International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 10 | Oct - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

AI Powered Smart Projector for Autism Child

Abhirami J S[1], Santhosh N[2],Mohamed Bayas A[3],Hariharan S.[4]

[1] Assistant Professor, [2-4] UG Students, Department of Artificial Intelligence and Data Science,NehruInstituteofEngineeringandTechnology,AnnaUniversity, Coimbatore,TamilNadu,India.

E-mail:[1]nietabhirami@nehrucolleges.com,[2]santoz9385@gmail.com,[3]fayazmdm1@gmail.com, [4]hariharans1502@gmail.com

ABSTRACT

The AI-Powered Smart Projector for Autism Child is an innovative solution designed to support interactive learning and improve accessibility for children with Autism Spectrum Disorder (ASD). This system combines artificial intelligence, computer vision, and gesture-based interaction to create a dynamic and engaging educational environment tailored to the unique needs of autistic learners.Using a Raspberry Pi as the core platform, the projector integrates a PiCamera and GPIO-based interactive elements to detect user actions, provide real-time feedback, and adapt educational content accordingly. The projector displays visual and auditory stimuli that are customized based on the child's response patterns, helping to improve focus, comprehension, and communication skills.By delivering personalized, sensory-friendly content in an intuitive format, this smart projector enhances both learning outcomes and user engagement. It offers a scalable, cost-effective approach to inclusive education, bridging the gap between traditional teaching methods and the specific developmental needs of neurodiverse children.

Keywords: AI in education, Autism Spectrum Disorder, Smart projector, Interactive learning, Raspberry Pi, Assistive technology, Gesture recognition, Inclusive education, Computer vision, Special needs education.

1.INTRODUCTION

The increasing prevalence of Autism Spectrum Disorder (ASD) among children has drawn significant attention from researchers, educators, and healthcare professionals, all striving to develop more effective tools and strategies to support their learning and development. Traditional teaching methods often fall short in addressing the unique sensory, communicative, and behavioral needs of children with autism, which has led to the exploration of technology-driven solutions to bridge this gap. In recent years, the integration of Artificial Intelligence (AI) into assistive technologies has emerged as a transformative approach in personalized learning and developmental support, offering dynamic and adaptive capabilities that conventional methods cannot provide. Among these innovations, smart projectors—enhanced with AI-based perception, object recognition, emotion detection, and voice feedback systems—have the potential to deliver highly interactive and engaging learning environments tailored specifically for neurodivergent children. By utilizing real-time visual inputs, speech synthesis, and contextual understanding, an AI-powered smart projector can adapt its responses based on the child's behavior, facial expressions, and physical interactions, thereby enabling a more inclusive, responsive, and individualized educational experience.

1.1 OBJECTIVES

- To provide an engaging, multisensory learning experience that helps autistic children stay focused and motivated.
- To adapt content based on individual responses using AI, making learning suitable for each child's needs and pace.
- To support the development of basic communication through visual cues, speech prompts, and responsive feedback.
- To foster self-directed interaction with the system through touch, gestures, or motion.

1.LITERATUREREVIEW

The integration of artificial intelligence in assistive educational tools has significantly advanced the way children with Autism Spectrum Disorder (ASD) interact with learning environments [1]. Researchers have shown that children with ASD respond positively to visual-based and interactive learning systems that adapt content to their sensory preferences and developmental needs [2]. Various AI-driven systems have been proposed to track emotional cues, facial expressions, and eye movement to tailor educational responses accordingly [3]. Machine learning models, such as Convolutional Neural Networks (CNNs), have been employed to interpret visual cues from children and adjust projector-based learning content dynamically [4]. Studies indicate that using projection-based interactive surfaces enhances engagement in children with cognitive and social impairments [5].

