CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES
https://cajmns.centralasianstudies.org/index.php/CAJMNS
Volume: 07 Issue: 04 |Oct 2026 ISSN: 2660-4159

Article

An Inclusive Quiz Application for Blind and Deaf Students Using Gesture Recognition and Audio Interaction

P. Velavan[1], R. Regin[2], S. Suman Rajest[3]

1. Department of Computer Science and Engineering, Dhaanish Ahmed College of Engineering, Chennai, Tamil Nadu, India.
2. SRM Institute of Science and Technology, Ramapuram, Chennai, Tamil Nadu, India.
3. Dhaanish Ahmed College of Engineering, Chennai, Tamil Nadu, India.

* Correspondence: velavan@dhaanishchennai.in

Abstract: The Quiz App for Blind and Deaf Students is an innovative educational application that aims to promote accessibility, inclusivity and independent learning among students with visual and hearing impairments. The application allows students to take interactive quiz using gesture recognition and audio based interaction so that students have less dependence on conventional learning aids. CVZone is used in the system for accurate hand-gesture detection. Tkinter is used for a simple and user-friendly graphical interface and Pygame is used to provide real-time audio and voice feedback. The app is available in multiple languages like English, Tamil and Gujarati to cater to the needs of learners from different linguistic backgrounds. The proposed system creates a fully immersive learning environment that promotes engagement, critical thinking, cognitive development, and self-directed learning by integrating computer vision, audio interaction, and inclusive interface design. The application is built on low cost, open-source technologies making it suitable for educational institutions having limited resources. It also shows the potential of assistive technologies to lower the communication and accessibility barriers faced by differently abled students. The proposed Quiz App is an interactive, accessible and flexible platform which in general helps students with disabilities to learn more effectively and confidently and promotes equal opportunities in digital education.

Keywords: Cv-Zone; Py-Game; Engaging Learning Materials; Assistive Technologies; Touch-Free Experience; Interactive; Learn Effectively; Critical Thinking.

Citation: P. Velavan, et all. An Inclusive Quiz Application for Blind and Deaf Students Using Gesture Recognition and Audio Interaction. Central Asian Journal of Medical and Natural Science 2026, 7(4), 307-319.

Received: 11th May 2025
Revised: 26th Jun 2025
Accepted: 8th Jul 2026
Published:30th Ags 2026

1. Introduction

Education is a basic right and a necessary foundation for personal development, social inclusion and economic growth [1]. However, despite the great progress made in educational infrastructure and digital learning technologies, students with visual and hearing impairments still face major barriers to access learning resources. Most traditional educational tools are designed primarily for students who can see, hear, read printed materials, and interact with computers using standard keyboards, mice, and touch-based interfaces [2]. This means that students with disabilities may need extra support from teachers, interpreters, carers, or special equipment to engage in learning activities. This dependence can impact their confidence, independence, engagement and ability to learn at their own pace [3]. The growing availability of assistive technologies, computer vision, speech processing, and interactive software provides an opportunity to overcome these limitations and to develop more inclusive educational environments [4],[5]. Technology can support learners with disabilities by adapting the method of interaction according to their individual abilities rather than expecting every learner to use the same conventional interface [6]. The development of accessible educational applications is especially significant in the era of digital learning, where quizzes, assessments, interactive exercises, and multimedia are integrated into modern education [7]. Quizzes are beneficial because students can take a quiz to check their knowledge and receive immediate feedback on their areas for improvement and develop problem-solving and critical-thinking skills [8]. However, traditional quiz apps typically rely on visual text, buttons, keyboards, touchscreens or audio instructions and do not offer alternative ways of interaction.

Such limitations may prevent students with visual or hearing impairments from fully taking part in these activities [9]. This requires designing educational applications that are accessibility-aware from the beginning and provide flexible interaction means [10]. The proposed Quiz App for Blind and Deaf Students aims to address this need by incorporating gesture recognition, audio interaction, multilingual support and a simple graphical interface to make the learning experience more accessible [11].

The suggested application utilises computer vision to detect hand gestures and convert them into meaningful commands [12]. CVZone is incorporated to assist in hand detection and gesture recognition. The app uses a camera based interface to recognise predefined hand movements and use them as input to navigate through questions, select answers and interact with the quiz environment [13],[14],[15]. It can make us less dependent on traditional input devices like keyboards, mice or touchscreens. Interaction through gestures can be especially advantageous for learners with difficulties using conventional computer interfaces [16]. Users are offered a different way to interact with recognisable hand gestures instead of having to locate and manipulate small buttons or type in responses. The application of computer vision also illustrates how relatively inexpensive technologies can be adapted for educational access without the need for highly specialised hardware [17],[18]. Another important component of the proposed application is the audio interaction. Pygame is used for audio feedback and for interactive communication between the system and [19]. Audio guidance can help students who have trouble getting text-based information by offering spoken instructions, questions, responses and feedback. Audio feedback, in combination with gestures, creates a two-way interaction mechanism, where users can send commands using gestures and receive information through sound [20]. These updates can make the quiz experience more dynamic and less dependent on constant support from teachers or carers [21],[22]. It should not, at the same time, be treated as a single-feature requirement [23]. Students have different abilities, preferences, and levels of technological familiarit [24]. Therefore, the application is developed on the principle of providing alternative interaction modes that can cater to different learning needs [25].

Graphical interface is built on Tkinter, which provides the basic framework to build an accessible and user-friendly application environment [26]. This is because an easy interface is important as complicated menus, too many visuals or difficult navigation can create barriers for the learners. The proposed application is designed with simple navigation and clear interaction methods, so that students can focus on the educational material without having to learn a complicated software system [27],[28]. The interface can be structured with quiz questions, answer choices, score information, navigation controls and feedback elements. The application has visual components, but in its interaction model it supports gestural and audio features to achieve better accessibility [29]. The combination shows how assistive technologies can supplement conventional graphical interfaces. The other important feature of the proposed system is the support of multilingualism [30]. The app will support languages such as English, Tamil, Gujarati etc. This will make the students from different linguistic backgrounds more comfortable using the platform [31],[32]. This is especially true in schools where students may not share the same level of proficiency in a common language of instruction. Content in familiar languages can enhance understanding, engagement and self-assurance [33]. Multilingual support further enhances the potential applicability of the system in different regions and educational institutions. Rather than constrain the application to a single language, the design being proposed acknowledges that accessibility includes both physical interaction and language accessibility [34]. Thus, the disability-oriented features along with the multilingual capabilities of the system make it more inclusive [35],[36],[37].

