



# The Review on Smart Companion Robot for People with Intellectual Disabilities and Epilepsy

<sup>1</sup>Chavan Avantika Santosh, <sup>2</sup>Prof.Bangar Abhishek P., <sup>3</sup>Prof.Bhosale Sachin B., <sup>4</sup>Prof.Karad Vandana A.

Dept. of Computer Engineering  
Jaihind College of engineering, Pune, India

**Abstract.** People with intellectual disabilities who experience epilepsy may require additional support for daily activities, seizure monitoring and emergency communication. Recent developments in artificial intelligence (AI), machine learning (ML) and assistive robotics offer opportunities to improve safety and caregiver support. This study reviews the supplied research papers on automated seizure detection, AI-based epilepsy monitoring and assistive technologies for people with disabilities. Zhu et al. (2024) proposed a hybrid SE-TCN-BiGRU network and reported high seizure-detection accuracy on the CHB-MIT and SH-SDU datasets. Garção et al. (2025) Developed a video-based approach for detecting seizures in real time using Lampsy, a non-intrusive monitoring solution powered by affordable edge devices. Research on assistive robotics highlights the potential of robots to support rehabilitation and interaction, while Milne-Ives et al. (2025) emphasised the underrepresentation of People with intellectual impairments participating in artificial intelligence research on epilepsy. Based on these findings, this study proposes a smart robotic assistant designed to support daily living through voice interaction, scheduled alerts, and seizure-event tracking, and caregiver notifications. The proposed system aims to provide personalised assistance through accessible interaction, privacy-conscious monitoring and human supervision. However, existing studies evaluate individual technologies rather than the complete proposed robot. Therefore, its effectiveness, usability and reliability cannot yet be assumed. Further development, user-centred testing and appropriate clinical evaluation are necessary to assess its practical benefits and safety. This study explores potential advancements and existing limitations in integrating intelligent seizure monitoring with socially assistive robotics to support people with intellectual disabilities and epilepsy.

**Keywords:** Smart Companion Robot, Intellectual Disability, Epilepsy, Seizure Detection, Artificial Intelligence, Machine Learning, Assistive Robotics, Caregiver Monitoring.

## I. Introduction

Epilepsy is a neurological disorder characterised by recurrent seizures that can affect an individual's health, safety and daily activities. For people with intellectual disabilities, epilepsy management can be particularly challenging because of communication



difficulties, dependence on caregivers and the need for continuous support. Milne-Ives et al. [1] highlighted that people with intellectual disabilities are underrepresented in epilepsy research despite their increased risk of adverse health outcomes.

Recent developments in artificial intelligence (AI) and machine learning (ML) have created opportunities for improving seizure detection, monitoring and personalised epilepsy care.

Automated seizure detection systems use different techniques, including electroencephalography (EEG) signal analysis, deep learning and computer vision. Zhu et al. [2] proposed a hybrid SE-TCN-BiGRU network for automatic seizure detection and reported promising classification performance on benchmark datasets. Similarly, Garção et al. [3] developed Lampsy, an unobtrusive video-based seizure-monitoring device designed for real-time operation on affordable edge hardware. These studies demonstrate the potential of intelligent monitoring technologies; however, their reported performance is specific to the datasets and experimental conditions evaluated.

Assistive robotics has also emerged as a promising field for supporting people with disabilities through interactive assistance, rehabilitation and improved engagement. Zapata et al. [4] reviewed assistive robotic technologies and identified a substantial concentration of research on physical disabilities, with comparatively limited attention to intellectual, sensory and psychosocial disabilities. This highlights the need for inclusive robotic systems designed around the specific needs, abilities and communication preferences of their intended users.

In this context, a smart companion robot could integrate accessible voice interaction, daily routine reminders, seizure-event monitoring and caregiver notification into a single assistive platform. The proposed system aims to provide personalised assistance and support communication between users and caregivers. However, the robot is a conceptual proposal, and its effectiveness and safety require further development and evaluation.

This paper reviews existing research on AI-based seizure detection and assistive robotics, identifies research gaps, and presents a conceptual framework for a smart companion robot intended to support people with intellectual disabilities and epilepsy.

