

Original Article

Intelli Verse 2.0– IoT Based Smart Control System for Eco System

Sumit Kashyap¹, Anuradha Misra²

^{1,2} Amity School of Engineering & Technology, Amity University Uttar Pradesh, India

Received Date: 16 March 2026

Revised Date: 28 March 2026

Accepted Date: 15 April 2026

Abstract: The way that contemporary systems communicate with physical objects and environments has been completely transformed by the Internet of Things (IoT). IoT has increased the accessibility and efficiency of automation by allowing devices to communicate via internet connectivity. One of the most useful applications of IoT technology are smart home systems, which let users automate daily chores and remotely operate appliances. Simultaneously, intelligent interaction techniques like natural language processing and voice recognition have been made possible by artificial intelligence (AI), allowing people to interact with machines more naturally. This study introduces Intelli Verse 2.0, an IoT-based smart ecosystem intended to connect home appliances with JARVIS, an AI-powered personal assistant. With voice commands, smartphone apps, or automated rules, users can operate appliances like lights, fans, and electronic devices with the proposed system. IoT devices linked by Wi-Fi networks, microcontroller-based control units, cloud platforms, and AI processing modules make up the system-architecture. The Intelli Verse platform was designed using a layered architecture consisting of three layers: device, network, and application. Environmental sensors, such as motion detectors, temperature sensors, and light sensors, collect real-time data that allows the system to respond automatically to environmental conditions. Cloud platforms such as Firebase and MQTT brokers control device communication and data storage. The proposed system improves convenience, energy efficiency, and remote accessibility while providing a scalable ecosystem for future smart automation applications. The integration of AI-based voice assistants with IoT infrastructure demonstrates the potential for creating intelligent environments capable of simplifying everyday life.

Keywords: Internet of Things, Smart Home Automation, Artificial Intelligence Assistant, IoT Ecosystem, Voice Controlled Systems, NodeMCU, Cloud Computing

I. INTRODUCTION

The development of intelligent systems that can enhance human lifestyles through automation and connectivity is a result of the progress of digital technologies. The Internet of Things (IoT), which allows physical devices to connect to the internet and communicate with one another, has become a significant innovation among these technologies. IoT systems are made up of sensors, microcontrollers, cloud platforms, and communication networks that collaborate to gather data and carry out automated tasks.



One of the most significant applications of IoT technology is smart home automation. Smart home systems allow users to control appliances like fans, air conditioners, lighting systems, and security devices via internet-enabled platforms. These systems enhance convenience, boost security, and reduce energy consumption. By allowing machines to comprehend user commands and make intelligent decisions, artificial intelligence further improves IoT-based automation. AI-powered voice assistants enable users to communicate with devices through natural language commands. This method makes automation systems more accessible and does away with the need for complicated user interfaces.



Even though smart home systems are becoming more and more popular, many of the current solutions have drawbacks. While some systems don't integrate with AI-based assistants, others need several apps for various devices. Additionally, many solutions are expensive or difficult to configure.

This research proposes Intelli Verse 2.0, a unified smart ecosystem that integrates IoT devices with an AI-powered assistant called JARVIS. The system enables users to control appliances through voice commands, mobile applications, or automated rules based on sensor data.

The primary objectives of the Intelli Verse system are:

- To develop an IoT-based smart ecosystem for device automation
- To integrate an AI voice assistant for natural interaction
- To enable remote monitoring and control of appliances
- To improve energy efficiency through intelligent automation

The proposed system demonstrates how the integration of IoT and AI technologies can create intelligent environments capable of simplifying everyday life.

II. LITERATURE REVIEW

The growing need for intelligent living spaces has led to extensive research on smart home automation systems in recent years. Wired networks that linked appliances via centralized control panels were the foundation of early home automation systems. These systems offered automation capabilities, but they were costly and challenging to set up. The viability of Internet of Things-based home automation systems has greatly increased with the development of wireless communication technologies like Bluetooth and Wi-Fi. Appliances can now be more easily connected to the internet and controlled via mobile applications thanks to microcontrollers like Arduino and NodeMCU. IoT-based systems that enable smartphone-based remote device control have been proposed by a number of researchers. To store device data and control user-device communication, these systems usually make use of cloud platforms.