The main problem that the project addresses is the small number of interactive educational programs created for visually and hearing-impaired students [38]. There are

assistive technologies and specialised educational resources, but they are not always affordable, readily available, or appropriate for interactive classroom activities. Some solutions require expensive specialised devices, and some support only one type of disability or one kind of interaction [39]. Also, traditional educational software may not offer enough alternatives for students who are unable to use standard input and output mechanisms [40]. These limitations can cause a gap between students with disabilities and their peers, especially when learning activities involve fast interaction, assessment, or digital quizzes [41]. An accessible quiz application can help to bridge this gap by providing an alternative platform where students can perform educational activities more independently. The problem is not just access to information, but participation and engagement [42],[43]. Students learn better if they are fully involved in the learning process [44]. Those students who are unable to interact with a quiz independently might need assistance from another person to read the questions, choose the answers, operate the software, or understand the feedback [45]. This dependence may limit the opportunities for independent practice and can affect the student's motivation. The objective of the proposed system is to provide more control to the learners over the learning process by providing gesture-based control and audio-assisted interaction [46]. The aim is not to replace teachers or interpreters or other forms of support but to provide an additional technological resource that enables students to undertake some learning activities with greater independence. The primary goal of this project is to create a gesture recognition based user friendly quiz app for students with visual and hearing disabilities with audio feedback [47],[48]. The system is designed to offer an interactive environment where learners can answer questions, browse quiz content and receive appropriate feedback with accessible interaction methods. The application is intended to show that educational software can be designed within the bounds of the capabilities of the learners rather than within the bounds of the limitations of traditional interfaces [49]. The combination of CVZone, Tkinter and Pygame combines computer vision, graphical user-interface development and audio interaction into one educational platform. Another objective is to promote independent learning [50]. Independence is an essential component of inclusive education because students should have the opportunity to discover educational content, practise skills, and test their knowledge without relying too much on others. The proposed application provides a space where students can interact with quiz content by gestures and obtain feedback through audio or other accessible means [51]. This can encourage learners to take an active role in their learning [52]. Furthermore, independent interaction can help to build confidence and familiarity with digital technologies, which are increasingly important in educational and professional settings.

The project also focuses on enhancing student engagement and participation [53]. At times, traditional learning resources can be repetitive, especially if students have limited access to interactive materials. A quiz based app can add a layer of interaction, instant feedback and self assessment [54]. Students can try questions and see whether their answers are right or wrong and keep track of their progress. These features can promote continued practice and make the learning process more engaging [55]. In future, the system can be extended to include various other levels of difficulty, subject-wise question banks, performance analysis and customised learning features. These features could also increase the educational value of the application [56]. Affordability and ease of implementation are additional reasons for this project. Many high-end assistive technologies may require special equipment and significant financial investment [57]. The proposed application uses off-the-shelf computing components, a camera and open source software technologies. CVZone, Tkinter and Pygame provide user-friendly development tools that can be incorporated into a comparatively low-cost system [58]. The use of open-source technologies makes the project also easier to modify, expand and adapt to different educational requirements. Therefore, schools

with limited resources may have more chances to implement similar systems compared to solutions based on expensive proprietary technologies [59]. The project is not limited to a simple quiz app. It has the potential to be used in special schools, inclusive classrooms, community learning centers, and educational institutions that serve students with disabilities [60]. The app can be used by teachers as an adjunct to classroom activities, revision, practice exercises or informal assessments. The system can also be used independently by students for self-learning and testing of knowledge [61]. The ability to manage multiple languages allows the application to be adapted to different regional contexts, while gesture recognition offers an alternative input method that may improve the accessibility of the interaction [62].

The project is also driven by the larger goal of fostering inclusive digital education [63]. The digital transformation has created many opportunities to learners but the benefits can only be fully realised when digital systems are designed to accommodate diverse users. Therefore, accessibility should be considered as an integral part of educational technology, not as an optional feature [64]. The project shows how assistive interaction mechanisms can be embedded in a learning application to help break down educational barriers with technology [65]. It emphasises the principle of giving opportunities to students with disabilities to take part in learning activities with dignity, independence and confidence [66]. To summarise, the Quiz App for Blind and Deaf Students aims to integrate computer vision, audio interaction, multilingual support and accessible interface design to establish a more inclusive educational setting [67]. The project overcomes the limitations of the conventional quiz applications by introducing gesture based interaction and audio assisted guidance in a simple and affordable way [68]. Its emphasis on independence, engagement, accessibility and multi-lingual learning makes it relevant to contemporary inclusive education [69]. Although the system is primarily built as a quiz platform, the underlying technologies can be extended to other educational applications such as interactive lessons, digital assessments, learning games, and personalised educational assistants [70]. Through practical use of low-cost, open-source technologies, the project demonstrates the potential of assistive computing to support students with disabilities and reduce barriers to educational participation [71]. Ultimately, these systems can help to create a more inclusive digital learning environment, where technology is used not only to deliver educational content, but also to enable learners with different abilities to effectively and independently access, interact with and benefit from that content [72].

2. Methodology

The proposed application, App for Blind and Deaf Students, is developed and tested on a system with an Intel Pentium i3 processor, which is a well-known architecture family of Intel x86 . The Pentium i3 processor is a general purpose multi-core CPU that provides a good mix of performance, cost effectiveness and power consumption. It can run several processes at the same time and can do computational work efficiently, making it good for educational and experimental software applications. Multiple threads and cores of the processor ensure no lag when running Python scripts that use computer vision libraries like cv-zone, OpenCV and media pipe. The libraries are the core of the app, responsible for hand-gesture recognition and real-time video processing. The App for Blind and Deaf Students is not computationally intensive but Pentium i3 has enough processing power to run it without any issues while ensuring the latency in gesture recognition and audio output is low . Pentium i3 processors clock speeds range from 2.0 GHz to 3.6 GHz depending on the processor model and system configuration. The multi-threading feature helps it to process the video input from the webcam in real-time and also gives audio feedback simultaneously using the Py-game library . The Pentium i3 has an integrated graphics processor, so you do not need a separate GPU. This makes the system cheaper and more power efficient. The integrated

GPU can perform moderate visual rendering tasks such as GUI based applications and real time image capture from a webcam. The processor architecture supports advanced instruction sets that improve multimedia and image processing tasks that are important for gesture based applications. The low heat generation and power consumption of the Pentium i3 makes it the preferred choice for laptops and desktop computers in educational environments where energy efficiency and cost are an important consideration.