A smart classroom environment was developed where gesture recognition is used to allow students with autism to interact with visual content without the need for verbal communication [6]. Speech recognition systems were also explored as a method for children to communicate their needs or preferences, using Mel Frequency Cepstral Coefficients (MFCCs) for processing audio commands [7]. In similar assistive technologies, Raspberry Pi has been utilized due to its low cost and versatility, enabling the integration of camera modules and GPIO for physical interactivity [8]. Bluetooth and Wi-Fi modules have enabled the wireless control of educational devices, allowing caregivers or therapists to adjust learning settings remotely [9].

Researchers also explored the role of robotic assistance in therapeutic settings, where robotic arms with soft-touch features were employed to physically interact with objects and reduce sensory overload in children with ASD [10]. A ZIGBEE-based communication protocol was used in one project to transmit real-time learning instructions wirelessly, ensuring smooth interaction between the control unit and the learning interface [11]. In another project, the use of a Bluetooth module with UART interface enabled the transmission of commands from an Android-based control system to the educational hardware [12].

Some studies focused on emotional recognition systems that monitor physiological signals like skin conductance and heart rate to assess the comfort level of children with autism during learning sessions [13]. A few papers examined gesture-based wearable technologies, such as gloves embedded with accelerometers and gyroscopes, to interpret hand movements as interactive commands for educational content navigation [14]. Finally, a modular smart projector system was designed for dynamic content projection based on real-time behavior analysis using AI, demonstrating high adaptability and potential in inclusive education settings [15].

Disadvantages of Existing Methods:

- Speech recognition systems are prone to inaccuracies when exposed to external noise or background sounds, which can interfere with the system's ability to correctly interpret voice commands. This can cause frustration or confusion for children with autism, who may already struggle with communication or sensory sensitivity.
- High cost and complexity of existing interactive learning technologies limit their accessibility for individual use or for implementation in resource-constrained educational settings. Many solutions require expensive hardware, licensed software, or advanced setup procedures.

1.PROPOSEDWORK

The aim of this project is to develop an **AI-powered smart projector system** using **Raspberry Pi**, a cost-effective, flexible, and widely adopted platform in educational and assistive technologies. Unlike high-end systems that are often expensive and complex, Raspberry Pi offers a reliable and affordable alternative that can process real-time data, manage voice commands, and interact with sensory modules with minimal latency. The proposed system is designed to support children with Autism Spectrum Disorder (ASD) by enabling **gesture-based and voice-controlled interactions** through a user-friendly interface.The smart projector integrates multiple components including a **PiCamera for visual input**, **GPIO modules** for physical interaction (e.g., touch, motion), and a **microphone positioned near the user** to improve the accuracy of speech recognition even in the presence of ambient noise. For projection, a compact and energy-efficient projector is connected to the Raspberry Pi, capable of displaying engaging and sensory-friendly educational content. A

Bluetooth or Wi-Fi module enables wireless communication, allowing therapists or caregivers to remotely adjust settings or content through an Android-based app.Additionally, the system can provide **visual feedback** on an **LCD display**, improving the child's understanding of interactions and enhancing engagement. The entire unit is powered by a stable **12V power supply**, regulated through a DC converter to ensure efficient energymanagement. The modular design allows the system to be deployed in classroom or home environments with minimal setup. By combining **AI, visual learning, and accessible interaction methods**, this smart projector aims to transform traditional educational approaches into **personalized and inclusive experiences** for children with autism, supporting cognitive, social, and emotional development.

