interpretation. This dynamic can also extend to interactions between humans and machines, as well as machines and humans.

The studies referenced in sources [17-22] explore the expression of emotional words by humans in exceptional circumstances. These emotions are categorized into various types, including joy, sadness, fear, suffering, panic, anger, frustration, admiration, or astonishment. In scenarios of human-machine communication during exceptional situations, emotional words typically associated with fear, suffering, or panic are especially identifiable.

Assessing emotional words spoken by individuals in exceptional circumstances is a nuanced and subjective endeavor. However, various methods can be employed to better understand and interpret their emotional resonance across different contexts. These methods include [23]: Lexical Analysis, Vocal Tone Analysis, Intuition and Empathy, Context Analysis.

To identify the key words pronounced by humans in various exceptional situations, a survey was conducted with multiple-choice selection, involving a sample of over 150 participants. For evaluation, emotional situations were simulated: ”***Spaimă***” (Fear), ”***Suferință***” (Suffering), ”***Furie***” (Anger), ”***Frică***” (Terror), ”***Alarmă***” (Alarm) and ”***Surpriză”*** (Surprise)**.** Words were proposed for evaluation that had a higher probability of being pronounced in various exceptional situations: ”***Start***”, ”***Stop***”, ”***Ajutor***”, ”***A-a-u-u-u***”, ”***Help***” and ”***SOS***”. The results of the survey are presented in Table 1.

Table 1

The results of human-pronounced keyword evaluation in exceptional situations

	Start	Stop	Ajutor	A-a-u-u-u	Help	SOS	Total	%, max.*
Spaimă	17	49	48	25	29	20	188	26.06
Suferintă	12	30	30	71	31	9	183	38.80
Furie	20	89	15	17	12	9	162	54.94
Frică	12	33	57	20	35	24	181	31.49
Alarmă	35	52	23	11	22	38	181	28.73
Surpriză	84	15	9	42	4	7	161	52.17
Total	180	268	182	186	133	107		
%, max.*	46.67	33.21	31.32	38.17	26.32	35.51		

Note: % max. - maximum value obtained as a result of the survey.

Thus, based on the analysis of the survey results, we can conclude that:

- The word ”***Start***” it is pronounced 84 times in emotional situations of ”***Surpriză***”, which constitutes 46.67%.
- The word ”***Stop***” it is pronounced 89 times in emotional situations of ”***Furie***”, which accounts for 33.21%, and 52 times in emotional situations of “***Alarmă***”, which accounts for 19.40%, and 49 times in emotional situations of “***Spaimă***”, which accounts for 18.28%.
- The word “***Ajutor***” is pronounced 57 times in emotional situations of “***Frică***”, which constitutes 31.32%, and 48 times in emotional situations of “***Spaimă***”, which constitutes 26.37%.
- The word “***A-a-u-u-u***” is pronounced 71 times in emotional situations of “***Suferință***”, which constitutes 38.17%, and 42 times in emotional situations of “***Surpriza***”, which constitutes 22.58%.

- The word "***Help"*** is pronounced 35 times in emotional situations of "***Frică***", which constitutes 26.32%, and 31 times in emotional situations of "***Suferință***", which constitutes 23.30%.
- The word ***"SOS***" is pronounced 38 times in emotional situations of "***Alarmă",*** which constitutes 35.51%, and 24 times in emotional situations of "***Frică***", which constitutes 22.43%.
- In an emotional state of "***Spaimă***", the word ***"Stop"*** is pronounced 49 times, which constitutes 26.06%.
- In an emotional state of "***Suferință***", the word "***A-a-u-u-u"*** is pronounced 71 times, which constitutes 38.80%.
- In an emotional state of "***Furie***", the word "***Stop"*** is pronounced 89 times, which constitutes 54.94%.
- In an emotional state of ***"Frică***", the word "***Ajutor"*** is pronounced 57 times, which constitutes 31.49%.
- In an emotional state of ***"Alarmă",*** the word ***"Stop"*** is pronounced 52 times, which constitutes 28.73%.
- In an emotional state of ***"Surpriză***", the word ***"Start"*** is pronounced 84 times, which constitutes 52.17%.