With the advancement of speech recognition technology, voice-controlled automation systems have also grown in popularity. Natural language commands can be used by users to communicate with devices through AI-powered assistants. Natural Language Processing (NLP) is one of the technologies that enables machines to decipher user commands and carry them out.

Nevertheless, a lot of current systems do not incorporate intelligent automation capabilities and instead concentrate on device connectivity. Certain systems are not interoperable, which makes it difficult for devices made by different manufacturers to communicate with one another.

By fusing IoT connectivity with AI-powered voice control, the Intelli Verse system tackles these issues. The suggested system offers a more adaptable and scalable solution for smart automation by combining sensors, cloud platforms, and intelligent assistants into a single ecosystem.

III. SYSTEM ARCHITECTURE

The Intelli Verse architecture consists of three layers:

- Device Layer: This layer includes hardware components such as sensors, microcontrollers, and appliances. These devices collect environmental data and execute control commands.
- Network Layer: The network layer handles communication between IoT devices and cloud servers using Wi-Fi protocols.
- Application Layer: This layer includes the AI assistant and mobile application that interact with users.

A. Sensors Used in the System

- Several sensors are integrated into the Intelli Verse ecosystem to collect environmental data. DHT11 Temperature and Humidity Sensor
- The DHT11 sensor measures temperature and humidity levels in the environment. These values allow the system to automate devices such as fans or air conditioning systems.
- PIR Motion Sensor: The PIR sensor detects human movement. It is used to automatically activate lighting systems when someone enters a room.
- LDR Light Sensor: The LDR sensor measures light intensity. It enables the system to automatically turn on lights when the environment becomes dark.

B. Cloud Technology

- Cloud computing is essential for managing IoT communication and storing device data. Firebase Cloud Database
- Firebase provides a real-time database that synchronizes device states between IoT devices and mobile

applications.

- MQTT Communication Protocol: MQTT is a lightweight messaging protocol used for communication between IoT devices and cloud servers. It ensures fast and reliable data transmission.

IV. SYSTEM DESIGN

To build a smart ecosystem, the Intelli Verse system design combines hardware, software, and communication technologies. System Components

- NodeMCU microcontroller
- Relay modules
- Sensors
- Cloud database
- AI assistant
- Mobile application

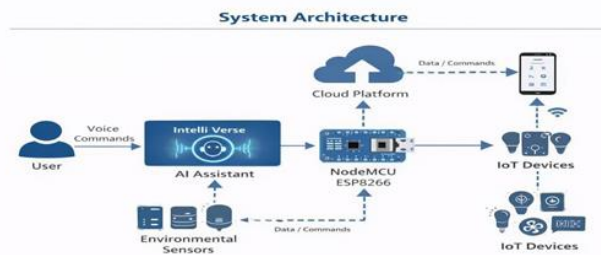


Figure 2: System Architecture

IV. DATA FLOW DIAGRAM (DFD)

The data flow within a system is represented by a Data Flow Diagram (DFD). It offers a visual depiction of the flow of data between various procedures, data repositories, and outside parties. The DFD aids in illuminating the processing and transmission of user commands, sensor data, and device control signals through the various components of the proposed Intelli Verse 2.0 IoT Based Smart Control System. Three DFD levels—Level 0 (Context Diagram), Level 1, and Level 2—are used by the system to provide a clear explanation of the information flow. Every level offers more and more information about the system's internal interactions and processes.

A. Level 0 Data Flow Diagram (Context Diagram)

A high-level summary of the entire system is given by the Level 0 DFD, also called the Context Diagram. The Intelli Verse Smart Control System, which communicates with external entities like the user and smart appliances, is depicted in this diagram as a single process. Through the AI assistant, the user gives voice commands or control instructions to the system. After processing these commands, the system transmits the proper control signals to linked IoT devices and household appliances. The user may also receive feedback or status updates from the system.

Without delving into internal system details, this diagram aids in comprehending the general interaction between the user and the smart ecosystem.