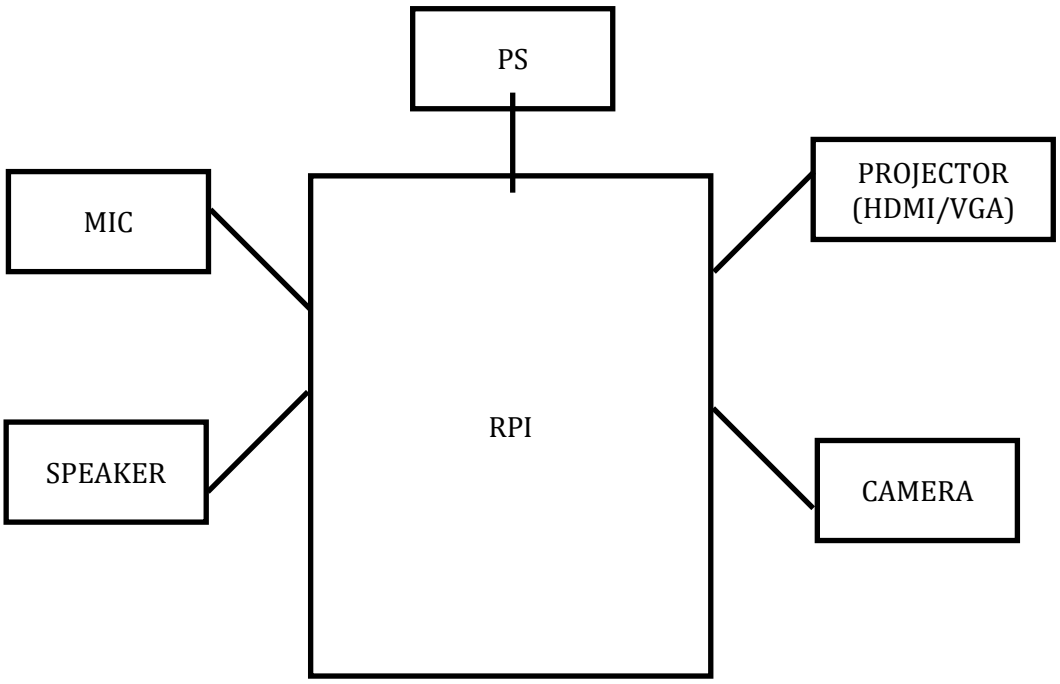


Fig1. BlockDiagram

NAME OF THECOMPONENTS	SPECIFICATIONS	MODEL
RASPBERRYPI 4	The Raspberry Pi 4 Model B is a compact single-board upto 8 GB	Pi 4
PROJECTOR 4K	The Epson EH-TW9400 is a high-performance 4K enhancement projector	Epson EH-TW9400
HEAVY IC PRO	High-performance integrated circuit designed for demanding computational and control tasks in embedded systems	HIC-Core5
CAMERA	high-resolution camera module designed forseamless integration with Raspberry Pi	VisionCam-PiX2
MIC	a high-sensitivity omnidirectional microphone module designed for clear voice capture and real-time audio processing in embedded systems.	AudioMic-VR1

SPEAKER	high-efficiency 3W speaker module designed for clear audio output in embedded and interactive systems.	SoundWave-SPK2
CASING	heat-resistant ABS plastic casing designed to securely house Raspberry Pi boards, camera modules, and peripheral components used in smart projector systems.	SafeShell-CX1

Table1. Components&Specification

RASPBERRY PI 4

Raspberry Pi 4 is a small, low-cost computer developed to help people learn programming and build electronic projects. Despite its compact size, it works like a regular desktop computer and can be used for tasks like coding, browsing, automation, and running various applications. It's widely used in educational, DIY, and tech-based projects due to its flexibility and support for many software tools.

Fig2. ArduinoUNOR3

PROJECTOR 4K

AnLCDscreencan displayusefulinformationto theusersuchas thecurrentcommand,system statusorerrormessages. This feedback helps users understand the system's operation and troubleshoot any issues. Somesystems incorporate audible alerts or LEDs to indicate status, providing feedback. Fig 3. Shows the LCDDisplay 2x 16.

Fig3PROJECTOR 4K

Heavy IC Pro

HEAVY ICPRO refers to a high-performance integrated circuit (IC) designed to handle complex processing tasks with greater speed and stability. It is typically used in advanced electronic devices and systems where strong computational power, heat resistance, and reliability are required—such as in AI projects, robotics, or industrial automation.