As a result of the survey analysis, it can be concluded that to intervene in exceptional situations during the operation of an electro-mechanical system, the key words ***„Stop"*** and ***„Ajutor"*** specific to the Romanian language can be used.

5. Spectral Analysis of Waveform (Sound) of the Selected Keywords

For the spectral analysis of the selected key words for commands with mechatronic systems in exceptional situations, a software product was developed in Python using the TensorFlow and Keras libraries.

Spectral analysis of sound is the process of decomposing the sound signal, generated by a human, into its frequency components. It is performed to visualize and analyze the frequency and intensity spectrum of the signal. This analysis allows distinguishing between sounds generated by the human in normal and emotional states, thereby enabling the identification of the operator's emotional state.

The spectral analysis algorithm involves the following steps:

Capturing the sound signal, which involves acquiring the sound using a microphone (see Figure 1).

The transformation of the signal into the frequency domain. The sound signal is passed through a transformation algorithm, such as the Fourier Transform, which decomposes it into sinusoidal components at different frequencies.

Visualization of the spectrum. The frequency and intensity spectrum is visualized in the form of a spectrogram. This is a graph that shows the intensity of the signal as a function of frequency and time.

Spectrum analysis. The spectrum is analyzed to identify the signal's characteristics, such as the fundamental frequency (pitch), harmonics, and vocal formants.

Interpretation of the results. The results of the spectral analysis are interpreted to gain a deeper understanding of the signal and its acoustic characteristics. This may involve identifying patterns or anomalies in the spectrum and evaluating their impact on the signal, ultimately identifying the emotional state of the individual.

Therefore, spectral analysis of sound allows for the understanding of the characteristics of the audio signal and the evaluation of its impact in various contexts, providing an effective way to investigate and interpret the information present in sound signals.

In Figure 2, the results of processing and analyzing the sound generated for the word ***"Ajutor"*** in a neutral (non-emotional) state are presented: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