Level 0 DFD: Context Diagram

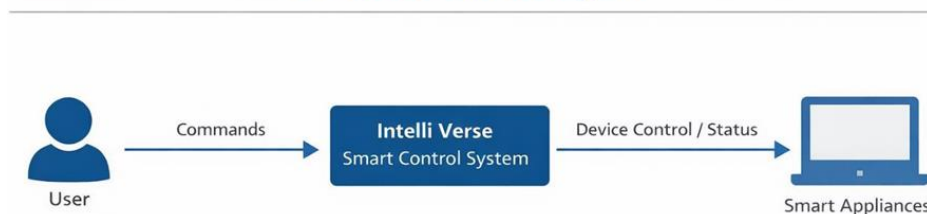


Figure 3: Level 0 Data Flow Diagram

B. Level 1 Data Flow Diagram

The Level 1 DFD divides the primary system process into a number of significant components that manage various system functions. These elements include IoT device control, cloud communication, AI command processing, and speech recognition. At this stage, the speech recognition module first receives a voice command from the user. The AI command processor then decides what to do after interpreting the recognized command. The cloud server receives the command and serves as a bridge for communication between IoT devices and the AI assistant. The IoT

controller (NodeMCU) receives the processed command from the cloud server and uses it to turn on or off connected appliances like fans, lights, and other smart devices. This stage offers a more comprehensive comprehension of how

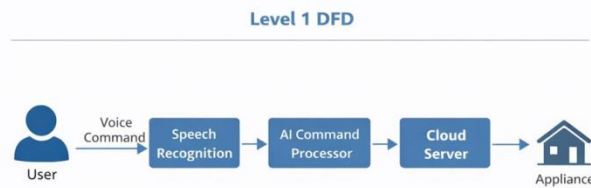


Figure 4: Level 1 Data Flow Diagram

C. Level 2 Data Flow Diagram

A more thorough understanding of the system's internal operations is offered by the Level 2 DFD. In order to clarify how the system handles commands and controls data flow between components, it further dissects the modules displayed in Level 1. Environmental sensors at this level gather data in real time, including motion, temperature, and light intensity. The NodeMCU microcontroller, which serves as the IoT system's central control unit, receives the data gathered by these sensors. To store and retrieve system data, the NodeMCU communicates with the cloud database.

The AI assistant receives commands from users, processes them, and transmits them to the cloud database. The command is then sent by the cloud platform to the NodeMCU controller, which carries it out by turning on the appropriate relay or appliance-connected device.

This level aids in the explanation of the system's intricate workflow, which includes device control functions, cloud communication, and sensor data processing.

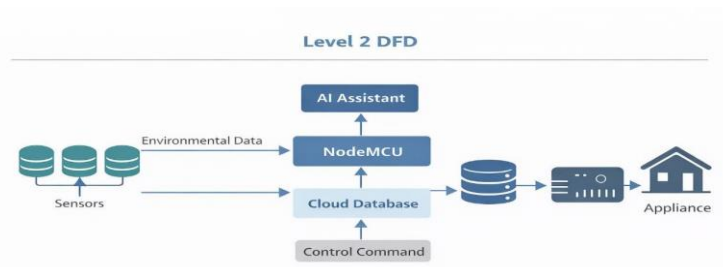


Figure 5: Level 2 Data Flow Diagram

V. IMPLEMENTATION

The Intelli Verse system is implemented by integrating hardware devices with software platforms capable of processing commands and managing device communication.

A. Hardware Implementation

The NodeMCU microcontroller acts as the central controller of the system. Appliances are connected to relay modules that receive control signals from the microcontroller. Sensors continuously collect environmental data and transmit it to the controller.

B. Software Implementation

Cloud communication modules, voice recognition algorithms, and device control programs are all included in the software component.

Using microphones, the JARVIS assistant records voice commands and uses speech recognition algorithms to translate them into text.

The command is interpreted and the proper device action is determined by natural language processing techniques.