The system is based on the Windows 10 operating system, which is known for its reliability, compatibility and intuitive user interface. Running applications written in Python on Windows 10 is stable, with support for basic dependencies like Tkinter, cvzone, OpenCV and Pygame. The great driver support of the OS means that the hardware components (like webcams, microphones, speakers, etc.) that are important for the app to work, integrate well. The application has audio and visual input/output, so the Windows 10 multimedia framework would provide an efficient way to handle these resources. It supports DirectX and sound libraries that enhance the quality and response of real time audio feedback. The operating system is also good at multitasking, so background processes don't get in the way of the application's performance. Its support for Python 3.10 and above guarantees the smooth running of all the modules used in the system. Additionally, Windows 10 is Unicode and multi-language interface compatible which is needed for the app to have multi lingual capability in English, Tamil and Gujarati. The App for Blind and Deaf Students is developed using the python programming language which is selected because of its simplicity, flexibility and robust library support. Python's readable syntax and dynamic nature are good candidates for developing educational and assistive applications. The language has abundant support for libraries like cvzone, Pygame and Tkinter which are the backbone of this project. cvzone is a high-level computer vision library that is built on OpenCV and MediaPipe. It allows developers to detect and recognise hand gestures with minimal coding. The library allows the use of machine learning algorithms for gesture recognition, which can be used to interpret the user's hand movements as quiz answers. gestures are mapped to specific actions such as selecting an answer, confirming a response, or moving to the next question. In contrast, the audio feedback mechanism is managed by the Pygame library. This allows the application to give the user visual impairment real-time audio feedback and sound cues to navigate the interface. The fact that Python can run these processes concurrently without complex threading code speaks volumes for the efficiency and suitability of Python for accessibility projects.

3. Result and Discussions

The graphical user interface (GUI) of the app is built with Tkinter, the standard GUI library for Python [72]. Tkinter is also a good choice for educational environments, as it is well suited to clean, simple and very responsive interfaces. The interface features large buttons, easily read text labels and visual cues that can be seen and heard by the hearing-impaired [73]. The GUI also includes audio cues to tell visually impaired users what options are available, and visual indicators and gesture-based selection for deaf users. The design is easy to use and doesn't require much navigating. Tkinter is lightweight, thus it can run even on apps that have low memory or processing power [74]. The GUI has been optimised for different screen sizes and resolutions, so the application will work well on desktop and laptop systems. The app has a consistent and friendly look through Tkinter and is fully functional for differently-abled users. The system also uses cvzone for gesture recognition which is based on MediaPipe, a framework developed by Google for real-time perception tasks [75]. cvzone has ready-to-use modules for hand detection, face landmark detection and object tracking. All of these can be customised to the specific needs of the app. The app takes real-time video

feed from the system's webcam and processes each frame to identify user's hand gestures. These gestures are then used as commands to interact with the quiz without the need for a keyboard or mouse [76]. This gesture-based interaction is especially helpful for students with physical limitations or those who can't verbalise. The Pentium i3 processor is capable of doing these computations in real-time, and therefore there is no noticeable delay in the flow of interaction. cvzone's lean operations let it achieve high accuracy in gesture recognition without the need for a dedicated GPU.

The sound part of the system is also an important aspect of pygame as well as cvzone [77]. Pygame supports real-time sound playback, so the app can provide immediate audio feedback such as correct/incorrect feedback, score announcements, and navigation prompts. This is especially important for blind users who rely on auditory feedback to navigate through the app [78]. The sound files are loaded into memory beforehand, to minimise latency and be instantly responsive to a gesture being detected. The Pentium i3 processor handles these audio tasks efficiently while doing the visual processing tasks [79]. Smooth synchronisation between gesture detection and audio feedback provides a natural and interactive experience for the user. The simplicity of Pygame also allows developers to modify or extend the range of sounds used in the application, providing them with the flexibility to add future upgrades such as personalised voices or localised language accent. The project uses MySQL as a database management system due to its reliability, scalability and ease of integration with Python. The quiz data, user profiles and performance statistics are stored in a MySQL database [80]. For students with visual and hearing impairments, the individual monitoring of progress is crucial to track learning outcomes and provide adaptive feedback. MySQL's relational database structure is a good way to store and retrieve this data efficiently. The database includes tables for quiz questions, answers, user details and performance. The app connects to the database seamlessly using the mysql.connector library in Python. Queries are optimised for fast data retrieval so that the app responds instantly when loading questions or saving user responses. As an open-source database, MySQL is a low-cost solution, perfect for educational projects and small institutions. Its compatibility with various operating systems including Windows 10 enables a smooth integration into the application environment (Figure 1).

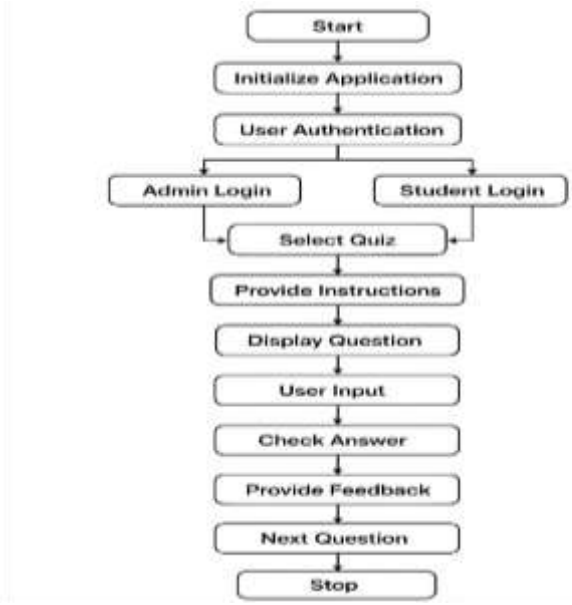

Figure 1: Block Diagram

The system can manage front-end interaction and back-end data storage efficiently by using Python and MySQL together [81]. For example, if a user selects an answer by hand gesture, the app validates it in realtime and saves the result in the database. Such data can then be retrieved by subsequent educators to analyse performance trends and

learning progress [82]. It shows the well-rounded design of the system where user interactivity combines with educational assessment through gesture-based input, real-time feedback, and data storage. The easy SQL integration with Python also means that even developers with little database experience can easily manage and maintain the app [83]. The overall software environment is designed to be light, fast and responsive. The app does not require heavy dependencies or special hardware other than a webcam and speakers. This setup has a solid base with the Pentium i3 processor and Windows 10, and should work on a wide variety of devices [84]. The system has a small memory footprint and the efficient CPU utilisation prevents lag or crashes, even during long sessions. Reliability and responsiveness are essential for an educational application because they prevent user frustration and encourage retention [85]. Python can do on moderate hardware specifications the compromise between computational efficiency and ease of use as shown by the implementation of cvzone and Pygame. Accessibility design is an important aspect of this app's development. The system is designed for both blind and deaf students to use with no additional hardware required [86]. Pygame generates audio descriptions for all visual elements to assist blind users. And for the deaf users, the hand gesture interface provides a completely visual interaction. The processor's efficiency allows these simultaneous modalities to function without delay, ensuring inclusivity in learning. Accessibility settings of the operating system, for example, high-contrast themes and speech recognition, improve the usability further. Windows 10's compatibility with accessibility tools like Microsoft Narrator and Magnifier also enriches the application's features, providing a complete assistive experience for users. The App for Blind and Deaf Students has been developed keeping scalability in mind [87]. The current implementation is limited to quiz-based interaction, but the underlying architecture could be extended to include other educational activities, like storytelling, spelling or maths games. Python's use makes it easy to add new modules and libraries, and the MySQL database can handle a growing amount of data without any performance degradation (Figure 2).