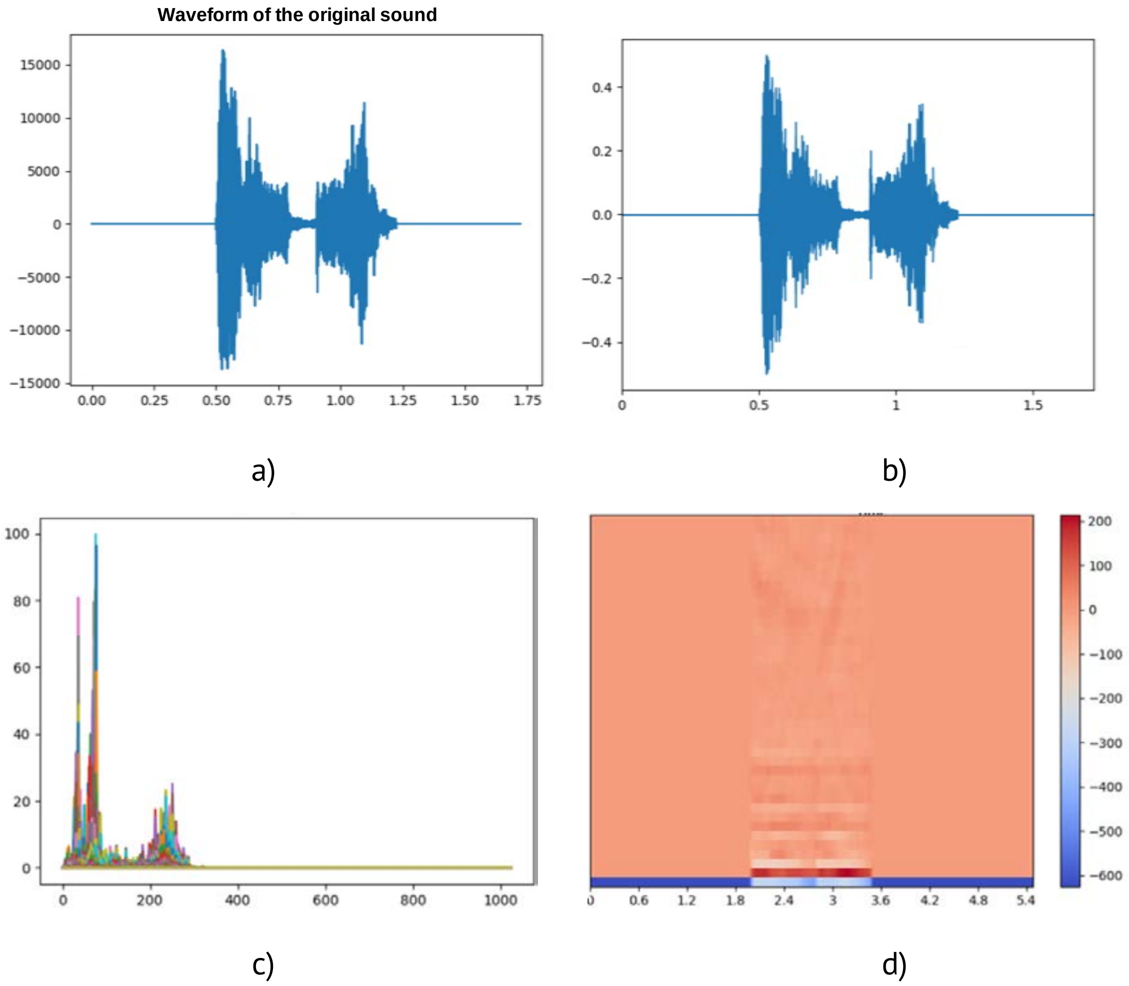
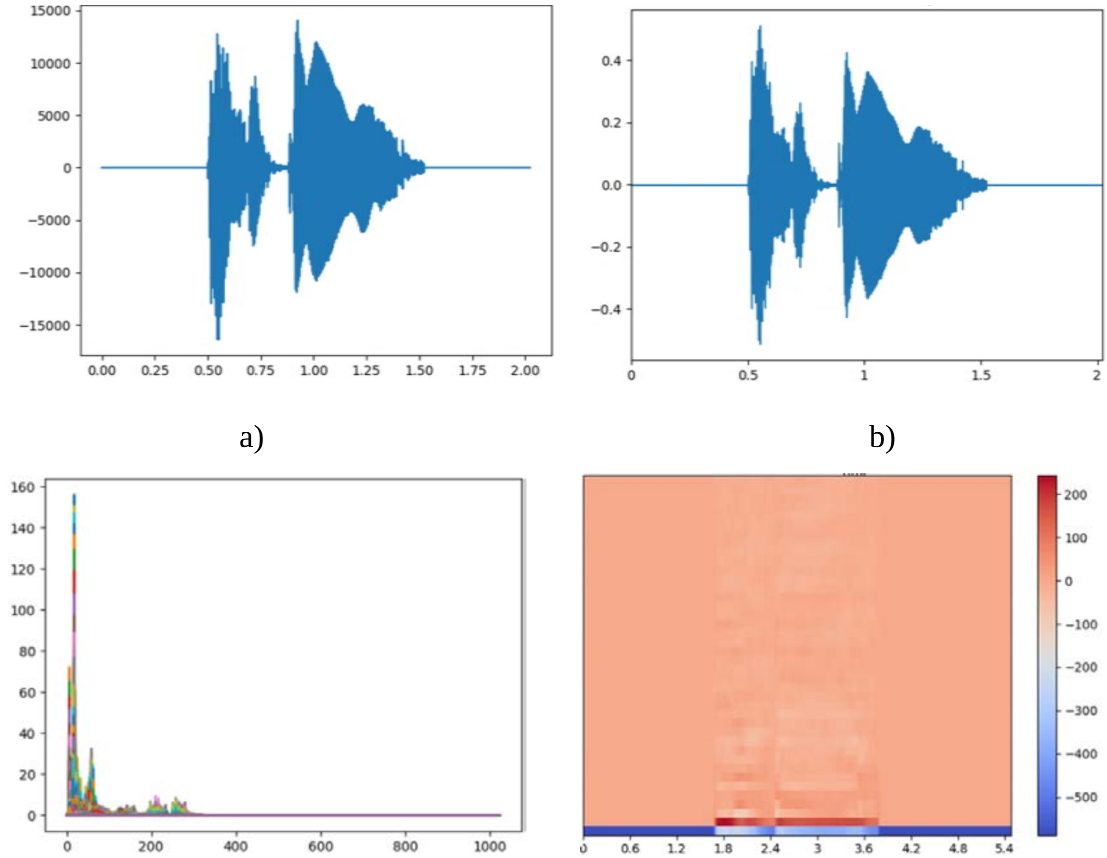