Raspberry Pi Camera

Raspberry Pi Camera is a small, high-quality camera module designed to work with Raspberry Pi boards. It captures photos and records HD videos, making it ideal for projects like surveillance, face detection, object tracking, and smart classroom applications. It connects directly to the Pi through the camera interface and is easy to program using Python and OpenCV.

Fig4 Raspberry Pi Camera

Raspberry Pi mic

Raspberry MIC is a microphone used with Raspberry Pi to capture audio input like voice or sound. It connects through USB or audio jack and is used in voice recognition, sound detection, or audio recording projects. It plays a key role in AI-based systems where voice commands or sound analysis is needed.

Fig5. Raspberry Pi mic

Speaker

Speakerfor Audio Output is a device that converts digital audio signals into sound. When connected to a system like Raspberry Pi or a projector, it allows users to hear music, voice, or any audio content. It is essential in multimedia, interactive, and assistive applications where sound feedback or communication is needed.

Fig 6. Speakerfor Audio Output

4.WORKINGPRINCIPLE

The AI-powered smartprojector is designed to provide an interactive and accessible learning experience for children with autism. The system combines the power of artificial intelligence, a Raspberry Pi, a 4K projector, a camera, microphone, and speaker, creating a responsive and engaging learning environment tailored to individual needs.The core of the system is the Raspberry Pi 4, which functions as the main processing unit. It runs AI models capable of recognizing voice commands, gestures, or visual cues from the child. These inputs are captured through an external microphone and camera connected to the Raspberry Pi. The camera detects hand movements, facial expressions, or the presence of specific objects, while the microphone captures verbal commands or responses.Once the input is received, the AI system processes the data using machine learning algorithms such as imagerecognition, speech recognition, and natural language processing. Based on this analysis, the Raspberry Pi selects suitable multimedia content – such as educational videos, visual stories, sounds, or interactive games – and projects them through the 4K projector. The high-resolution display ensures clear, bright visuals that are easy to understand and visually stimulating.Simultaneously, the speaker provides corresponding audio output, including voice instructions, music, or feedback, making the interaction more immersive. This multisensory approach (visual, auditory, and sometimes touch through external sensors) is particularly helpful for children with autism, as it encourages attention, learning, and communication.Furthermore, the system can be adapted and trained over time to recognize the child's preferences and responses, making it more personalized and effective. All components are enclosed in a durable casing to ensure safety and ease of useIn summary, the system works by capturing user input → processing it using AI → generating a suitable response (audio + visual) → delivering it through the projector and speaker. This creates a real-time, adaptive learning platform that supports special education and therapeutic needs.