## II. Review Methodology

### 1. Search strategy

The proposed Smart Companion Robot for People with Intellectual Disabilities with Epilepsy is based on a review of research related to artificial intelligence (AI), machine learning (ML), automated seizure detection, and assistive robotics. Zhu et al. [1] proposed a hybrid SE-TCN-BiGRU model for automatic seizure detection and reported high detection accuracy using the CHB-MIT and SH-SDU datasets. Garção et al. [2] developed Lampsy, a real-time video-based epilepsy monitoring device designed to detect seizure events using edge computing. These studies demonstrate the potential of intelligent systems to support seizure monitoring. Zapata et al. [3] reviewed assistive robotics technologies for people with disabilities and identified the need for further research involving people with intellectual, sensory, and psychosocial disabilities. Milne-Ives et al. [4] also highlighted the limited representation of people with intellectual disabilities in AI-based epilepsy research and discussed challenges involving data availability, communication, ethics, and safety.

The methodology of this study involves reviewing the supplied research papers, identifying their objectives and approaches, comparing their findings, and determining how their technologies could contribute to a smart companion robot. The review focuses on seizure-event monitoring, accessible voice interaction, daily routine reminders, caregiver notifications, and assistive



support. Based on the reviewed literature, a conceptual system is proposed that combines intelligent monitoring with socially assistive robotic functions to help support people with intellectual disabilities who experience epilepsy. The robot is intended to assist users and caregivers rather than replace medical professionals or human supervision. Since this work is based on a literature review and conceptual design, no new experimental data have been collected to establish the effectiveness, reliability, or clinical safety of the complete proposed system. Further development and user-centred testing will be required to evaluate its practical performance.

| Criterion         | Included                                                                                                                | Excluded                                                                            |
|-------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Topic             | Epilepsy, seizure detection, intellectual disabilities, assistive robotics, AI-based monitoring, and caregiver support. | Studies unrelated to epilepsy, intellectual disabilities, or assistive technologies |
| Evidence type     | Research articles, review papers, and relevant commentaries from the supplied papers.                                   | Publications lacking sufficient relevant research information.                      |
| Verifiability     | Papers with identifiable authors, publication details, and DOI or other verifiable records where available.             | Papers with unverified publication details.                                         |
| Period            | Priority given to recent studies published between 2020 and 2025, along with relevant foundational studies.             | Duplicate records and superseded versions of papers.                                |
| Technology        | EEG-based seizure detection, video monitoring, machine learning, deep learning, and socially assistive robots.          | Technologies without a clear connection to the proposed robot.                      |
| Target Population | Studies involving epilepsy, intellectual disabilities, or assistive support for people with disabilities.               | Studies with no meaningful relevance to the intended users.                         |

### 3. Study selection

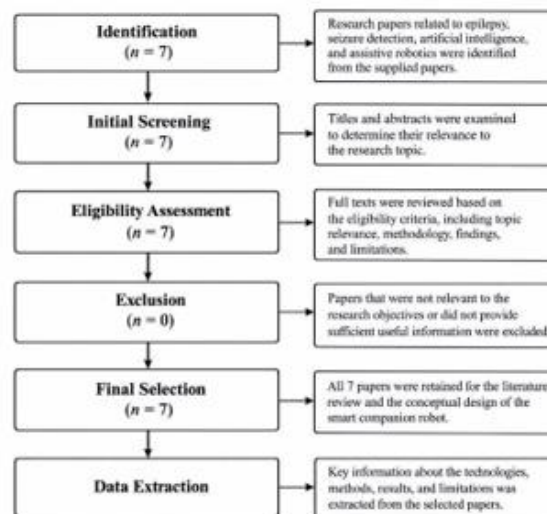


Fig. 1 Study Selection Process

Fig. 1: Study Selection Process shows how research papers were selected for your topic, Smart Companion Robot for People with Intellectual Disabilities with Epilepsy.