Figure 2. The results of processing and analyzing the sound generated for the word *"Ajutor"*: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

In Figure 3, the results of processing and analyzing the sound generated for the word ***"Ajutor"*** in an emotional state of fear are presented: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

The comparative analysis of the diagrams shows a significant difference between the normal and emotional states of the human when pronouncing the word *"**Ajutor",*** thus allowing the identification of the emotional state, which will lead to initiating the procedure for switching the mechatronic system to a maximum safety mode.

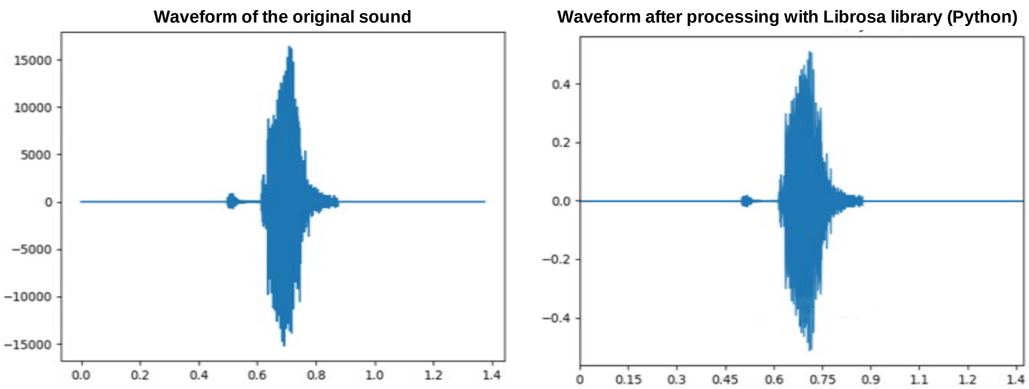


a) b)

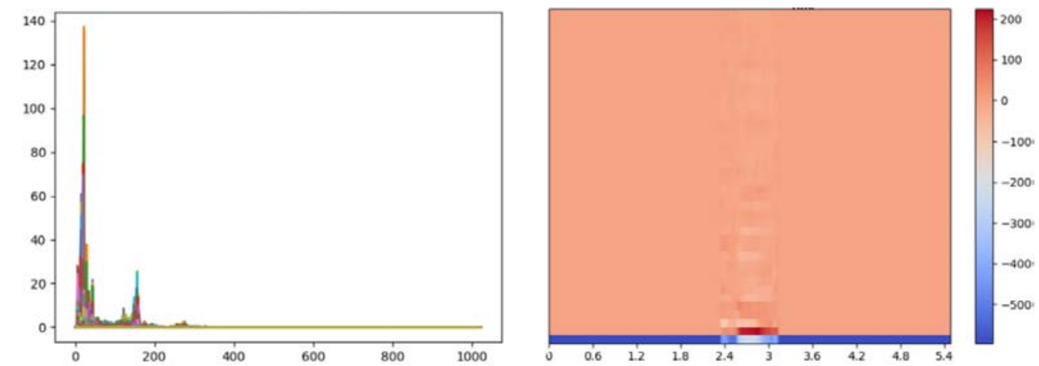
c) d)

