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AI-Powered Companion Robot for Elderly Care

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Abstract: With the global aging population on the rise, there is a growing need for intelligent systems that assist the elderly in leading independent and healthier lives. This project presents an AI-Powered Companion Robot for Elderly Care, a multi-functional robotic solution integrating artificial intelligence, health monitoring, emotional support, and mobility assistance. The system is controlled through a user-friendly web interface and voice commands, built using a Raspberry Pi and a 4-wheel robotic platform.

The robot offers a wide range of modules including companion- ship through a sentiment-aware chatbot with music and games, real-time health monitoring using sensors like MLX90614 and MAX30102, guided exercises, daily reminders, and an emergency alert system that sends SMS and email notifications to caregivers. One of the key achievements is the seamless integration of voice- enabled control and AI-based interaction, enhancing accessibility and usability.

This project was developed at Konkan Gyanpeeth College of Engineering (KGCE), Karjat, and highlights how technology can bridge the gap in elderly care—ensuring safety, health, and emotional well-being.

Index Terms: Artificial Intelligence, Elderly Care, Companion Robot, Human-Robot Interaction, Machine Learning, Health Monitoring, Smart Assistance, NLP, Fall Detection, Emotion Recognition.

I. INTRODUCTION

With the rise in global life expectancy, the elderly pop- ulation is growing rapidly, leading to increased demand for elderly care solutions that can offer safety, comfort, and emotional well-being. Many elderly individuals live alone or away from their families, which can result in loneliness, health neglect, and difficulty in managing daily activities. Traditional eldercare systems, while helpful, are often limited to basic monitoring or human-dependent caregiving. The advancement of Artificial Intelligence (AI), Internet of Things (IoT), and robotics has opened up new possibilities in the healthcare domain, especially in designing autonomous and intelligent systems that can provide both physical and emotional assis- tance.

Previous research and developments in this field include health monitoring devices, fall detection systems, and sim- ple robotic assistants. Some systems focus on telemedicine, while others address specific health issues like heart rate or blood oxygen monitoring. However, very few systems are comprehensive in nature, combining health monitoring, emotional companionship, emergency support, and remote control in a single unified platform. Robotic companions like Paro (robotic seal) and Pepper (social humanoid robot) have gained popularity, but they often lack integration with real-time monitoring, smart reminders, and web-controlled interfaces. Moreover, such solutions tend to be expensive or limited in functionality for daily personal use.

Our project aims to bridge these gaps by developing an AI-powered robotic companion tailored specifically for el- derly care. This robot not only assists with physical health monitoring and emergency alerts but also provides emotional companionship through an AI chatbot, music therapy, and games. It integrates reminder systems for medication and appointments and features a fall detection mechanism and a manual emergency button that instantly alerts caregivers. Ad- ditionally, the robot and its car can be remotely managed via a web interface, offering full control and monitoring even from a distance. This project was developed at Konkan Gyanpeeth College of Engineering (KGCE), Karjat. By merging multiple technologies into one affordable, user-friendly system, our solution addresses both the emotional and physical needs of the elderly in a holistic way.

II. EASE OF USE

A. User-Centered Design for the Elderly

To ensure ease of use, the companion robot is designed with a user-centered approach. The interface is simplified with large, clear icons, voice interaction capabilities, and adaptive feedback mechanisms. Special consideration is given to the cognitive and physical limitations often associated with elderly users.

B. Maintaining the Integrity of the Specifications

The system architecture adheres to pre-defined technical specifications to maintain consistency and reliability. Modular components are integrated using industry-standard protocols, ensuring that the AI modules (e.g., NLP, fall detection, emotion recognition) operate seamlessly. Rigorous testing is conducted to ensure the robot remains compliant with safety and usability standards.

C. Abbreviations and Acronyms

The following abbreviations and acronyms are used throughout this paper:

- AI — Artificial Intelligence
- ML — Machine Learning
- NLP — Natural Language Processing
- HRI — Human-Robot Interaction
- IoT — Internet of Things
- CNN — Convolutional Neural Network
- SVM — Support Vector Machine
- GPS — Global Positioning System

Each abbreviation is defined upon its first occurrence in the paper to maintain clarity and readability.