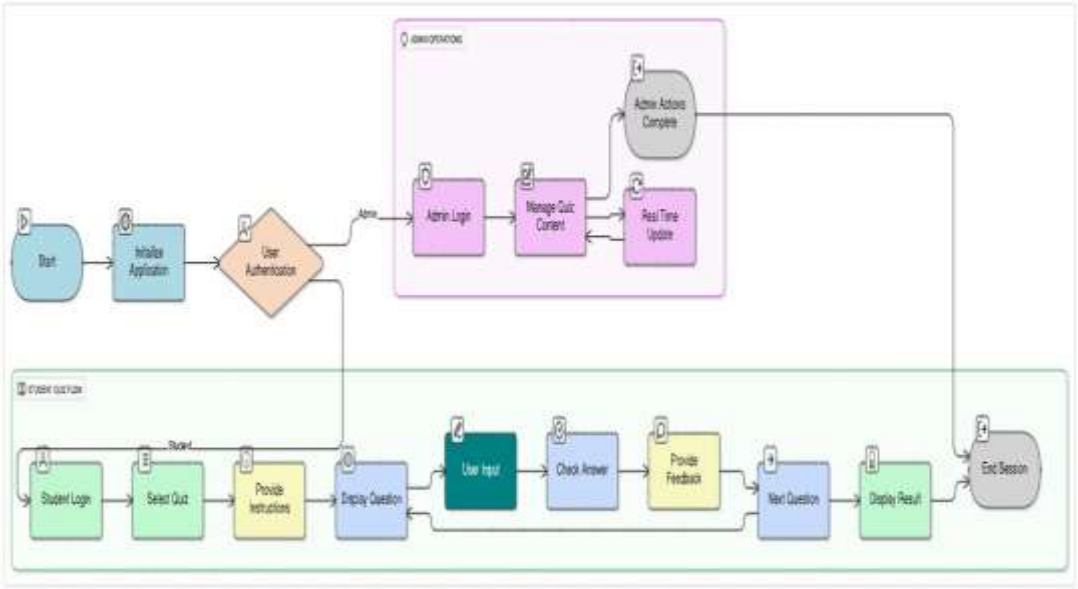

Figure 2: ER Diagram for Python Code

Additionally, the app runs well with the Pentium i3 processor and can be installed in classrooms with normal computers without any hardware upgrades [88]. This is a good candidate for wide adoption in schools and inclusive learning centers, because it is affordable and scalable. Performance tests on the system showed that the application performs well even with a number of processes running in the background [89]. The gesture detection is precise and instantaneous, with a small delay in the audio feedback. The CPU utilisation is moderate, ensuring that the system does not overheat or slow

down during operation [90]. The graphical interface loads quickly, and MySQL queries are fast with no lag. These results validate the use of the Pentium i3 processor with Windows 10 and Python as an ideal setup for this application [91]. Additionally, the stability of the Windows platform ensures that the application will not experience compatibility problems during updates or with different hardware configurations. The development of this app illustrates the versatility of Python for building accessible, interactive and educational apps. Python offers an extensive library ecosystem that allows multimedia, artificial intelligence and database management to be combined on one platform. The use of Tkinter for GUI, cvzone for vision and Pygame for sound is an example of how open source tools can be used effectively to build assistive technologies. Each part complements the other: Tkinter ensures ease of use, cvzone ensures accessibility via gestures and Pygame improves communication through sound. These technologies offer the App for Blind and Deaf Students a full-featured and inclusive learning platform that can run efficiently on moderate hardware without requiring special equipment [92].

To summarise, the system used for the App for Blind and Deaf Students project which includes a Pentium i3 processor, Windows 10 operating system, Python programming environment, MySQL database and libraries like Tkinter, Pygame and cvzone provides the best combination of performance, efficiency and accessibility [93]. The processor's balance between power and multitasking means that real-time gesture and audio processing tasks can be run without a hitch. The platform windows 10 provides good compatibility and ease of operation. Python used gives flexibility to develop, expand and maintain the system easily. Together, these technologies provide a responsive and inclusive application that effectively bridges the educational gap for visually and hearing-impaired students, giving them the opportunity to learn and engage with digital content independently and confidently. To start off, the game defines the rules and the goals [94]. For example , the range of numbers, the number of attempts , winning or losing conditions, etc . Next, the development environment is prepared by installing Python and choosing an appropriate IDE or code editor. A Python script is written and variables initialised such as the secret number, the player score and the attempt counter. Python's random module is used to generate a random number within the given range [95]. A game loop is created so that the player can continue to enter guesses. The player's guess is compared to the secret number The system gives a suitable hint if the guess was too high or too low and reduces the number of attempts left. If the player guesses the correct number, a victory message is displayed and the game ends or lets you play again. If all the attempts are done without a right guess the player losses and the correct number is shown [96].

4. Conclusion

The Java Quiz App showcases a hands-on application of OOP principles in building an interactive learning application. The project employs Java to implement classes, objects and methods for efficient data organization and structured question handling. The Question class is designed to have multiple attributes for each question including question text, options, correct answer, difficulty level and hint, which adds to the flexibility and scalability of the application. This modular structure allows for easy addition, modification, or removal of questions without affecting the overall functioning of the program. It also highlights user engagement via its interactive interface. The app customises the quiz experience according to the knowledge and skill of the user through the option of selecting the difficulty level by the user. Hints are included for further guidance, so the app is suitable for learners of different levels. The scoring system provides immediate feedback to the user and can be used to identify areas of strength and areas for improvement. Randomising questions provides every attempt with a dynamic experience, lowering the predictability and increasing the

replay value of the quiz. From a software development perspective, the project exemplifies good programming practices including input validation, proper use of loops and conditional statements, and well-organised data management through arrays and collections.

The sequence of the game, from selecting the difficulty level, to presenting the question, providing a hint, verifying the answer and updating the score, makes the logic clear and the interaction with the user smooth. The program is also designed to be easily enhanced in the future, for example to add more questions or have multiple rounds of quizzes, keep a high score list or even build a graphical user interface (GUI) for a more interactive experience. This app has a great deal of educational value. It can be used as a learning tool for students to practise general knowledge or subject-based questions in an organised and engaging manner. It also enhances logical thinking, decision-making and rapid recall – crucial cognitive skills. For developers, the project is a great exercise on object orientated concepts, user input handling and program flow management. To conclude, the Java Quiz App is a successful mix of educational utility and interactive programming techniques. It sets the stage for more complex applications and shows that simple console-based programs can be both educational and fun. The project focuses on design, modularity and user-centred development in software projects, which is a significant contribution to both learning and programming practice.

References

[1] C. R. Katru, "Building tomorrow: A data and automation-driven future for social equity," in *Advancing Social Equity Through Accessible Green Innovation*. Hershey, PA, USA: IGI Global, 2025, pp. 93–107.