Figure 3. The results of processing and analyzing the sound generated for the word "*Ajutor*" in an emotional state of fear: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

In Figure 4, the results of processing and analyzing the sound generated for the word "***Stop***" in a neutral (non-emotional) state are presented): a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.



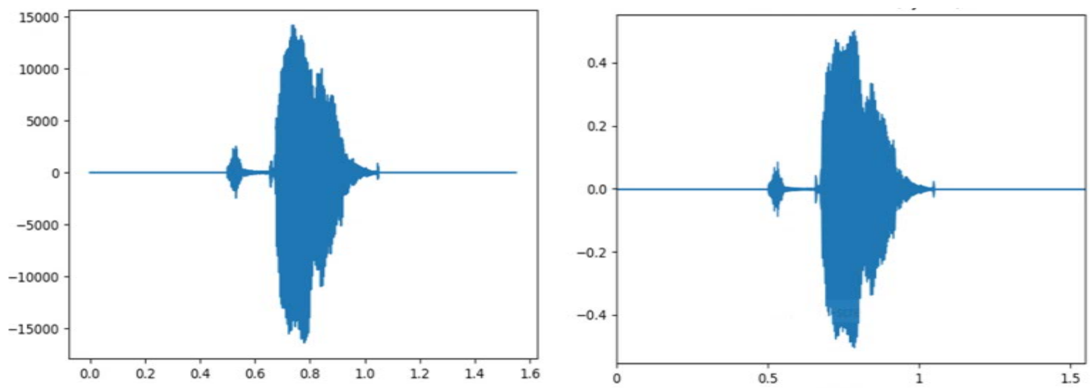
a) b)



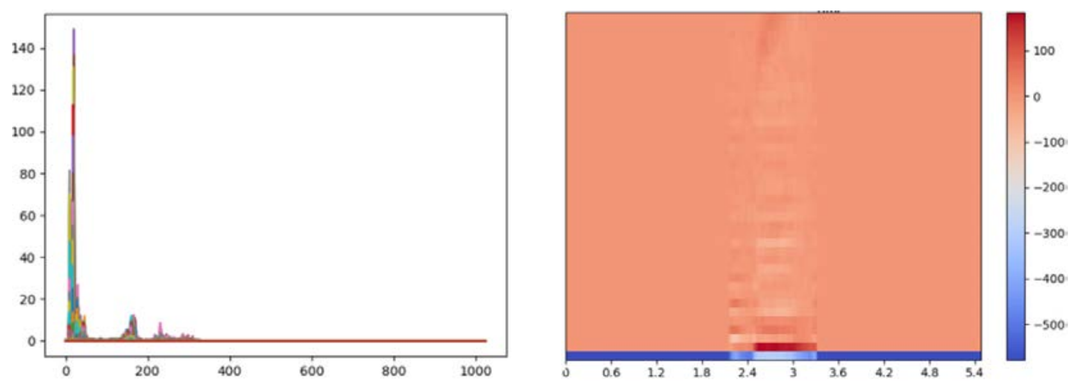
c) d)

Figure 4. The results of processing and analyzing the sound generated for the word *"Stop"*:): a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

In Figure 5, the results of processing and analyzing the sound generated for the word ***"Stop"*** in an emotional state of fear are presented: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.



a) b)



c) d)

Figure 5. The results of processing and analyzing the sound generated for the word *"Stop"* in an emotional state of fear: a) Waveform of the original Sound; b) Waveform after processing with Librosa library from Python; c) spectrogram Frequency-Amplitude; d) Log-Mel Spectrogram Time-Power-Frequency.