D. Units

This project involves both software-based AI techniques and hardware components. Standard SI (International System of Units) is used throughout the system for clarity and consistency. A key hardware component, the MLX90614 infrared temperature sensor, is used to measure the object temperature (e.g., a person's forehead) and ambient temperature. Both readings are obtained in degrees Celsius (°C), adhering to SI unit conventions. Other measurements, such as time (in seconds), voltage (in volts), and distance (in meters), are expressed in SI units. Bounding box calculations for fall detection are processed in pixel units within the computer vision module, while alerts are timestamped in seconds. No mixed units (SI and CGS) are used in any equations or data processing. Decimal values are written with a leading zero for readability (e.g., 0.75 seconds). Units are spelled out in full when appearing in body text (e.g., "several volts") to avoid ambiguity and ensure clarity.

E. Equations

To support the system functionalities, several mathematical computations and algorithms are used. The following equa- tions describe key components in the system:

$$BPM = \frac{SAMPLE\_FREQ \times 60}{average\_peak\_interval} \quad (1)$$

This equation calculates the heart rate (beats per minute) using the time interval between detected peaks in the IR signal. Here, *SAMPLE_FREQ* is the sampling frequency of the sensor, and *average_peak_interval* is the average time difference between consecutive detected peaks.

$$MA[i] = \frac{1}{N}\sum_{j=0}^{N-1} x[i+j] \quad (2)$$

This moving average filter (MAF) is used to smooth the IR signal from the MAX30102 sensor. N is the size of the averaging window, and $x[i]$ is the input IR value at position i.

$$SpO_2 = A - B \cdot R \quad (3)$$

The blood oxygen saturation level (SpO_2) is estimated using a ratio R of AC and DC components of red and infrared signals. A and B are empirically derived constants based on calibration.

$$threshold = height - width \quad (4)$$

This threshold calculation helps determine fall detection based on the aspect ratio of the bounding box detected by YOLO. If $threshold < 0$, a fall is inferred (i.e., the person is lying horizontally).

Equation (1) is used in the heart rate monitoring feature of the MAX30102 module, while Equation (4) is part of the heuristic used for fall detection. Equations (2) and (3) ensure reliable and filtered input for accurate pulse and SpO_2 estimation.

F. Some Common Mistakes

1) The word "data" is plural, not singular. In the context of AI models and algorithms for elderly care, it's important to remember that data refers to multiple data points collected over time.
2) The subscript for the permeability of vacuum µ0, and other common scientific constants, should use zero with subscript formatting, not a lowercase letter "o". For instance, in equations related to sensor technologies used in elderly care, such precision is crucial.
3) In American English, commas, semicolons, periods, ques- tion and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of bold or italic typefaces, to highlight a word or phrase, punctuation should appear outside of the quotation marks. This is particularly important when discussing specific terminology related to AI in your project.
4) A graph within a graph is an "inset", not an "insert". In the visual representation of robot functionalities for elderly care, make sure that insets are used properly to showcase small details, like sensor data.
5) Do not use the word "essentially" to mean "approxi- mately" or "effectively" when describing the AI's capa- bilities. Instead, be precise about its functionalities, such as recognizing emotions or monitoring health.
6) In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep the word lowercase. For instance, if the title is "AI- Powered Companion Robot using Machine Learning for Elderly Care," you may consider changing it to "AI- Powered Companion Robot that Uses Machine Learning for Elderly Care" if it fits better.
7) Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle". In your AI project, use "effect" when discussing the outcomes of AI interventions (e.g., the effect of the robot on elderly care) and "affect" when referring to emotions (e.g., the robot's ability to affect an elderly person's mood).
8) Do not confuse "imply" and "infer". In AI-based appli- cations, it's important to use these terms correctly. For example, the robot might infer health conditions based on sensor data, but the system might imply certain actions based on its programming.
9) The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen. For example, you might refer to the robot as a "non-invasive" system, meaning it doesn't intrude into the elderly person's space unnecessarily.
10) There is no period after the "et" in the Latin abbreviation "et al.". For example, when referring to previous studies in AI and robotics, write "Smith et al." instead of "Smith et al.".
11) The abbreviation "i.e." means "that is", and the abbre- viation "e.g." means "for example". Be precise in your usage when describing specific cases of AI applications in elderly care (e.g., "e.g., emotion recognition technology" and "i.e., AI models designed to assist elderly individu- als").