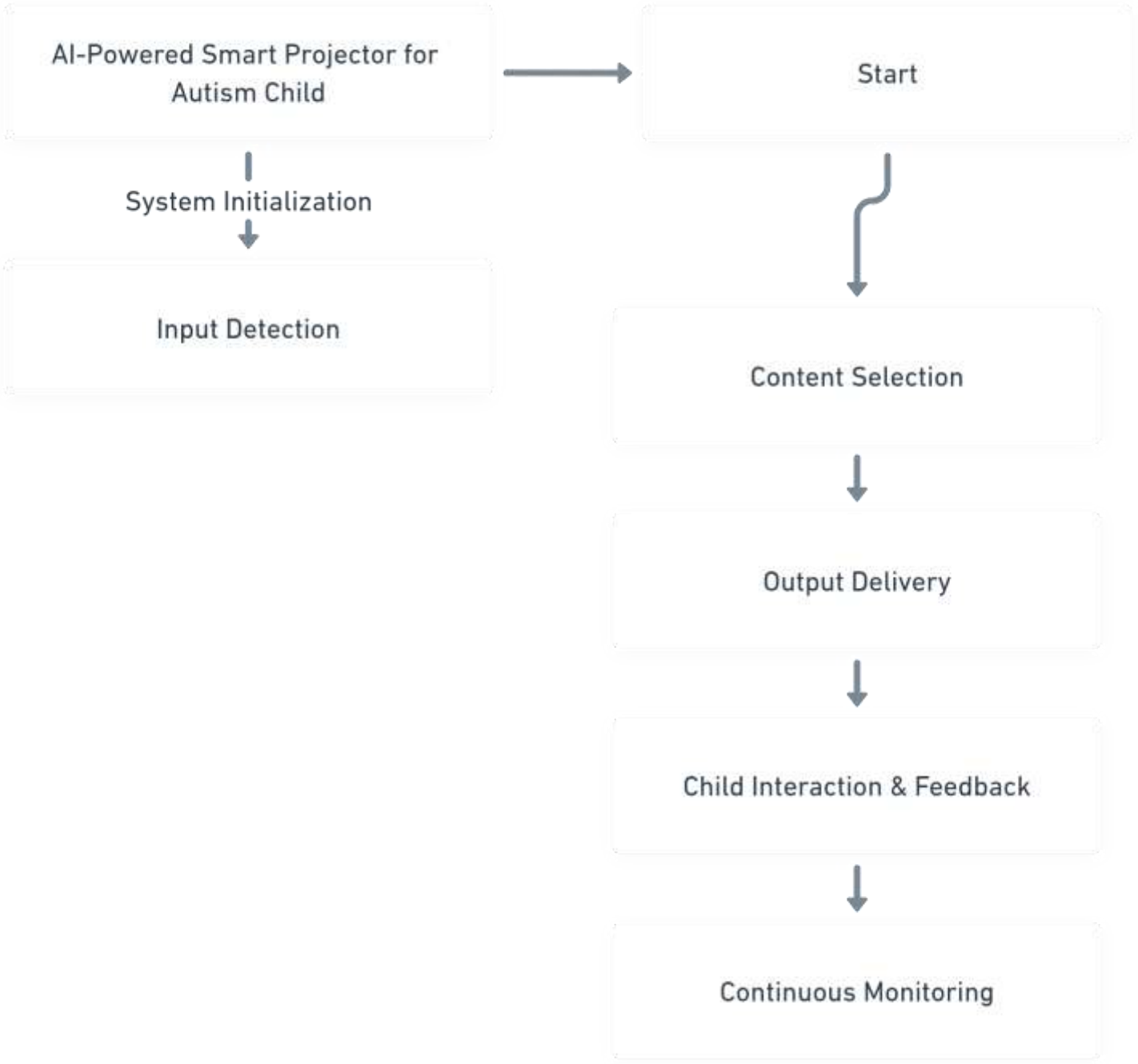


Fig8. Flow ChartofVoiceRecognition

RPA User Interface

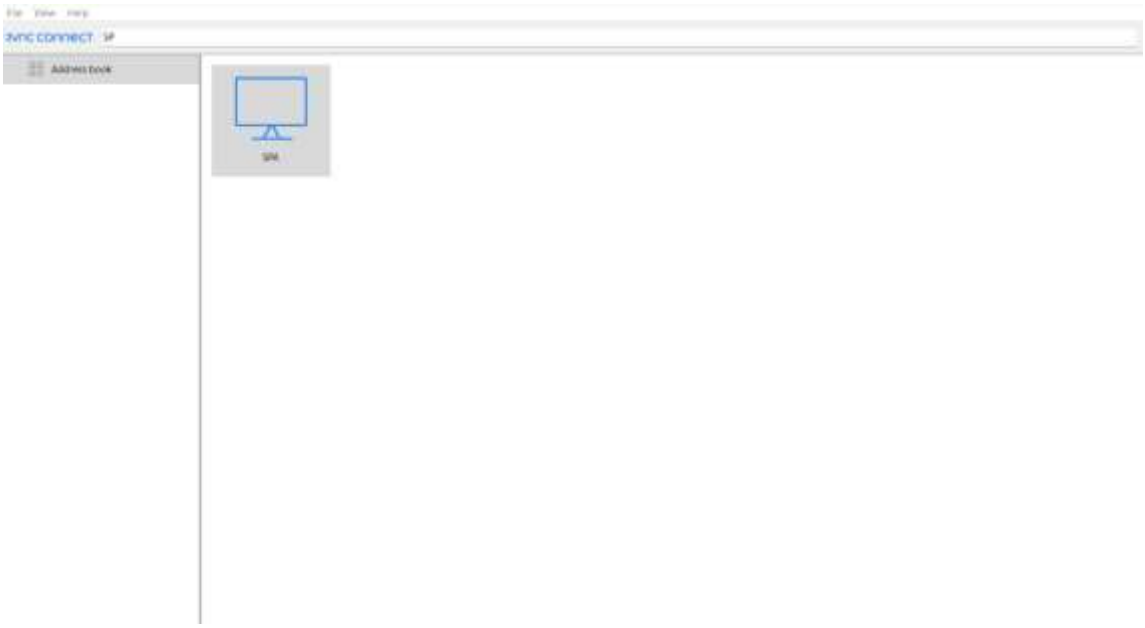


Fig9.RPAUserInterface

RPA (Robotic Process Automation) User Interface is the graphical front-end or dashboard that enables users to interact with, control, and manage RPA bots and automated workflows. It serves as a critical bridge between human users and the automation system, allowing both technical and non-technical individuals to design, execute, and monitor automated tasks with ease. Through a well-structured and user-friendly interface, users can visualize and customize automation processes using tools such as drag-and-drop workflow builders, real-time dashboards, and configuration panels.The RPA UI simplifies the complexity of backend automation logic and presents it in an understandable, accessible format. This allows organizations to streamline repetitive, rule-based tasks without requiring advanced programming skills. Key functions like bot scheduling, task tracking, error logging, and performance monitoring are typically integrated into the interface, giving users full control and transparency over automation activities.In enterprise environments, RPA UIs also support role-based access control, secure data handling, and integration with third-party applications like ERP and CRM systems. As a