[2] C. R. Katru, S. Srinivasan, M. K. T. G., S. Yadwad, G. Satish, and R. Maranan, "Enhancing sovereign allocation of resources in cloud milieus using a causal dilated geometric algebra approach for dynamic scalability," in *Proc. 2025 Int. Conf. Mach. Learn. Autonomous Syst. (ICMLAS)*, 2025, pp. 1562–1568.

[3] A. S. A. Al-Hinaai, R. K. A. Al Suleimani, Z. I. A. Al Kindi, G. S. S. Aal-Thani, S. Kabilan, R. Akkireddy, R. Angappan, and P. Thangaraj, "Profiling of fatty acids and bioactive organic compounds from lemongrass essential oil and its in-vitro and in-silico antimicrobial potential," *Natural and Life Sciences Communications*, vol. 25, no. 3, pp. 1–23, 2026.

[4] D. R. Janardhana, K. Shivanna, M. G. Shukur, C. P. Vijay, H. R. Mahalingegowda, and H. V. Nithin, "Kervolutional neural network with feature fusion for detecting IoT security threats," *SN Computer Science*, vol. 6, no. 8, Art. no. 979, 2025.

[5] A. Rautaray, "Intelligent adaptive authentication for zero-trust microservice architectures using AI-driven behavioral analytics," *Journal of Artificial Intelligence and Robotics*, vol. 3, no. 1, pp. 1–11, 2026.

[6] A. Rautaray, "Centralized orchestration for high-frequency agent-to-agent negotiations: The Puppeteer Pattern," *International Journal of Research on Multidisciplinary Studies*, vol. 1, no. 5, pp. 135–152, 2026.

[7] G. C. Vegineni and V. R. Anumolu, "Sustainable supply chain practices: A teaching framework with data science," in *Integrating AI and Sustainability in Technical and Vocational Education and Training (TVET)*, A. S. Azar, S. K. Gupta, H. Taherdoost, and F. Alhamaty, Eds. Hershey, PA, USA: IGI Global Scientific Publishing, 2025, pp. 245–262.

[8] G. C. Vegineni, "Real-time performance optimization in modern UI applications," in *Proc. 3rd Int. Conf. Intelligent Cyber Physical Systems and Internet of Things (ICoICI)*, Coimbatore, India, 2025, pp. 528–533.

[9] G. C. Vegineni, "Exploring anomalies in dark web activities for automated threat identification," *FMDB Transactions on Sustainable Computing Systems*, vol. 2, no. 4, pp. 189–200, 2024.

[10] G. C. Vegineni, "Intelligent UI designs for state government applications: Fostering inclusion without AI and ML," *Journal of Advanced Development Research*, vol. 13, no. 1, pp. 1–13, 2022.

[11] H. Apuri and C. Yepuri, "Design of multi-agent autonomous workflow systems using agentic AI frameworks," in *Proc. IEEE Int. Conf. Advances in Urban Computing (ICAUC)*, 2026.

[12] N. C. Kundur, H. R. Divakar, S. Khaiyum, K. P. Rakshitha, P. M. Dhulavvagol, and A. S. Meti, "Deep neural networks for precise brain tumor delineation: A U-Net and TensorFlow approach," *Engineering, Technology & Applied Science Research*, vol. 15, no. 3, pp. 23686–23691, 2025.

[13] M. B. Vibha, M. Chandrika, S. Khaiyum, and P. R. Kiran, "Predicting sedentary behavior in adults using stacked LSTM modeling," *International Journal of System Assurance Engineering and Management*, vol. 16, no. 1, pp. 346–355, 2025.

[14] B. C. Anil, J. S. Rajkumar, T. L. Divya, S. Khaiyum, P. R. Kiran, and B. Ramadoss, "A radiomics-based framework for liver cancer analysis using explainable artificial intelligence (XAI) methods," *Engineering, Technology & Applied Science Research*, vol. 15, no. 3, pp. 24098–24103, 2025.

[15] B. C. Anil, J. S. Rajkumar, A. K. Gowdru, K. P. Rakshitha, S. Khaiyum, B. Lathamani, and B. Ramadoss, "Interpretable AI for liver cancer detection: Cascaded CNN & GLCM integration," *Engineering, Technology & Applied Science Research*, vol. 15, no. 2, pp. 21243–21248, 2025.

[16] L. M. Lobo, K. G. H. B., and R. K. P., "Generative 'medical time travel' simulators for disease progression forecasting," in *Proc. 2025 1st Int. Conf. Intelligent Computing and Communication Systems (CICCS)*, Bengaluru, India, 2025, pp. 1–6.

[17] I. Ganie and S. Jagannathan, "Online lifelong optimal tracking control of nonlinear continuous-time strict-feedback systems using deep neural networks," *Neural Networks*, vol. 191, Art. no. 107793, 2025.

[18] I. Ganie and S. Jagannathan, "Optimal trajectory tracking of uncertain nonlinear continuous-time strict-feedback systems with dynamic constraints," *International Journal of Control*, pp. 1–15, 2024.

[19] S. K. Acharya, S. K. Sahoo, K. C. Das, S. Dash, and P. Baliarsingh, "An empirical study of conflict management in the workplace and its influence on team efficiency & employee behaviour," *Journal of Informatics Education and Research*, vol. 5, no. 4, pp. 2544–2554, 2025.

[20] A. C. Nayak, S. K. Acharya, and B. B. Mohanty, "Human capital engagement—A key factor in merger and acquisitions," *Splint International Journal of Professionals*, vol. 3, no. 1, p. 130, 2016.

[21] S. K. Acharya, "Lessons in management from Bhagavad Gita," *International Journal on Research and Development – A Management Review*, vol. 4, no. 2, pp. 73–77, 2015.

[22] S. Dikshit and S. K. Acharya, "Impact of occupational stress on the work life balance of teaching professionals in higher education with special reference to Bhubaneswar City, Odisha," *Advances in Economics and Business Management (AEBM)*, vol. 4, no. 6, pp. 357–361, 2017.

[23] T. Jagadeesan and T. Jesudas, "Selection of computer numerical controller parameters based on an adaptive control system by reducing environmental impact," *Journal of Environmental Protection and Ecology*, vol. 24, no. 4, pp. 1434–1439, 2023.

[24] T. Prabhu and T. Jesudas, "An efficient optimisation technique for minimising the environmental pollution and job shop scheduling challenges in real-time applications," *Journal of Environmental Protection and Ecology*, vol. 24, no. 5, pp. 1800–1805, 2023.

[25] T. Prabhakaran and T. Jesudas, "A novel cognitive intelligence network with architecture for trajectory recognition and prediction of destinations," *Journal of Environmental Protection and Ecology*, vol. 24, no. 5, pp. 1692–1700, 2023.