G. Authors and Affiliations

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H. Figures and Tables

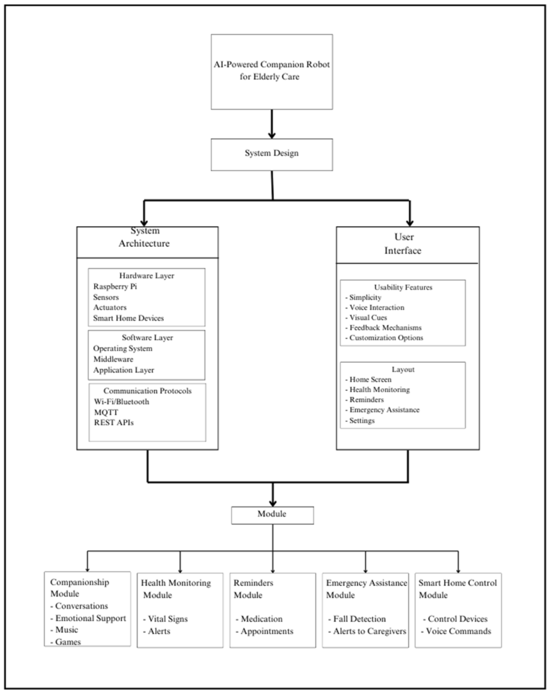


Fig. 1. Flow chart of the system.

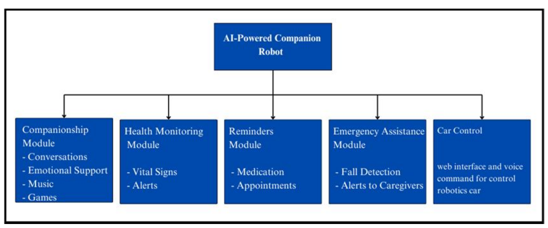


Fig. 2. Block diagram of the AI-powered companion robot.

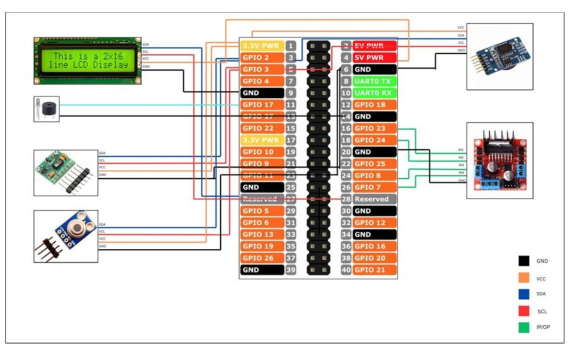


Fig. 3. Wiring diagram of the hardware connections.

Fig. 4. Robotic Web Interface.

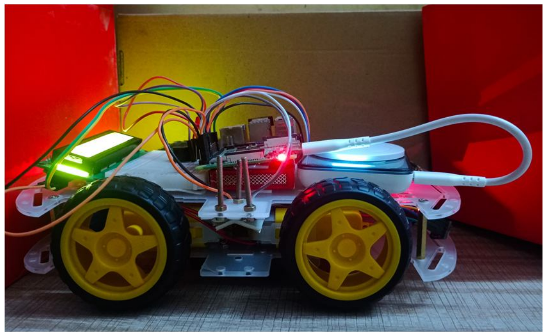


Fig. 5. Robotic Car Model.

III. WIRING DIAGRAM EXPLANATION

Figure 3 illustrates the hardware wiring connections between the Raspberry Pi and various sensors/modules used in the system. This wiring diagram shows the connection of various sen- sors and modules to a Raspberry Pi using its 40-pin GPIO header. Here's a short summary of the components and their connections:

A. *Components Used*

1) 16x2 I2C LCD Display – For visual output.
2) IR Receiver – Used for remote control input.
3) MAX30102 / MLX90614 Sensor – MLX90614 mea- sures temperature; MAX30102 measures heart rate and SpO.
4) L298N Motor Driver – Controls the robot's motors.
5) RTC Module – Keeps track of real-world time.
6) Buzzer and LED – Used for audible and visual alerts.

B. *Wiring Overview*

- Power Connections:
  - VCC (Orange lines): Connected to 3.3V or 5V power pins depending on module requirements.
  - GND (Black lines): All components share a common ground with the Raspberry Pi.
- Communication Protocols:
  - I2C (Blue for SDA, Red for SCL): Shared among the RTC module, MLX90614, MAX30102, and LCD. Connected to GPIO2 (SDA) and GPIO3 (SCL).
- Motor Driver (L298N): Controlled using GPIO18, GPIO23, GPIO24, and GPIO25 (Green lines).
-

IV. SYSTEM ARCHITECTURE

The proposed system is built around a Raspberry Pi micro- controller, acting as the central unit coordinating all subsys- tems. The system integrates multiple hardware and software components to assist elderly individuals in their daily life by offering health monitoring, conversational support, voice- based interaction, and emergency alerting.