The study selection process was conducted to identify research papers relevant to the development of a Smart Companion Robot for People with Intellectual Disabilities with Epilepsy. Seven supplied research papers were examined by reviewing their titles, abstracts, and available full texts. The papers covered automated seizure detection using machine learning and deep learning, real-time video-based epilepsy monitoring, assistive robotics, disability-support technologies, and the application of AI in epilepsy care for people with intellectual disabilities. Each paper was assessed according to its relevance to the research objectives, methodology, findings, and limitations. The selected papers were then used to identify useful technologies, research gaps, and potential features for the proposed

### III. Literature Review

Several studies have explored the use of artificial intelligence (AI), machine learning (ML), deep learning, and assistive robotics to support people with epilepsy and disabilities. These studies provide a foundation for developing a Smart Companion Robot for People with Intellectual Disabilities with Epilepsy. The literature focuses on automatic seizure detection, real-time monitoring, assistive interaction, and caregiver support.

#### 1. Artificial Intelligence and Machine Learning in Epilepsy

Artificial intelligence (AI) and machine learning (ML) are increasingly used in epilepsy research to analyse brain signals and identify seizure patterns. These technologies can process large amounts of medical data and help detect changes associated with epileptic seizures. Traditional seizure monitoring often requires continuous observation or analysis of electroencephalogram (EEG) recordings. AI-based systems aim to support this process through automatic signal classification.

AI in epilepsy and intellectual disabilities. Milne-Ives et al. (2025) discussed the applications of AI in epilepsy care for people with intellectual disabilities. The study highlighted the potential of AI for seizure monitoring and personalised support. However, the authors identified challenges related to limited representative datasets, communication difficulties, accessibility, and ethical concerns. The study emphasised that AI technologies should consider the specific needs of people with intellectual disabilities.

Machine learning for seizure detection. Zhu et al. (2024) and Cao et al. (2025) investigated deep learning techniques for detecting epileptic seizures using EEG signals. Their studies demonstrated that intelligent algorithms can identify seizure-related patterns from recorded brain activity. These technologies provide possible approaches for developing an automated seizure-monitoring module, although their reported performance does not establish the reliability of a complete companion robot.

#### 2. EEG-Based Seizure Detection Technologies

Electroencephalogram (EEG) technology records electrical activity in the brain and is widely used in epilepsy diagnosis and monitoring. EEG signals contain patterns that may help distinguish seizure activity from normal brain activity. Deep learning models can automatically extract useful features from these signals and classify different brain states.

SE-TCN-BiGRU technology. Zhu et al. (2024) proposed a hybrid SE-TCN-BiGRU network for automatic seizure detection. The model combines Squeeze-and-Excitation (SE), Temporal Convolutional Network (TCN), and Bidirectional Gated Recurrent Unit (BiGRU) techniques. The SE component helps identify important signal features, TCN extracts temporal patterns, and BiGRU analyses sequential information. The model achieved average patient-specific accuracies of 98.77% on the CHB-



MIT dataset and 93.61% on the SH-SDU dataset. These results demonstrate the potential of hybrid deep learning models for EEG-based seizure detection.

CNN-Bi-LSTM technology. Cao et al. (2025) developed a hybrid Convolutional Neural Network and Bidirectional Long Short-Term Memory (CNN-Bi-LSTM) model with feature fusion. CNN extracts important features from EEG signals, while Bi-LSTM analyses changes in signal patterns over time. The researchers evaluated the model using the Bonn, New Delhi, and CHB-MIT epilepsy datasets and reported strong seizure-classification performance. This technology could inform the design of an optional EEG-based monitoring component in the proposed robot.

Limitations of EEG monitoring. Although these models achieved high accuracy on research datasets, practical implementation requires suitable EEG recording equipment, signal processing, and reliable operation under real-world conditions. The reported results cannot be directly applied to a companion robot without additional validation.

### **3. Video-Based Seizure Monitoring Technology**

Video-based monitoring is another approach used to detect epileptic seizures. Unlike EEG-based systems, video monitoring analyses visible body movements instead of electrical brain signals. This technology may reduce the need for wearable monitoring equipment and can support observation in suitable indoor environments.

Lampsy monitoring system. Garção et al. (2025) developed Lampsy, an automatic seizure-detection device based on video processing and edge computing. The system processes video data to identify seizure-related movement patterns and was demonstrated at 30 frames per second. The researchers reported sensitivity and specificity of approximately 99.76% on their study dataset. These findings show the potential of real-time video-based seizure monitoring.