VI. SYSTEM SCENARIO

Example scenario of system operation: User says:

"JARVIS turn on bedroom light." Process:

- Voice captured by microphone
- Speech recognition converts audio to text

- AI assistant interprets command
- Command sent to cloud server
- NodeMCU receives instruction
- Relay module activates light

VII. ADVANTAGES AND DISADVANTAGES

When it comes to creating intelligent automation environments, the Intelli Verse 2.0 system has a number of benefits as well as certain drawbacks. One of the system's primary benefits is its capacity to offer intelligent and practical device control, enabling users to operate appliances via voice commands or remote access without requiring direct physical contact. This makes daily tasks easier and increases user comfort. Because IoT sensors can monitor environmental conditions and automate devices based on real-time data, the system also promotes energy efficiency by lowering needless power consumption. Furthermore, the system is highly accessible and flexible due to the integration of cloud connectivity, which allows remote monitoring and control via the internet from any location. By facilitating natural language communication between humans and machines, the addition of an AI-powered assistant enhances user interaction. But there are some drawbacks to the system as well. Because many system functions depend on cloud communication, one of the main drawbacks is its reliance on reliable internet connectivity. System performance may be impacted by an unreliable or unavailable internet connection. Security and privacy risks present another difficulty because, in the absence of robust security measures, IoT devices linked to networks may be susceptible to cyberattacks. Additionally, the initial cost of sensors, microcontrollers, and networking equipment may necessitate a larger initial investment, and the installation and configuration of numerous hardware and software components may increase the complexity of system setup. In spite of these restrictions, the system still provides a promising solution for smart ecosystem

VIII. FUTURE SCOPE

The Intelli Verse 2.0 system has significant potential for future development and expansion. In the future, the system can be enhanced by integrating machine learning algorithms that allow devices to learn user behavior patterns and automatically perform tasks without requiring manual commands. Advanced data analytics and predictive automation could also be implemented to optimize energy consumption and improve system efficiency. The system can further be expanded to support smart city infrastructure, including traffic management, environmental monitoring, and intelligent public services. Another potential improvement is the integration of advanced security protocols and blockchain-based IoT security to protect devices from cyber threats. Additionally, future versions of the system could incorporate more advanced natural language processing techniques similar to those used in assistants such as Amazon Alexa, Google Assistant, and Apple Siri, which would improve voice recognition accuracy and enable more natural interaction between users and the smart ecosystem.

IX. CONCLUSION

Intelli Verse 2.0, an IoT-based smart ecosystem combined with an AI-powered personal assistant, was introduced in this study. The system shows how an intelligent automation platform can be created by combining IoT devices, cloud communication, and artificial intelligence. Effective device control, real-time monitoring, and user-friendly voice command interaction are all made possible by the suggested architecture. The system advances IoT-based automation technologies and offers a scalable and affordable solution for smart environments.

X. REFERENCES

- [1] H. Sabit, "Artificial Intelligence-Based Smart Security System Using Internet of Things for Smart Home Applications," *Electronics*, vol. 14, no. 3, 2025. [Online]. Available: <https://www.mdpi.com/2079-9292/14/3/608>
- [2] K. Varma et al., "Smart Home Automation with AI Integration," in *Int. Conf. on Advanced Computing*, 2025, pp. 28-35. [Online]. Available: <https://www.ijamred.com/volume1/issue4/paper-details/IJAMRED-V1I4P28.html>
- [3] S. Kalivarathan et al., "Intelligence of Things: A Spatial Context-Aware Control System for Smart Devices," arXiv:2504.13942, 2025. [Online]. Available: <https://arxiv.org/abs/2504.13942>
- [4] S. S. Lakshmi et al., "Innovations in Voice-Controlled Smart Home Technology," 2025. [Online]. Available: <https://www.ijraset.com/research-paper/innovations-in-voice-controlled-smart-home-technology>
- [5] Adaptation in Smart Home Automation Systems: A systematic review of decision-making and interaction, *IoT Journal*, vol. 5, pp. 101-115, 2025. [Online]. Available: <https://www.sciencedirect.com/science/article/abs/pii/S2542660525001015>
- [6] V. A., N. Kumar, and H. M. L., "IoT-Based Smart Home Automation Systems: Enhancing Energy Efficiency and Security," *IJRASET*, 2024. [Online]. Available: <https://www.ijraset.com/research-paper/iot-based-smart-home-automation-systems>
- [7] S. Kalivarathan et al., "Intelligence of Things: A Spatial Context-Aware Control System for Smart Devices," arXiv:2504.13942, 2025. [Online]. Available: <https://arxiv.org/abs/2504.13942>