- Sentiment-Aware Chatbot: Built using the VADER (Va- lence Aware Dictionary and sEntiment Reasoner) library from NLTK, the chatbot analyzes user input to determine sentiment polarity—*positive*, *negative*, or *neutral*. Based on the sentiment score, the bot tailors its responses to show empathy, encouragement, or comfort, enhancing user engagement and emotional support.
- Health Monitoring Sensors: Two sensors are used:
– MLX90614 – A contactless infrared temperature sensor that provides body temperature readings.
– MAX30102 – An optical sensor used to measure heart rate and blood oxygen levels (SpO2) [12].
- Web Dashboard: Displays real-time health data and chatbot interactions through a Flask-based web interface, accessible to caregivers or family members.
- Voice Control Module: Enables hands-free interaction through speech recognition (using the SpeechRecognition library) and speech synthesis (pyttsx3). Users can engage in voice-based conversations with the chatbot or issue real-time voice

commands to control the robot's movement—such as "Move forward", "Turn left", or "Stop". This dual- functionality system enhances accessibility and user convenience, especially for elderly users with limited mobility.

- Emergency Alert System: The system integrates both manual and automated mechanisms to notify caregivers in emergencies.
- – Web Interface Alert: A dedicated emergency button is provided on the dashboard. When clicked, it instantly sends SMS and email alerts to the caregiver via third-party APIs, notifying them of an emergency situation.
- – Fall Detection: A hybrid approach is used to identify falls:

∗ YOLOv8 Object Detection: [11] Identifies and localizes people in each video frame using bound- ing boxes and confidence scores.

∗ Heuristic Analysis: Calculates the bounding box aspect ratio. A fall is inferred when the bounding box width becomes greater than its height (i.e., the person is lying horizontally). The condition is: threshold = height – width if threshold < 0: fall_detected = True

∗ Notification Logic: Once a fall is detected, an alert is triggered only once per incident using a fall_detected flag to prevent repeated notifications. The system also sends email and SMS alerts to the caregiver.

V. IMPLEMENTATION

The proposed system integrates multiple software compo- nents to form a cohesive and interactive AI-powered elderly care assistant. The implementation combines artificial intelli- gence, speech technologies, web development, and real-time monitoring to ensure reliability and user-friendliness.

- Programming Language: Python was selected as the core development language due to its simplicity, versa- tility, and strong ecosystem of libraries for AI, IoT, and voice processing.
- Artificial Intelligence and Machine Learning:
  - scikit-learn: Used for implementing classical ma- chine learning models such as SVM and Random Forest for fall detection and basic emotion classifi- cation.
  - TensorFlow: Employed for advanced deep learning tasks, particularly in emotion recognition through facial expression and speech tone analysis.
- Voice Interaction Module:
  - SpeechRecognition: Converts user speech into text, enabling hands-free interaction for elderly users.
  - pyttsx3: Converts system outputs, chatbot responses, and emergency alerts into speech, providing audio feedback to the user.
- Web-Based Dashboard: A lightweight dashboard was built using the Flask framework to offer caregivers and family members an intuitive interface. Key features in- clude:
  - Real-time display of biometric data such as heart rate, and oxygen saturation (SpO_2).
  - Activity and interaction logs from the chatbot and voice assistant modules.
  - A manual SOS trigger button for emergencies.
- Alert and Notification System: To ensure quick re- sponse during emergencies, the system integrates with external messaging services:
  - Twilio API: Sends real-time SMS alerts to registered caregivers.
  - SMTP Protocol: Delivers alert emails when abnor- mal sensor readings or emergency commands are detected.

VI. RESULTS

The proposed system was evaluated in a controlled, simu- lated environment involving five elderly participants aged between 65 and 78. The evaluation focused on system responsiveness, accuracy, and user experience across its core functionalities. The key observations are as follows:

– Health Monitoring Performance:

∗ The MLX90614 infrared sensor demonstrated re- liable performance, measuring forehead tempera- ture with a margin of error within ±0.3°C.