result, the RPA user interface plays a vital role in making automation scalable, efficient, and adaptable to business needs. It empowers users to manage digital workflows with confidence and contributes significantly to process improvement and productivity gains.**RPA (Robotic Process Automation) User Interface** refers to the graphical front-end or dashboard that allows users to interact with, control, and manage RPA bots or workflows. It acts as the bridge between the user and the RPA system, enabling both technical and non-technical users to automate tasks, monitor processes, and make adjustments as needed. The interface typically includes visual tools like drag-and-drop workflow designers, dashboards for tracking bot performance, and configuration panels for setting automation rules. With an intuitive UI, users can design, deploy, and refine automation solutions efficiently without needing to write complex code, making RPA highly accessible across various business departments.It is essential for democratizing automation, enabling wider adoption across industries, and ensuring operational efficiency with minimal technical barriers.

ProgramminginFoundation

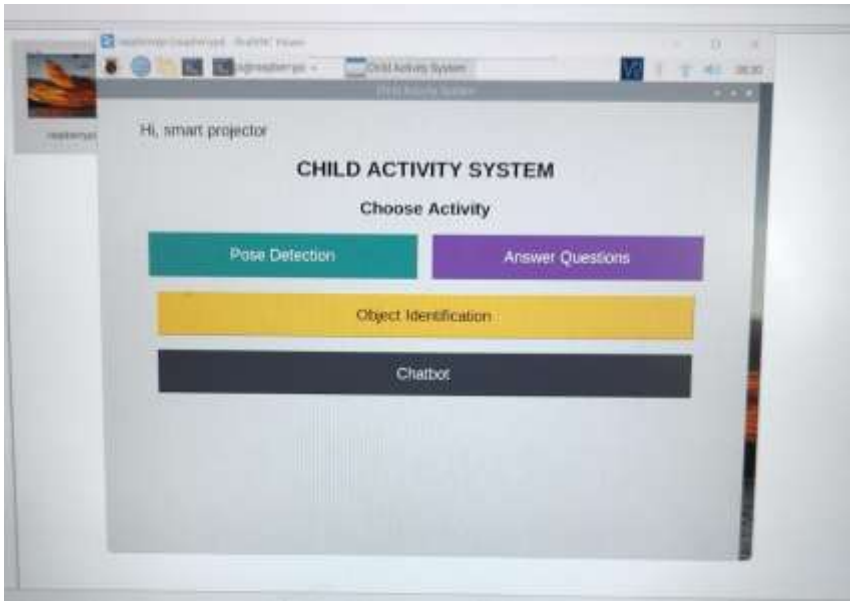
ProgrammingourArduinoUNO isverymuch importantbecauseitmakes ourprojectto moveanddothenecessaryjob that is given. Fig 11. shows the Arduino Code.