Edge computing technology. Edge computing allows data to be processed locally on a device instead of relying entirely on remote cloud servers. In the Lampsy system, this approach supports real-time video analysis using affordable computing hardware. Such technology could be considered for a companion robot equipped with a camera and suitable processing hardware. Limitations of video monitoring. Video-based detection depends on factors such as camera position, lighting, visibility, and the movements associated with different seizure types. It may not detect seizures without visible movement. Privacy and user consent must also be considered when introducing camera-based monitoring.

### **4. Assistive Robotics for People with Disabilities**

Assistive robotics refers to robotic systems developed to support people with physical, cognitive, or other disabilities. These systems may help users perform activities, communicate, participate in rehabilitation, or interact with their environment. Assistive robots can combine sensors, control systems, and interaction technologies to provide different forms of assistance.

Inclusive assistive robotics. Zapata et al. (2025) conducted a systematic review of 89 studies on assistive robotics for people with disabilities. The review examined technologies developed to improve accessibility, independence, and daily support. The authors identified that much of the existing research focused on physical disabilities, while applications for people with intellectual, sensory, and psychosocial disabilities received less attention.

Socially assistive robots. Feingold-Polak et al. (2024) investigated a socially assistive robot for stroke rehabilitation through a long-term pilot randomised controlled trial. The robot was used to support structured rehabilitation activities through social interaction. The study demonstrated how robotic systems can be investigated in real rehabilitation environments. However,



the results were obtained from people undergoing stroke rehabilitation and cannot be directly generalised to epilepsy or intellectual disability.

Application to companion robots. These studies suggest that robotic interaction could be explored for providing reminders, instructions, encouragement, and routine assistance. For the proposed smart companion robot, the interaction system should be simple, predictable, and adjustable according to the user's abilities.

### **5. Interactive Assistive Technologies and Communication Support**

Interactive assistive technologies are designed to support communication, learning, engagement, and daily activities. These technologies include software applications, robotic systems, digital learning tools, and other interactive devices. Their effectiveness depends partly on how well they match the abilities and preferences of the intended users.

Assistive technologies for autism. Alves et al. (2020) conducted a systematic review of assistive technologies used in Applied Behavior

Analysis (ABA) interventions for autism. The reviewed technologies included robotics, interactive software, gamification, and image-processing applications. The study discussed the importance of considering users' learning needs, communication abilities, and individual characteristics when developing assistive systems.

Personalised interaction technology. The findings of Alves et al. provide design considerations for creating accessible interaction systems. A smart companion robot could be designed to use short spoken instructions, simple visual messages, and caregiver-configured reminders. These are proposed design features rather than functions experimentally validated by the reviewed study for people with intellectual disabilities and epilepsy.

### **6. Integration of AI and Assistive Robotics**

Integrating artificial intelligence with assistive robotics creates opportunities to combine monitoring and daily assistance in a single system. AI-based methods can analyse monitoring data, while robotic interaction technologies can provide instructions, reminders, and communication support. Such integration may be useful when designing assistive systems for people who require additional supervision.

Intelligent seizure-monitoring module. The EEG-based models developed by Zhu et al. (2024) and Cao et al. (2025), along with the video-based approach demonstrated by Garção et al. (2025), provide different possible methods for identifying seizure events. A proposed companion robot could connect to a suitable, independently validated monitoring system and use its outputs to notify caregivers. The research papers do not demonstrate that these specific algorithms have already been integrated into the proposed robot.

Daily assistance and caregiver communication. The assistive robotics studies by Zapata et al. (2025) and Feingold-Polak et al. (2024) provide useful ideas for user interaction and supportive activities. The proposed robot could include daily reminders, simple voice-based communication, and caregiver notifications. These features would require user-centred design and practical evaluation.

Safety and accessibility. Milne-Ives et al. (2025) highlighted the need to consider the specific requirements of people with intellectual disabilities when developing AI-based epilepsy technologies. Monitoring errors, accessibility difficulties, privacy,



and dependence on automated systems are important concerns. Therefore, a companion robot should be designed as a supportive device rather than a replacement for medical care or human supervision.