∗ The MAX30102 pulse oximeter consistently mea- sured heart rate, with variations remaining within ±3 beats per minute across repeated trials.

– Chatbot Interaction and Sentiment Response:

∗ The sentiment-aware chatbot successfully classi- fied user input into positive, neutral, and negative emotional categories using predefined rules and

ML models.

- ∗ Participants responded favorably to empathetic chatbot replies, which helped in establishing trust and ease of communication.

– Voice Command Recognition:

- ∗ Voice commands such as ” and “I feel sick ”I am happy” were accurately recognized and processed.
- ∗ In quiet indoor settings, the system achieved over 90 percent accuracy in understanding and execut- ing voice commands without the need for physical
interaction.

– Emergency Alert Mechanism:

- ∗ The fall detection mechanism and predefined panic phrases (e.g., “Emergency alert”) reliably triggered emergency alerts.
- ∗ Caregivers received timely notifications via SMS and email during all test scenarios, confirming end-to-end functionality of the alert system.

– Dashboard Monitoring and Accessibility:

- ∗ The web-based dashboard updated sensor data in real time, with graphical visualizations refreshing every few seconds.
- ∗ The interface was intuitive and accessible on both desktop and tablet devices, enabling caregivers to monitor multiple parameters with ease.

VII. CONCLUSION

This project presents an AI-powered companion robot tai- lored for elderly care, combining health monitoring, emo- tional interaction, fall detection, and remote management into a single, affordable platform. The integration of voice commands, sentiment-aware AI chatbot, and emergency alert systems ensures both physical and emotional support for elderly users. Future enhancements include advanced emotion recognition using deep learning, multi-language support for regional accessibility, and integration with medical databases for predictive health analytics.

VIII. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who supported us throughout the development of this project, AI-Powered Companion Robot for Elderly Care. First and foremost, we thank our project guide, [Guide’s Name], for their valuable guidance, encouragement, and continuous support, which were instrumental in shaping this project. We also extend our thanks to the faculty members of the Department of Computer Engineering, Konkan Gyanpeeth College of Engineering, for their insightful suggestions and motivation during various stages of this project. We are deeply grateful to our families and friends for their constant encouragement, patience, and moral support throughout the duration of this work.

REFERENCES

[1] Anjum, F., Gani, R., Isty, M. N., Ali, M. S., and Hasan, M. (2024). IoT-based smart home automation system: Ensuring safety for the elderly. In 2024 2nd International Conference on Advance- ment in Computation Computer Technologies (InCACCT), pages 214–219.

[2] Clara Berridge, A. Y. Z., M. Robillard, J., and Kaye, J. (2023). Companion robots to mitigate loneliness among older adults: Perceptions of benefit and possible deception. Frontiers in Psy- chology, 14:1106633.

[3] Hamim, M., Paul, S., Hoque, S., Rahman, M., and Baqee, I. (2019). IoT based remote health monitoring system for patients and elderly people. pages 533–538.

[4] Hannah Louise Bradwell, Katie Jane Edwards, R. W. S. T. R. B. J. (2019). Companion robots for older people: Importance of user-centred design demonstrated through observations and focus groups comparing preferences of older people and roboticists in south west England. BMJ Open, 9(9):e032468.

[5] KANGMinsoo, Seob, K., Won, S., and Ho, K. (2021). A study on the feasibility of IoT and AI-based elderly care system application. Korean Journal of Artificial Intelligence, 9(2):15–21.

[6] Lu, L.-C., Lan, S.-H., Hsieh, Y.-P., Lin, L.-Y., Lan, S.-J., and Chen, J.-C. (2021). Effectiveness of companion robot care for dementia: A systematic review and meta-analysis. Innov Aging, 5(2):igab013.

[7] Muhd Amir, N. I., Dziyauddin, R. A., Mohamed, N., Ismail, N. S. N., Kaidi, H. M., Ahmad, N., and Izhar, M. A. (2024). Fall detection system using wearable sensor devices and machine learning: A review. IEEE.