Fig11. Raspberry pi 4

Voicecommands

- Play video
- Move the slide to right
- Move the slide to right
- Open quiz
- Open chatbot

Learning Module



Module

4. RESULTS

Theproposedmodel ofour projectisdisplayed below.Fig 14.Showsthe proposedmodel

Fig14. Proposedmodel

5.DISCUSSSION

The AI-powered smart projector system presents a promising solution to address the educational and accessibility challenges faced by children with Autism Spectrum Disorder (ASD). By leveraging Raspberry Pi, PiCamera, voice recognition, and gesture-based controls, the system offers a low-cost, interactive, and adaptable learning environment. Unlike traditional classroom tools, this setup responds to the individual's behavioral cues, enabling a personalized experience that fosters attention, emotional comfort, and cognitive development. The system's modular design and user-friendly interface also allow caregivers or educators to easily monitor and adapt the learning content. Although speech recognition systems may be affected by background noise, careful microphone placement and gesture support ensure reliable operation. Compared to other high-end assistive technologies, this project emphasizes affordability and scalability without compromising on functionality.

Furthermore, the integration of AI enables real-time decision-making and content adaptation based on the child's interaction patterns, which enhances the effectiveness of learning sessions. The interactive projector not only increases engagement but also helps reduce anxiety and stress often experienced in traditional learning environments. The visual

and auditory stimuli can be tailored to match the sensory preferences of autistic children, promoting a more comfortable and focused experience.

Another key advantage of this system is its portability and ease of setup. It can be used in various settings, including homes, therapy centers, and special education classrooms. As the content and behavior recognition modules are customizable, the same device can be used for children with different needs and learning levels. However, to further improve the system, future developments can explore integrating emotion detection and advanced machine learning models for deeper personalization. In summary, the AI-powered smart projector is a step forward in building inclusive, intelligent, and responsive educational tools for children with autism, promoting better learning outcomes and emotional well-being.

6.CONCLUSION

The AI-Powered Smart Projector system presents a meaningful step toward inclusive and accessible education for children with Autism Spectrum Disorder (ASD). By integrating artificial intelligence, gesture and speech recognition, and visual learning through projection, the system creates a personalized, engaging, and adaptive learning environment. The use of Raspberry Pi and cost-effective hardware components ensures affordability and ease of implementation, making it suitable for both classroom and home settings.The system addresses key challenges faced in existing methods, such as high cost and inaccuracy in noisy environments, by positioning input devices close to the user and simplifying hardware requirements. Through interactive content and responsive feedback, the projector enhances cognitive, sensory, and communication skills in autistic children. It promotes independence, reduces reliance on traditional learning methods, and supports emotional comfort through sensory-friendly interaction.By integrating artificial intelligence, gesture and speech recognition, and visual learning through projection, the system creates a personalized, engaging, and adaptive learning environment. The use of Raspberry Pi and cost-effective hardware components ensures affordability and ease of implementation, making it suitable for both classroom and home settings.The system addresses key challenges faced in existing methods, such as high cost and inaccuracy in noisy environments, by positioning input devices close to the user and simplifying hardware requirements.Through interactive content and responsive feedback, the projector enhances cognitive, sensory, and communication skills in autistic children. It promotes independence, reduces reliance on traditional learning methods, and supports emotional comfort through sensory-friendly interaction.Additionally, this solution encourages the involvement of caregivers and educators by offering remote control and customization through wireless connectivity. The flexibility of the platform allows for easy integration of future upgrades such as emotion detection, multilingual support, and real-time progress tracking, further broadening its educational impact. The intuitive interface and interactive nature of the system help build confidence and improve attention span, critical for effective learning in neurodiverse children.