The comparative analysis of the diagrams in Figure 4 and Figure 5 shows a significant difference between the normal state and the emotional state of the human when pronouncing the word "***Stop***", thus offering the possibility to identify the emotional state that will trigger the procedure to transition the mechatronic system into a maximum safety mode or stop its operation.

6. Conclusions

This paper addresses a current interdisciplinary topic focused on the integration of voice emotion recognition technologies into the control systems of mechatronic devices, particularly household appliances. In the context of a society increasingly dependent on technology, the proposed approach aims to enhance safety, efficiency, and human-machine interaction by using emotions as a significant input in exceptional situations.

The defined objectives of the research highlight the relevance and potential of implementing these techniques and technologies across various fields, from household mechatronic systems to more complex industrial robotic systems. The identification and use of vocal emotions in device control meet the emerging needs for safety and personalization in the use of household appliances. The importance of advanced artificial intelligence algorithms and neural networks for emotion recognition, optimizing human-device interaction, and reducing risks in critical situations is emphasized.

Integrating voice emotion recognition techniques and technologies into mechatronic devices can redefine safety and comfort standards, with significant implications for their design and use in the near future. The study thus contributes to technological progress and the development of innovative solutions, tailored to a constantly evolving modern society.

For the future, research is planned for the design and implementation of speech emotion processing and identification models using reconfigurable Field-Programmable Gate Array (FPGA) devices, which will significantly reduce costs and system complexity, facilitating widespread adoption.

Acknowledgments: The research conducted in this paper is part of the doctoral thesis topic. The analysis and evaluation of the key words selected for the study were carried out with the technical and technological support provided by the Department of Computer Science and Systems Engineering, Technical University of Moldova.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Aswani, T.B.; Kewalramani, K.; Malekar, N. Industrial Robotics. *International Research Journal of Engineering and Technology* 2020, 7(8), pp. 2329-2332. ISSN: 2395-0056.
2. Rizzoni, G.; Kearns, J. *Principles and Applications of Electrical Engineering*. McGraw-Hill, NY, SUA, 2022, 992 p. ISBN: 978-126-025-804-2.
3. Chapman, S.J. *Electric Machinery Fundamentals*, McGraw-Hill, 5th Edition, New York, NY., USA, 2012, 680 p. ISBN: 978-0-07-352954-7.
4. Dagostino, F.; Wujek, J. *Mecanical and Electrical Systems in Architecture, Engineering and Construction*, Pearson, 5th Edition, Upper Saddle River, New Jersey, USA, 2009, 960 p. ISBN: 978-013-500-004-5.
5. Melkebeek, J.A. *Electrical Machines and Drives. Fundamentals and Advanced Modelling*. Springer, Cham, Switzerland, 2018, 733 p. ISSN: 1860-4676, DOI: 10.1007/978-3-319-72730-1.
6. Wilson, C.; Hargreaves, T.; Hauxwell-Baldwin, R. Benefits and Risks of Smart Home Technologies. *Energy Policy* 2017, 103, pp. 72-83. DOI: 10.1016/j.enpol.2016.12.047.