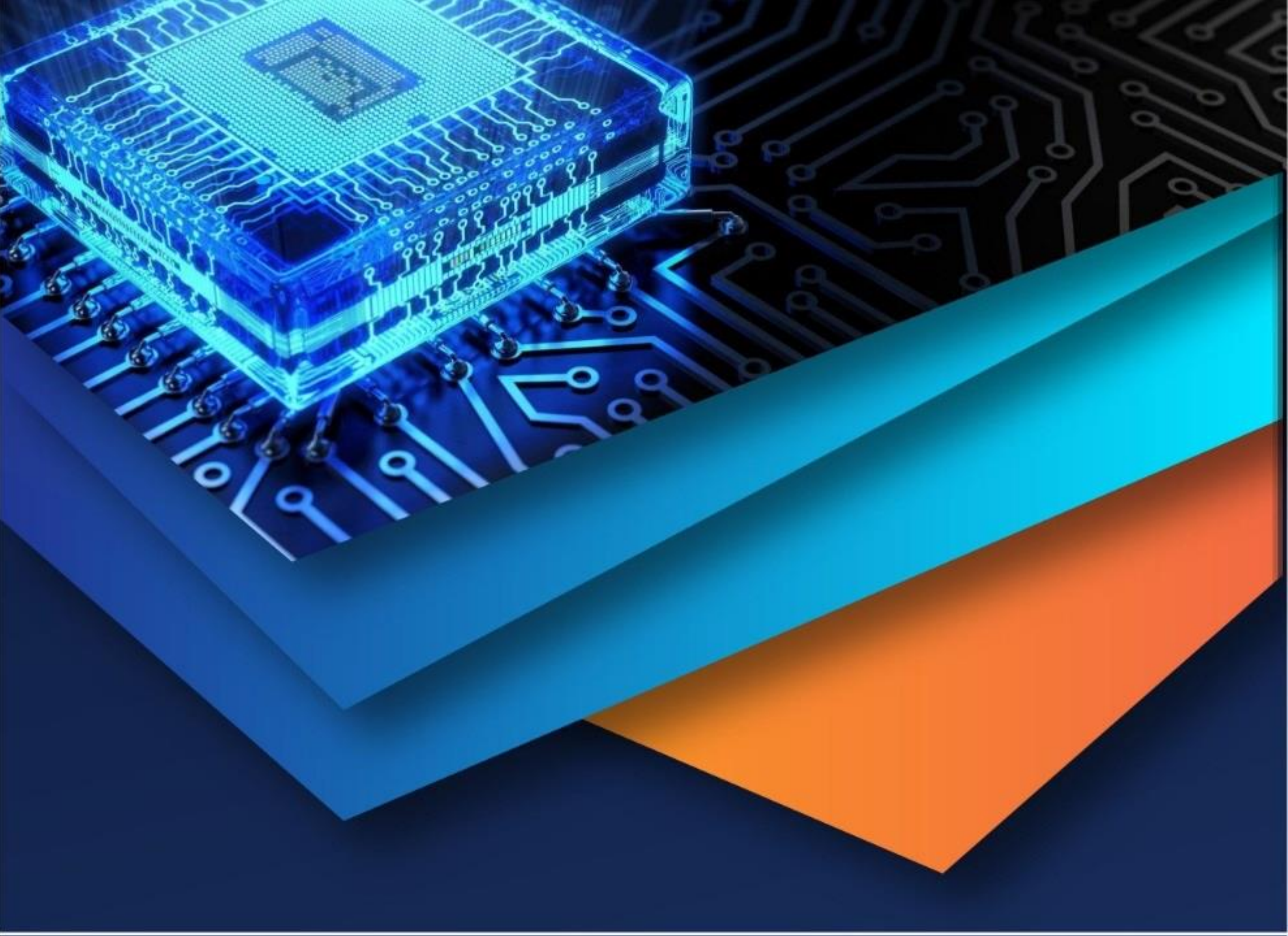
[8] Patel, A. N., Murugan, R., Maddikunta, P. K. R., Yenduri, G., Jhaveri, R. H., Zhu, Y., and Gadekallu, T. R. (2024). AI-powered trustable and explainable fall detection system using transfer learning. Image and Vision Computing, 149:105164.

[9] Uddin, M. Z., Khaksar, W., and Torresen, J. (2018). Ambient sensors for elderly care and independent living: A survey. Sensors, 18(7).

[10] Vrancˇic´, A., Zadravec, H., and Orehovacˇki, T. (2024). The role of smart homes in providing care for older adults: A systematic lit- erature review from 2010 to 2023. Smart Cities, 7(4):1502–1550.

[11] Youtube url fall detection https://youtu.be/wrhfMF4uqj8?si= 56XMLsHk63mch-jp

[12] MAX30102 https://github.com/doug-burrell/max30102\ endthe- bibliography



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