REFERENCE

[1] Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). ‘Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015’, *Journal of the Scholarship of Teaching and Learning*, 16(3), 39-56.

[2] Amaral, M. P., & Martins, F. (2021). ‘Artificial Intelligence in special education: A systematic review’, *Education and Information Technologies*, 26(5), 1-29..

[3] Ching, Y. H., & Hursh, J. (2014). ‘Digital game-based learning for children with autism spectrum disorder: A pilot study’, *Educational Technology Research and Development*, 62(6), 775-795.

[4] Goodwin, M. S. (2008). ‘Enhancing and accelerating the pace of autism research and treatment: The promise of developing innovative technology’, *Focus on Autism and Other Developmental Disabilities*, 23(2), 125-128

[5] Kagohara, D. M., van der Meer, L., Ramdoss, S., et al. (2013). ‘Using iPods and iPads in teaching Programs for individuals with developmental disabilities : A systematic review’, Research in Develop Disabilities , 34(1), 147-156..

[6] Kim, J., & Rehder, B. (2020). 'AI-powered adaptive learning technologies for children with autism spectrum disorder', *IEEE Access*, 8, 123456-123467

[7] Kumar, D., & Sharma, A. (2022). 'Design and development of an AI-based smart projector for interactive learning in inclusive classrooms', *International Journal of Educational Technology in Higher Education*, 19(1), 1-15..

[8] Liu, C., Conn, K., Sarkar, N., & Stone, W. (2008). 'Physiological signals analysis for evaluating engagement level of children with autism', *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 16(5), 548-557.

[9] Odom, S. L., Thompson, J. L., Hedges, S., et al. (2015). 'Technology-aided interventions and instruction for adolescents with autism spectrum disorder', *Journal of Autism and Developmental Disorders*, 45(12), 3805-3819

[10] Simacek, J., Dimian, A. F., & McComas, J. J. (2017). 'Communication interventions for young children with autism: A review of technology-based approaches', *Focus on Autism and Other Developmental Disabilities*, 32(4), 199-210.

[11] Al-Azawei, A., &Badii, A. (2019). 'Designing inclusive intelligent tutoring systems for learners with special needs: Challenges and opportunities', *International Journal of Emerging Technologies in Learning (iJET)*, 14(20), 111–125.

[12] Bhatnagar, R., & Das, A. (2021). 'Role of AI-powered assistive tools in special education: A review', *Journal of Educational Computing Research*, 59(8), 1473–1490.

[13] Cabibihan, J. J., Javed, H., Ang, M., & Aljunied, S. M. (2013). 'Why robots? A survey on the roles and benefits of social robots in the therapy of children with autism', *International Journal of Social Robotics*, 5(4), 593–61

AUTHORBIOGRAPHY

Ms.AbhiramiJS,Assistant Professor,

DepartmentofArtificial IntelligenceandDataScience,Nehru Institute of Engineering and Technology,Coimbatore, India.
ExpertiseinMachineLearning.

Mr.SanthoshN, UGStudent,

DepartmentofArtificial IntelligenceandDataScience,Nehru Institute of Engineering and Technology,Coimbatore, India.
PassionateinDataScience.

Mr.Mohamed Bayas A, UGStudent,

DepartmentofArtificial IntelligenceandDataScience,Nehru Institute of Engineering and Technology,Coimbatore, India.
PassionteinArtificialIntelligenceand DataScience.

Mr.HariharanS ,UG Student,

DepartmentofArtificial IntelligenceandDataScience,Nehru Institute of Engineering and Technology,Coimbatore, India.
PassionateinDataScience