7. Saleheen, R. U.; Farhan, A.; Ramesha, N. Z.; Tasnim, R.; Erin, M. T. U. R.; Shahria, S. Emerging Applications of Mechatronics. In: *Mechatronics: Fundamentals and Applications*, Springer Nature Singapore, Singapore, 2024, pp. 143-160. DOI: 10.1007/978-981-97-7117-2_7.
8. Monisha, S.T.A.; Sultana, S.; A Review of the Advancement in Speech Emotion Recognition for Indo-Aryan and Dravidian Languages. *Advances in Human-Computer Interaction* 2022, 9602429. DOI: 10.1155/2022/9602429.
9. Lopes, N.; Perkusich, M.; Lima, C. A Review of Emotion Recognition in Speech. *Journal of Information and Data Management* 2019, 10(4), pp. 222-234.
10. Zhang, Z.; Zhao, Y.; Liu, Z. A survey on deep learning for speech emotion recognition. *ACM Computing Surveys* (*CSUR*) 2019, 52(3), pp. 1-33.
11. Ververidis, D.; Kotropoulos, C. Emotional speech recognition: resources, features, and methods. *Speech Communication* 2006; 48(9), pp. 1162-1181.
12. Cowie, R.; Douglas-Cowie, E.; Tsapatsoulis, N.; Votsis, G.; Kollias, S.; Fellenz, W.; Taylor, J. G. Emotion recognition in human-computer interaction. *IEEE signal processing magazine* 2001, 18(1), pp. 32-80.
13. Borozan, O.; Ababii, C.; Roşca, N.; Lungu. I. The Use of Emotions in Speech to Control Exceptional Situation in Robotic Systems. In: *Proceedings of the XVI International Scientific and Practical Conference „Information Technologies and Automation-2023"*, Odessa, Ukraine, October 19-20, 2023, pp. 313-315.
14. Borozan, O. Safety System for Robotic Processes Based on Voice Emotion Recognition. In: *Proceedings of the Workshop on Intelligent Information Systems, WIIS-2023*, Chisinau, Republic of Moldova, October 19-21, 2023, pp. 55-61.
15. Borozan, O.; Turcan, A.; Ababii, C.; Lasco, V.; Struna, V. Speech Processing System for Emergency Management, In: *Proceedings of the International Scientific Conference on Mathematics & IT: Research and Education, MITRE-2023*, Chisinau, Republic of Moldova, 26-29 June, 2023, pp. 75.
16. Ababii, V.; Sudacevschi, V.; Borozan, O.; Fratavchan, V. Decision making system based on voice-emotional commands, In: *Proceedings of the International Scientific and Practical Internet Conference on "Informatics and Computer Technics Problems", PICT-2022*, 10-13 November, 2022, pp. 69-74.
17. Kuhn, L.K., Emotion recognition in human face and voice. PhD thesis, London, 2014; p. 261.
18. Ozseven, T. A novel feature selection method for speech emotion recognition. *Applied Acoustics* 2019, 146, pp. 320-326.
19. Bhardwaj, P.; Debbarma, S. A Study of Methods Involved in Voice Emotion. *International Journal of Advanced Research in Computer and Communication Engineering* 2014, 3(2), pp. 5517-5521.
20. Byun, S.W.; Lee, S.P. A Study on a Speech Emotion Recognition System with Effective Acoustic Features Using Deep Learning Algorithms. *Applied Sciences* 2021, 11(4), 1890.
21. Joshi, A.; Kaur, R. A Study of Speech Emotion Recognition Methods. *IJCSMC* 2013, 2(4), pp. 28 – 31.
22. Kerkeni, L.; Serrestou, Y.; Mbarki, M.; Raoof K.; Mahjoub, M. Speech Emotion Recognition: Methods and Cases Study. In: *Proceedings of the 10th International Conference on Agents and Artificial Intelligence, ICAART 2018,* Funchal, Madeira, Portugal, 24-26 January, 2018, 2, pp. 175-182.
23. Borozan, O. Emotional words uttered in exceptional circumstances, State, achievements and prospects of information systems and technologies. In: *Proceedings of the XXIV All-Ukrainian Scientific and Technical Conference of Young Scientists, Postgraduate Students, and Students* Odessa, Ukraine, April 18-19, 2024; pp. 328-329.

Citation: Borozan, O. Analysis and evaluation of Romanian voice commands for the control of mechatronic systems. *Journal of Engineering Science* 2024, XXXI (4), pp. 84-94. https://doi.org/10.52326/jes.utm.2024.31(3).01.

Publisher's Note: JES stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright:© 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Submission of manuscripts: jes@meridian.utm.md