#### IV. Comparative Analysis

The selected research papers were compared based on their proposed technologies, methods, key findings, limitations, and relevance to the Smart Companion Robot for People with Intellectual Disabilities with Epilepsy. Table II presents a comparative analysis of the seven studies.

The comparative analysis shows that existing research has made significant progress in seizure detection and assistive robotics. Zhu et al. and Cao et al. developed deep learning models for detecting seizures using EEG signals, while Garção et al. investigated video-based monitoring. These studies provide possible technical approaches for an optional seizure-monitoring module. Zapata et al., Alves et al., and Feingold-Polak et al. explored assistive technologies and robotic interaction for people with different support needs. Milne-Ives et al. highlighted the importance of including people with intellectual disabilities in AI-based epilepsy research.

**Comparative Analysis of Existing Research**

| Study                        | Technology / Method                                    | Key Findings                                                                                      | Limitations                                                       |
|------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Zhu et al. (2024)            | SE-TCN-BiGRU deep learning model using EEG signals     | Achieved 98.77% patient-specific accuracy on the CHB-MIT dataset.                                 | Requires EEG data; not tested as a companion robot.               |
| Garção et al. (2025)         | Lampsy video-based seizure detection                   | Demonstrated real-time monitoring at 30 FPS with high detection performance on the study dataset. | Performance may depend on camera visibility and seizure type.     |
| Zapata et al. (2025)         | Systematic review of 89 assistive robotics studies     | Identified the potential of robotics to support people with disabilities.                         | Limited research focusing on intellectual disabilities.           |
| Milne-Ives et al. (2025)     | Review and commentary on AI in epilepsy                | Highlighted opportunities for AI-based epilepsy support.                                          | Limited representative data and accessibility challenges.         |
| Alves et al. (2020)          | Systematic review of assistive technologies for autism | Discussed robots and interactive technologies for supporting learning and communication.          | Focused on autism rather than epilepsy.                           |
| Feingold-Polak et al. (2024) | Socially assistive robot for stroke rehabilitation     | Explored long-term robot-assisted rehabilitation in a pilot trial.                                | Focused on stroke rehabilitation, not seizure monitoring.         |
| Cao et al. (2025)            | CNN-Bi-LSTM model with feature fusion                  | Reported high accuracy for EEG-based seizure classification.                                      | Requires further validation for real-world clinical applications. |

However, the reviewed studies do not establish the effectiveness of a complete companion robot that combines accessible communication, daily routine reminders, seizure monitoring, and caregiver alerts for people with intellectual disabilities and epilepsy. Therefore, the proposed research explores the integration of these functions into a single conceptual assistive system.

## V. Proposed Conceptual Architecture

The proposed Smart Companion Robot for People with Intellectual Disabilities with Epilepsy is designed to provide daily assistance, simple communication, seizure monitoring, and caregiver support. As shown in Fig. 2, the conceptual architecture consists of five main modules: User Interaction Module, Processing and Control Module, Daily Assistance Module, Seizure-Monitoring Module, and Caregiver Notification Module. These modules are connected to support communication between the user, robot, and caregiver. The proposed system combines ideas from existing research on assistive robotics, artificial intelligence, and automated seizure detection.