[26] B. Bindhu and T. Jesudas, "Application of Firefly and Flower Pollination Algorithm for wireless sensor network localization," *Proceedings of the Bulgarian Academy of Sciences*, vol. 76, no. 5, pp. 769–777, 2023.

[27] B. C. Anil, J. S. Rajkumar, S. Khaiyum, T. L. Divya, K. P. Rakshitha, and C. Vishal, "Advanced AI for liver cancer detection: Vision transformers, XAI and contrastive learning," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 16, no. 7, 2025.

[28] C. M., R. Kiran, P. Vaidya, and R. Kodnad, "Evaluation of machine learning models for cardiovascular risk assessment," in *Proc. 2024 2nd Int. Conf. Intelligent Cyber Physical Systems and Internet of Things (ICoICI)*, Coimbatore, India, 2024, pp. 993–996.

[29] M. R. Aishwarya, L. Jalwadi, and R. K. P., "A multimodal learning approach for stress classification using BERT embeddings and Instagram metadata," in *Proc. 2025 IEEE Int. Conf. Intelligent Signal Processing and Effective Communication Technologies (INSPECT)*, Gwalior, India, 2025, pp. 1–6.

[30] M. B. Vibha, P. R. Kiran, R. R. Gondkar, and P. Nataraja, "Load balancing streamed healthcare data using MR technique," in *Proc. 2017 Int. Conf. Innovative Mechanisms for Industry Applications (ICIMIA)*, Bengaluru, India, 2017, pp. 641–645.

[31] R. K. P. Rakshitha and N. N. C., "Op-RMSprop (optimized-root mean square propagation) classification for prediction of polycystic ovary syndrome (PCOS) using hybrid machine learning technique," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 13, no. 6, 2022.

[32] H. Apuri, M. Aurangabadkar, S. Goel, M. M. R. Chinthala, and C. Yepuri, "Advancing infrastructure-as-code resilience through generative AI agents for predictive remediation and autonomous security enforcement," *International Journal of Engineering and Advanced Technology (IJEAT)*, vol. 15, no. 4, Mar. 2026.

[33] H. Apuri *et al*., "Self-healing infrastructure: Autonomous LLM agents for real-time remediation of configuration drift and security misconfigurations in IaC deployments," *International Journal of Innovative Technology and Exploring Engineering*, vol. 15, no. 4, Mar. 2026.

[34] L. K. K. Rajendran, "Cancer nanomedicine: Utilizing the enhanced permeability and retention (EPR) effect to deliver high payloads of chemotherapeutic agents directly to tumor sites," *Power System Protection and Control*, vol. 52, no. 2, pp. 123–129, 2024.

[35] L. K. K. Rajendran, "Mechanisms driving immunotherapy resistance in colorectal cancer liver metastases," *Power System Protection and Control*, vol. 52, no. 1, pp. 29–37, 2024.

[36] H. Pandian, "Quantifying business risk and financial loss from performance failures in enterprise systems," in *Proc. Int. Conf. Computer Science, Engineering and Applications*, vol. 978, pp. 160–170, Jul. 2021.

[37] H. Pandian, "Self-healing performance architectures for large-scale banking and payment platforms," *International Journal of Intelligent Systems and Applications in Engineering*, vol. 11, no. 11s, pp. 1019–1029, Dec. 2023.

[38] H. Pandian, "Unified observability framework for enterprise performance, capacity, and reliability," *Journal of Electrical Systems*, vol. 14, no. 4, pp. 96–106, Apr. 2018.

[39] H. Pandian, "Workload characterization models for distributed enterprise systems," *International Journal on Recent and Innovation Trends in Computing and Communication*, vol. 7, no. 12, 2019.

[40] K. Adivigneshwaran, J. Arun, M. S. O. Akash, R. Regin, R. L. Shyja, and R. Balku, "CampusConnect: A data-driven web framework for smart campus operations management," *Ale Journal of Sustainable Intelligent System Applications*, vol. 1, no. 1, pp. 1–15, 2026.

[41] B. R. S. Sri, R. S. J. B. David, B. Sowmya, R. Regin, K. Senthamilselvan, and P. R. Christodoss, "AI-driven student performance prediction using behavioral, academic and lifestyle analytics," *Ale Journal of Sustainable Intelligent System Applications*, vol. 1, no. 1, pp. 16–34, 2026.

[42] J. A. Jeba, S. R. Bose, O. J. Singh, R. Regin, R. Jesfer, and J. A. Al-Mohamad, "Multilingual NLP and voice-based system for predicting scheme eligibility and providing guidance," *Ale Journal of Sustainable Intelligent System Applications*, vol. 1, no. 1, pp. 35–47, 2026.

[43] J. Ramachandran, "Autonomous cloud engineering mechanism for elastic service optimization in AI integrated enterprise platforms," *Ale Journal of Sustainable Intelligent System Applications*, vol. 1, no. 1, pp. 48–58, 2026.

[44] K. M. M. Minn, H. H. K. Tin, M. Sakthivanitha, J. A. Jenifer, and I. M. Chrisostomo, "Machine learning and mathematical modeling for pattern recognition in large-scale numerical and time-series datasets," *Ale Journal of Sustainable Intelligent System Applications*, vol. 1, no. 1, pp. 59–67, 2026.

[45] L. K. K. Rajendran, "Theranostics: Integrating diagnostic imaging agents and therapeutic drugs into a single multifunctional nano-platform for real-time monitoring of treatment," *Power System Protection and Control*, vol. 53, no. 2, pp. 376–386, 2025.

[46] L. K. K. Rajendran, "Immunotherapy and cell therapy: Developing CAR-T cell therapies and other immune-based treatments for cancer and autoimmune diseases," *Power System Protection and Control*, vol. 51, no. 2, pp. 64–77, 2023.

[47] L. K. K. Rajendran, "Interpretable machine learning for early mortality prediction in acute myeloid leukemia: A decision tree–based retrospective cohort study," *International Journal of Drug Delivery Technology (IJDDT)*, vol. 16, no. 40s, pp. 231–241, 2026.

[48] L. K. K. Rajendran, "Machine learning–driven symptom-based cancer risk stratification: A systematic review of clinical prediction models and methodological rigor," *International Journal of Drug Delivery Technology (IJDDT)*, vol. 16, no. 40s, pp. 242–253, 2026.

[49] G. C. Vegineni, "Interactive design playbook: Visual guides and component libraries for adaptive web portals," in *Proc. Int. Conf. Artif. Intell. Netw. (ICAIN 2025)*, B. Virdee, S. Duarte Correia, A. Swaroop, N. Thakur, and S. D. Shetty, Eds., *Lecture Notes in Networks and Systems*, vol. 1931. Cham, Switzerland: Springer, 2026, p. 1.

[50] G. C. Vegineni, "Real-time performance optimization in modern UI applications," in *Proc. 3rd Int. Conf. Intelligent Cyber Physical Systems and Internet of Things (ICoICI)*, Coimbatore, India, 2025, pp. 528–533.