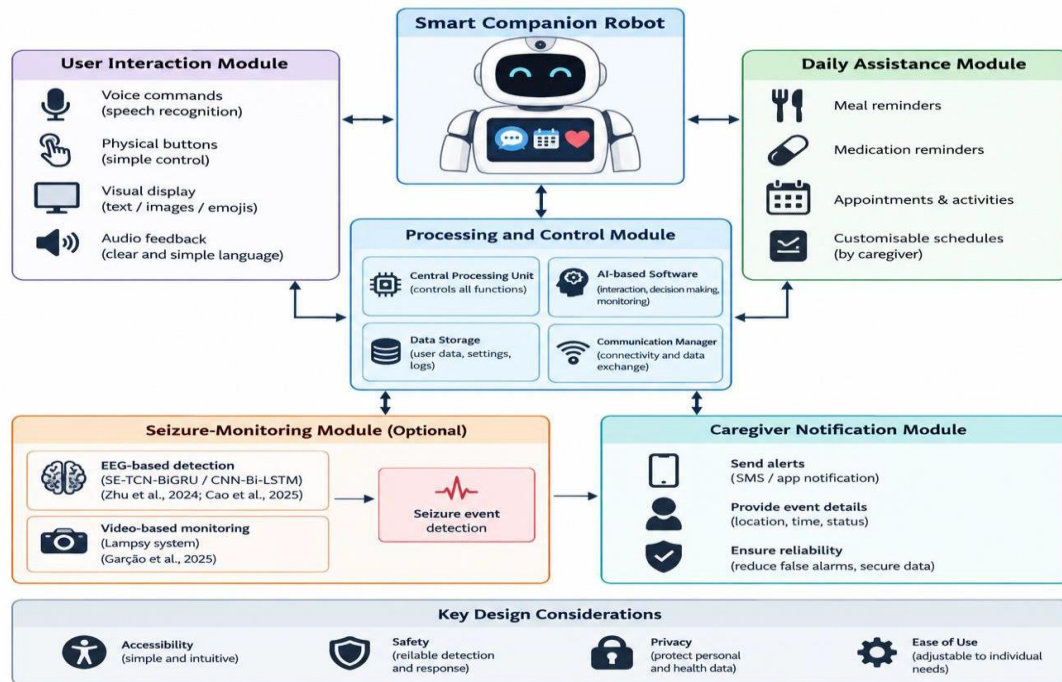


Fig. 2. Proposed Conceptual Architecture of Smart Companion Robot for People with Intellectual Disabilities with Epilepsy.

### 1. User Interaction Module

The user interaction module allows people with intellectual disabilities to communicate with the robot through simple voice commands, physical buttons, and a visual display. Speech recognition technology is proposed to understand basic instructions, while audio feedback provides clear responses. The display can show text, pictures, and emojis to make communication easier. Physical buttons provide an alternative for users who have difficulty using voice commands. This module aims to make the robot accessible and easy to operate.

### 2. Processing and Control Module

The processing and control module acts as the central unit of the smart companion robot. It



consists of a Central Processing Unit (CPU), AI-based software, data storage, and a communication manager. The CPU controls the robot's functions, while AI software supports interaction and the processing of monitoring information. Data storage maintains user preferences, reminder schedules, and relevant system records. The communication manager handles information exchange between the robot, monitoring system, and caregiver notification module.

### **3. Daily Assistance Module**

The daily assistance module is designed to help users manage routine activities. It provides reminders for meals, medication schedules, appointments, and other daily tasks. Caregivers can customise the reminder schedule according to the user's needs. The robot can deliver reminders through voice messages and visual notifications. This module aims to support routine management and encourage greater independence in everyday activities.

### **4. Seizure-Monitoring Module**

The optional seizure-monitoring module is designed to identify possible epileptic seizure events using EEG-based or video-based monitoring technologies. The EEG approach is informed by the SE-TCN-BiGRU model proposed by Zhu et al. (2024) and the CNN-Bi-LSTM model developed by Cao et al. (2025). These models analyse EEG signals to identify seizure-related patterns. Alternatively, video-based monitoring may use an approach informed by the Lampsy system developed by Garção et al. (2025), which analyses movement patterns through video processing. When a connected monitoring system identifies a possible seizure event, the information is passed to the processing and control module for further action. These approaches are proposed options and have not yet been validated within the complete robot.

### **5. Caregiver Notification Module**

The caregiver notification module is intended to provide information to registered caregivers when a possible seizure event is detected. The system may send alerts through SMS or a mobile application using available network connectivity. Notifications can include the event time, monitoring status, and location information when available. This module aims to improve communication between the user and caregiver and support timely assistance. Reliable notifications, protection of personal information, and reduction of false alarms are important design requirements.

### **6. Working Principle of the Proposed System**

The proposed system begins by receiving user commands or following a caregiver-configured daily schedule. The processing unit interprets the instructions and activates the required functions, such as providing reminders or audio responses. During normal operation, the robot assists users with daily activities and simple communication. If the optional seizure-monitoring module is connected, it analyses EEG signals or video information for possible seizure events. When an event is identified, the processing unit activates the caregiver notification module to send an alert. The caregiver can then assess the situation and provide appropriate assistance. The system is intended to support, not replace, human supervision or medical care.

### **7. Key Design Considerations**

The proposed architecture focuses on accessibility, safety, privacy, and ease of use. Simple language, clear visual indicators, and adjustable controls are important for users with different communication abilities. Monitoring reliability and caregiver notification performance must be evaluated before practical deployment. Personal and health-related information should be protected through appropriate data-security measures. The complete architecture remains a conceptual design and requires implementation, user testing, and clinical evaluation to determine its effectiveness and safety.

## VI. Research Challenges

The development of a Smart Companion Robot for People with Intellectual Disabilities with Epilepsy involves several technical, medical, and practical challenges. Although existing research demonstrates progress in artificial intelligence, seizure detection, and assistive robotics, integrating these technologies into a single reliable system requires further investigation. The major research challenges identified from the reviewed studies are discussed below.

- **Accurate Seizure Detection.** Zhu et al. (2024) and Cao et al. (2025) developed deep learning models for detecting epileptic seizures using EEG signals. Although these models achieved high accuracy on research datasets, detecting different seizure types in real-world environments remains challenging. Incorrect detection may result in false alarms or missed seizure events.
- **Limited Data for Intellectual Disabilities.** Milne-Ives et al. (2025) highlighted the limited availability of representative epilepsy datasets involving people with intellectual disabilities. Differences in communication abilities, behaviour, and individual support needs make it difficult to develop and evaluate AI systems suitable for all users.
- **Real-Time Monitoring.** Garção et al. (2025) demonstrated real-time seizure monitoring using video processing and edge computing. However, monitoring performance can be affected by camera position, lighting conditions, movement, and hardware limitations. Maintaining reliable monitoring in different environments is an important challenge.
- **Human–Robot Interaction.** Zapata et al. (2025) and Alves et al. (2020) discussed assistive technologies designed for people with different abilities and support needs. Developing a robot that understands simple commands and provides clear responses is challenging because users may have different communication, learning, and interaction requirements.
- **5. Integration of Multiple Technologies.** Combining AI-based seizure detection, robotic interaction, daily reminders, and caregiver notifications into a single system requires coordination between hardware and software components. Maintaining reliable communication and processing performance is a major technical challenge for the proposed architecture.
- **Privacy and Data Security.** The proposed robot may process sensitive information such as health-monitoring data, video recordings, and personal schedules. Protecting this information from unauthorised access is essential. Secure data storage, controlled access, and appropriate user or caregiver consent must be considered.
- **Reliability and Caregiver Alerts.** The proposed caregiver notification system must communicate possible seizure events accurately and promptly. Network failures, delayed notifications, and false alarms could reduce its usefulness. Therefore, reliable communication and suitable backup procedures require further investigation.
- **Cost, Accessibility, and User Acceptance.** Developing an affordable and easy-to-use companion robot is another challenge. The system should provide simple controls, adjustable interaction features, and accessible communication methods. Its usability and acceptance by people with intellectual disabilities and their caregivers must be evaluated through future testing.

## VII. Research Gaps and Future Directions

The reviewed research papers demonstrate significant progress in artificial intelligence, automated seizure detection, and assistive robotics. However, several research gaps remain in developing a Smart Companion Robot for People with Intellectual Disabilities with Epilepsy. Existing studies mainly focus on individual technologies, while their integration into a single accessible and reliable robotic system requires further investigation. The major research gaps and future directions are discussed below. The reviewed studies identify several research gaps in seizure detection, assistive robotics, and AI-based support for people with intellectual disabilities. Table III summarises these gaps and the possible future directions for the proposed Smart Companion Robot.