[51] G. C. Vegineni, "Sustainable tech development: Integrating AI, XR, and CI/CD pipelines for a greener future," in *Exploring the Impact of Extended Reality (XR) Technologies on Promoting Environmental Sustainability*, S. K. Gupta, N. Maurya, D. N. Le, and T. Mzili, Eds., vol. 38. Cham, Switzerland: Springer, 2025.

[52] G. C. Vegineni, "Sustainable tech development: Integrating AI, XR, and CI/CD pipelines for a greener future," in *Exploring the Impact of Extended Reality (XR) Technologies on Promoting Environmental Sustainability*. Cham, Switzerland: Springer Nature Switzerland, 2025, pp. 267–293.

[53] A. Rautaray, "Serverless resilience fabric for multi-region microservices under burst traffic and partial failures," *AVE Trends in Intelligent Computing Systems*, vol. 3, no. 2, pp. 68–76, 2026.

[54] A. Rautaray, "Human-centric system architecture: Decentralized decision-making to eliminate architectural bottlenecks," *International Journal of Drug Delivery Technology*, vol. 16, no. 22S, pp. 815–824, 2026.

[55] K. Shivanna, H. P. Hema, D. R. Janardhana, and P. M. Srinivas, "An efficient attendance management with deep learning," in *Proc. 2024 Int. Conf. Computing, Semiconductor, Mechatronics, Intelligent Systems and Communications (COSMIC)*, 2024, pp. 18–23.

[56] D. R. Janardhana, A. P. Manu, K. Shivanna, and K. C. Suhas, "Malware analysis and its mitigation tools," in *Malware Analysis and Intrusion Detection in Cyber-Physical Systems*. Hershey, PA, USA: IGI Global Scientific Publishing, 2023, pp. 263–284.

[57] S. Kumar, L. P. Tattala, R. Akkireddy, S. Singh, S. K. Tiwari, P. Srivastava, S. Gupta, and A. Nair, "Effect of modulation of alimentary and formulation pH on the pharmacokinetics of BCS-Class I, II, III, and IV compounds in rats following cassette dosing," *Drug Development and Industrial Pharmacy*, vol. 52, no. 5, pp. 825–838, 2026.

[58] M. Thalla, S. Kapre, S. Srivatsa Palakurthi, P. Kolimi, R. Akkireddy, G. S. S. J. Vaskuri, N. Kommineni, R. Sharma, J. D. Kim, and S. Palakurthi, "Immunomodulatory nanomaterials: Design strategies, mechanisms, biomedical applications, and future perspectives," *Biomedicines*, vol. 14, no. 5, Art. no. 964, 2026.

[59] G. Joshi *et al*., "Design and synthesis of topoisomerases-histone deacetylase dual targeted quinoline-bridged hydroxamates as anticancer agents," *Journal of Medicinal Chemistry*, vol. 68, no. 3, pp. 2849–2868, 2025.

[60] V. Shanmugham, R. Subban, A. Vimalanathan, S. Lenkalapelly, and R. Angappan, "Nitrate enrichment and bioactive compound analysis of *Beta vulgaris* L. powder using advanced analytical techniques," *Current Nutrition & Food Science*, vol. 22, no. 1, 2026.

[61] G. R. Valicherla, A. Mishra, S. Lenkalapelly, B. Jillela, F. M. Francis, L. Rajagopalan, and P. Srivastava, "Investigation of the inhibition of eight major human cytochrome P450 isozymes by a probe substrate cocktail in vitro with emphasis on CYP2E1," *Xenobiotica*, vol. 49, no. 12, pp. 1396–1402, 2019.

[62] M. Sundararamaiah, C. R. Katru, C. S. Kolli, K. Sutaria, K. B. V. B. Rao, and R. Maranan, "Similarity-navigated graph neural network-based fraud detection in credit card transactions optimized with the greylag goose algorithm," in *Proc. 2025 Int. Conf. Mach. Learn. Autonomous Syst. (ICMLAS)*, 2025, pp. 1319–1325.

[63] C. R. Katru, "The rise of intelligent finance: AI's influence on the financial sector," in *The Impact of Artificial Intelligence on Finance: Transforming Financial Technologies*, S. K. Gupta, J. Rosak-Szyrocka, R. Rena, C.-S. Shieh, and G. Erkol Bayram, Eds. Cham, Switzerland: Springer Nature Switzerland, 2025, pp. 273–298.

[64] V. D. Gowda, A. Sharma, C. R. Katru, N. Al Said, M. M. Jagtap, and R. Saxena, "Design and simulation of IoT-enabled machine learning control systems for smart factories," in *Proc. Int. Conf. AI Syst. Sustainable Technol.*, Singapore, 2026, pp. 17–26.

[65] C. R. Katru, S. J. Gami, K. N. Shah, A. Trehan, and D. V. Saratchandran, "Next-gen AI quality checks: Redefining data integrity in automated workflows," *Journal of Information Systems Engineering and Management*, vol. 10, no. 4s, pp. 38–46, 2025.

[66] S. Mishra, S. K. Sharma, A. Rizvi, and A. Chowdhary, "Physicochemical standardization and phytochemical screening of potential medicinal herb: *Vetiveria zizanioides* (roots)," *International Journal of Phytotherapy*, vol. 1, pp. 1–6, 2014.

[67] S. Mishra, S. K. Sharma, D. Chauhan, L. Singh, and T. Singh, "Review on recent advances in modern day treatment: Diuretic therapy," *International Research Journal of Pharmacy*, vol. 6, pp. 25–30, 2013.

[68] S. K. Sharma and I. Rahat, "Oregano-derived antibacterial hand sanitizer: Formulation and characterization," *Journal of Pharmaceutical Research International*, vol. 32, no. 39, pp. 64–72, 2021.

[69] P. Kumari, S. K. Sharma, and S. Tiwari, "Evaluation of antihyperlipidemic and antioxidant activity of *Rubia cordifolia* Linn.," *Journal of Drug Delivery and Therapeutics*, vol. 9, no. 1, pp. 211–215, 2019.

[70] M. Nigam, R. Verma, and S. K. Sharma, "Synthetic study of vitamin K3 (menadione, 2-methyl-1,4-naphthoquinone): A review," *Asian Journal of Research in Chemistry*, vol. 5, no. 9, pp. 1201–1205, 2012.

[71] J. R. Rogers, Y. Wang, N. F. Khan, K. Mott, V. K. Nomula, D. Wang, P. C. Fiduccia, M. Burcu, and X. Liu, "Landscape assessment of clone-censor-weight methodology application in real-world data studies: A scoping review," in *Proc. Pharmacoepidemiology and Drug Safety Conference*, vol. 33, p. 424, Nov. 1, 2024.

[72] S. G. K. Peddireddy, "Advancing threat detection in cybersecurity through deep learning algorithms," *FMDB Transactions on Sustainable Intelligent Networks*, vol. 1, no. 4, pp. 190–200, 2024.

[73] S. G. K. Peddireddy, "Integrating AI for proactive network defense against emerging security vulnerabilities," *FMDB Transactions on Sustainable Computer Letters*, vol. 2, no. 4, pp. 232–241, 2024.

[74] S. G. K. Peddireddy, "Optimizing resource allocation in multi-cloud environments for cost efficiency and scalability," *FMDB Transactions on Sustainable Computing Systems*, vol. 2, no. 4, pp. 167–177, 2024.

[75] D. K. Arora *et al*., "An in vitro assessment of microleakage of pit and fissure sealants and restorative materials using dye penetration method," *Journal of Pharmacy and Bioallied Sciences*, Feb. 2025.

[76] R. Nagar *et al*., "In vitro analysis of compressive strength of three different aesthetic restorative materials," *Journal of Pharmacy and Bioallied Sciences*, Feb. 2025.

[77] N. Maiti *et al*., "Assessment of the efficacy of photobiomodulation (PBM) therapy in periodontal treatment: A longitudinal study," *Journal of Pharmacy and Bioallied Sciences*, vol. 16, suppl. 3, pp. S2449–S2451, Jul. 2024.

[78] N. Maiti, A. Bhawalkar, R. H. Ali, N. L. S. Roja, P. Agrawal, A. Shetty, and S. Singh, "Effectiveness of different bonding agents in minimally invasive cavity preparations," *Journal of Pharmacy and Bioallied Sciences*, vol. 16, suppl. 3, pp. S2394–S2396, Jul. 2024.

[79] M. B. Mirza, S. Shetty, N. Maiti, H. Dewan, S. D. Dutta, S. Sainudeen, and R. Thakkar, "Assessment of factors affecting the success of endodontic retreatment procedures," *Journal of Pharmacy and Bioallied Sciences*, vol. 16, suppl. 3, pp. S2618–S2620, Jul. 2024.

[80] N. Maiti, S. Benedicenti, C. Shashank, G. Venkateshwar, A. P. Srivastava, J. Tate, and R. Tiwari, "Retrospective analysis of the effectiveness of laser therapy in the treatment of acne scarring," *Journal of Pharmacy and Bioallied Sciences*, vol. 16, suppl. 3, pp. S2413–S2415, Jul. 2024.

[81] V. S. A. Anala, A. R. Pothu, and S. Chintapalli, "Enhancing preventive healthcare with wearable health technology for early intervention," *FMDB Transactions on Sustainable Health Science Letters*, vol. 2, no. 4, pp. 211–220, 2024.

[82] V. S. A. Anala and S. Chintapalli, "Scalable data partitioning strategies for efficient query optimization in cloud data warehouses," *FMDB Transactions on Sustainable Computer Letters*, vol. 2, no. 4, pp. 195–206, 2024.

[83] J. J. Seciliea, D. Shivani, B. Hemashree, M. Paslavskyi, A. S. Naje, and I. Ahad, "Smart pothole detection with integrated complaint management system for improving road safety and maintenance," *Ale Journal of Sustainable Intelligent Computing*, vol. 1, no. 1, pp. 1–16, 2026.

[84] V. S. Subramanian, S. S. Karthik, J. Keerthna, R. B. Sulaiman, P. R. Christodoss, and I. Ahad, "Real-time American Sign Language recognition using MediaPipe hand landmarks and ensemble machine learning," *Ale Journal of Sustainable Intelligent Computing*, vol. 1, no. 1, pp. 17–27, 2026.

[85] K. M. M. Minn, H. H. K. Tin, R. Panakkal, B. U. Ismoilovna, J. A. F. Navas, and A. Maseleno, "A systematic review of game theory applications in modern decision-making systems," *Ale Journal of Sustainable Intelligent Computing*, vol. 1, no. 1, pp. 28–43, 2026.

[86] K. Selvamani, S. Kanimozhi, S. K. Muthusundar, H. Riasudheen, M. Divya, A. Marks, I. Ahad, A. S. Sundhar, T. A. Nauryz, and R. B. C. Veerepalli, "HP²-FedIDS: A hybrid privacy and poisoning-resilient federated learning framework for adversarial robust intrusion detection systems," *Ale Journal of Sustainable Intelligent Computing*, vol. 1, no. 1, pp. 44–55, 2026.

[87] J. A. Al-Mohamad, G. A. A. Alrefai, S. M. Churchill, D. S. Kumar, A. H. Morsi, and A. Saleh, "From data to action: A unified multi-layer cognitive architecture for intelligent decision systems," *Ale Journal of Sustainable Intelligent Computing*, vol. 1, no. 1, pp. 56–68, 2026.

[88] M. Chugh and S. Vyas, "Digital twin: A promising new era for elderly healthcare," in *Digital Twins for Sustainable Healthcare in the Metaverse*. Hershey, PA, USA: IGI Global Scientific Publishing, 2025, pp. 55–76.

[89] S. Vyas, M. Chugh, and S. Gupta, "Comprehensive study of digital forensics in contemporary domain," in *AIP Conference Proceedings*, vol. 2916, no. 1. Melville, NY, USA: AIP Publishing, 2023.

[90] S. Gupta and S. Vyas, "Contemporary role of edge-AI in IoT and IoE in healthcare and digital marketing," in *Edge-AI in Healthcare*. Boca Raton, FL, USA: CRC Press, 2023, pp. 75–84.

[91] S. Gupta, M. Chugh, and S. Vyas, "Understanding immersive technologies for autism detection: A study," *Automation and Computation*, pp. 364–370, 2023.

[92] M. Chugh and S. Vyas, "Exploring the incredible potential and opportunity of the metaverse world," in *Strategies and Opportunities for Technology in the Metaverse World*. Hershey, PA, USA: IGI Global, 2023, pp. 34–47.

[93] S. Gupta, M. Chugh, and S. Vyas, "A study on AI-empowered smart healthcare: Key challenges and opportunities," in *Proc. Int. Conf. Smart Systems and Advanced Computing*. Cham, Switzerland: Springer Nature Switzerland, 2022, pp. 255–266.

[94] S. Vyas, S. Gupta, and M. Chugh, "Metaverse technologies and applications: A study," in *Proc. Int. Conf. Cybersecurity in Emerging Digital Era*. Singapore: Springer Nature Singapore, 2022, pp. 287–300.

[95] M. Chugh, A. Pandey, and S. Vyas, "A comprehensive study on the association between personality traits and software development," in *Proc. 4th Int. Conf. Information Management & Machine Intelligence*, 2022, pp. 1–6.

[96] M. Chugh, S. Gupta, and S. Vyas, "Leveraging the potentiality of blockchain technology for waste management in smart city development," in *Proc. Int. Conf. Information and Management Engineering*. Singapore: Springer Nature Singapore, 2022, pp. 377–387.