Table 3. Research Gaps and Future Directions

| Research Area                   | Research Gap                                                                                     | Future Direction                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Integration of Technologies     | Existing studies mainly focus on seizure detection or assistive robotics separately.             | Develop a smart companion robot combining daily assistance, seizure monitoring, and caregiver alerts. |
| Intellectual Disability Support | Limited research focuses on AI-based epilepsy support for people with intellectual disabilities. | Design accessible and personalised robotic assistance according to individual needs.                  |
| Seizure Detection               | EEG-based models show high accuracy on research datasets but require real-world validation.      | Improve seizure detection using suitable sensors and validated deep learning models.                  |
| Video Monitoring                | Detection can be affected by lighting, camera position, and seizure type.                        | Investigate reliable real-time monitoring under different environmental conditions.                   |
| Human-Robot Interaction         | Existing robots may not meet different cognitive and communication needs.                        | Develop simple voice commands, visual instructions, and physical controls.                            |
| Daily Assistance                | Limited evidence on integrated robotic support for everyday routines in the target population.   | Introduce personalised reminders for medication schedules, meals, and appointments.                   |
| Caregiver Communication         | The reviewed studies do not validate caregiver alerts within the proposed integrated robot.      | Develop and test SMS or mobile application notifications for possible seizure events.                 |
| Privacy and Security            | Health monitoring and video recording raise privacy and data-security concerns.                  | Implement secure data storage, controlled access, and appropriate consent procedures.                 |
| Real-World Evaluation           | Limited evidence on long-term performance of an integrated robot for the intended users.         | Conduct usability, reliability, safety, and clinical evaluations with users and caregivers.           |
| Cost and Accessibility          | Advanced monitoring and robotic technologies may be difficult to implement affordably.           | Explore low-cost hardware and simple, user-friendly designs.                                          |

## VIII. Conclusion

This research reviewed the applications of artificial intelligence (AI), machine learning (ML), deep learning, and assistive robotics for supporting people with intellectual disabilities and epilepsy. The selected studies demonstrated promising developments in EEG-based seizure detection, real-time video monitoring, and socially assistive robotic technologies. Deep learning models such as SE-TCN-BiGRU and CNN-Bi-LSTM achieved high seizure-detection accuracy on research datasets, while video-based systems such as Lampsey demonstrated the potential for non-contact monitoring. Research on assistive robotics highlighted the importance of accessible communication, personalised assistance, and user-friendly interaction.

Based on these findings, a conceptual architecture for a Smart Companion Robot for People with Intellectual Disabilities with Epilepsy was proposed. The system aims to combine simple voice interaction, daily routine reminders, optional seizure monitoring, and caregiver notifications to support everyday activities and safety. However, challenges such as seizure-detection reliability, limited representative datasets, privacy, accessibility, and system integration remain. The proposed robot has not yet been implemented or experimentally validated. Future research should focus on prototype development, improved monitoring techniques, personalised interaction, and real-world evaluation. Overall, this study identifies the potential of integrating intelligent monitoring with assistive robotics to provide additional support for people with intellectual disabilities and epilepsy, while emphasising the need for further testing to establish the system's reliability, usability, and safety.



## References

1. M. Milne-Ives et al., "The use of AI in epilepsy and its applications for people with intellectual disabilities: Commentary," *Acta Epileptologica*, vol. 7, art. no. 13, 2025, doi: 10.1186/s42494-025-00205-7.
2. P. Zhu et al., "A novel SE-TCN-BiGRU hybrid network for automatic seizure detection," *IEEE Access*, vol. 12, 2024, Doi: 10.1109/ACCESS.2024.3406909.
3. V. M. Garção et al., "Lampsy: An invisible real-time epilepsy video monitoring and automatic seizure detection device," *IEEE Access*, 2025, Doi : 10.1109/ACCESS.2025.3575528.
4. M. Zapata et al., "Advancements in assistive robotics: A systematic review of inclusive technologies for people with disabilities," *IEEE Access*, 2025, Doi : 10.1109/ACCESS.2025.3608614.
5. F. J. Alves et al., "Applied behavior analysis for the treatment of autism: A systematic review of assistive technologies," *IEEE Access*, vol. 8, 2020, Doi : 10.1109/ACCESS.2020.3005296.
6. R. Feingold-Polak, O. Barzel, and S. Levy-Tzedek, "Socially assistive robot for stroke rehabilitation: A long-term in-the-wild pilot randomized controlled trial," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 32, 2024, Doi : 10.1109/TNSRE.2024.3387320.
7. X. Cao et al., "A hybrid CNN-Bi-LSTM model with feature fusion for accurate epilepsy seizure detection," *BMC Medical Informatics and Decision Making*, vol. 25, art. no. 6, 2025, Doi : 10.1186/s12911-024-02845-0.