# ADVANCE HOME AUTOMATION SYSTEM WITH SPEECH CONTROL AND POWER USAGE ANALYTICS †

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**Abstract:** Home automation has transformed modern living by enhancing convenience, security, and energy efficiency. This project presents a Raspberry Pi-based Smart Home Automation System that enables users to control household appliances via voice commands and a mobile application, eliminating reliance on cloud services for improved security and offline functionality. The system integrates real-time voltage and current measurement, energy consumption monitoring, and automated bill estimation. By processing inputs through Wi-Fi or Bluetooth, users can remotely control appliances such as lights and fans while tracking power usage through a web dashboard or mobile app. Offline functionality ensures uninterrupted operation even in areas with poor internet connectivity, while built-in overload protection prevents excessive power consumption. This project offers an intelligent, cost-effective solution for home energy management, making smart automation more accessible and secure.



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**Keywords:** home automation; Raspberry Pi; IoT; voice control; energy monitoring; offline system; smart appliances

## 1. Introduction

The rapid advancement of technology, smart home automation has become a key innovation in modern living, improving convenience, security, and energy efficiency. The integration of voice commands, mobile app control, and IoT-based monitoring allows users to manage home appliances effortlessly, ensuring an optimized and intelligent home environment. This project presents a Raspberry Pi-based Smart Home Automation System, enabling voice and mobile-based control of household appliances along with real-time voltage and current monitoring, automated bill calculation, and overload protection.

The advancement of technology has significantly influenced modern lifestyles, bringing about innovations that enhance convenience and efficiency. Among these, smart home automation has emerged as a revolutionary concept, transforming traditional homes into intelligent living spaces. By leveraging cutting-edge technologies such as voice control, mobile app integration, and IoT-based monitoring, homeowners can now manage their household appliances with ease and precision.Smart home automation plays a crucial role in improving security, energy management, and overall household efficiency.

The ability to control various appliances remotely through voice commands or mobile applications has eliminated the need for manual operation, making homes more user-friendly. This transformation not only enhances daily convenience but also ensures better control over energy consumption, leading to a more sustainable way of living.

One of the key benefits of smart home automation is its integration with IoT technology, which enables seamless communication between devices. IoT-based monitoring allows users to track and control home appliances in real time, ensuring optimal performance and energy efficiency. This feature helps homeowners make informed decisions regarding power usage, ultimately reducing electricity costs and minimizing energy wastage.

Furthermore, smart home automation enhances security by enabling remote access and monitoring. Advanced systems can send alerts and notifications in case of any unusual activity, allowing users to take immediate action. Features such as automated lighting, surveillance cameras, and smart door locks provide an added layer of security, ensuring peace of mind for homeowners.

As technology continues to evolve, the adoption of smart home automation is expected to increase, making intelligent living more accessible to people worldwide. The integration of voice commands, mobile app control, and IoT-based solutions is paving the way for a smarter, more efficient, and environmentally friendly future. This project aims to explore the potential of a Raspberry Pi-based smart home automation system, offering a comprehensive solution to modern living challenges.

## 2. Literature Review

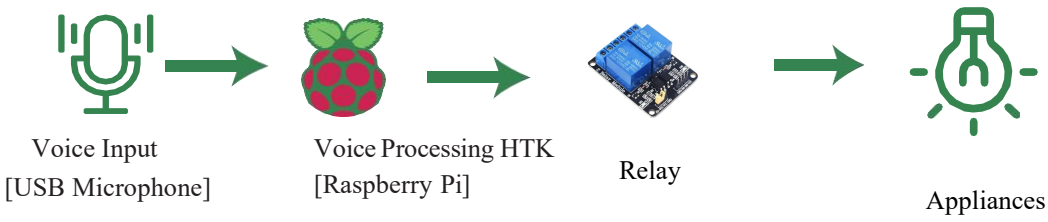
Smart home automation has gained significant attention due to its ability to improve convenience, security, and energy efficiency. With advancements in artificial intelligence and the Internet of Things (IoT), automation systems have evolved to integrate both offline and online functionalities. This literature review explores existing research on offline voice-assisted home automation using microphones connected to Raspberry Pi 4 and online mobile app-based automation, highlighting their advantages, challenges, and technological advancements.

Various researchers have proposed offline voice-assisted automation systems that utilize microphones connected to microcontrollers or single-board computers like Raspberry Pi. Errobidart et al. introduced an offline domestic system using a microphone for voice recognition. However, the absence of Natural Language Processing (NLP) restricted its ability to understand dynamic user commands, requiring predefined instructions for execution. Additionally, cost constraints and limited communication range posed challenges to widespread adoption.

G. et al. proposed a system employing the Hidden Markov Model Toolkit (HTK) to convert speech into text, facilitating command execution via GSM-based SMS communication. However, performance was limited due to short processing intervals, and the system lacked NLP integration, reducing flexibility. Moreover, the absence of an inbuilt microphone in the hub limited its standalone functionality, requiring additional hardware for effective voice processing.

H. Elsokah et al. developed a voice-controlled home automation system utilizing an EasyVR 2.0 shield and an Arduino microcontroller. Their system enabled communication via Wi-Fi and incorporated environmental monitoring features like temperature and humidity sensing. However, execution was restricted due to the limited processing capabilities of the EasyVR module, making it difficult to support complex commands.

**Figure 1.** Offline demotic system using voice commands.



Elsokah et al., proposed a next-generation domestic mechanization framework that is based on voice acknowledgment and that employments an Simple VR 2.0 shield in combination with an Arduino microcontroller [7]. The diagram of the framework is appeared in Figure 3. The framework com- municates between the center and keen plug through a Wi-Fi module and has the included advantage of joining natural inputs, such as mugginess and temperature. In any case, the number of commands that can be executed is constrained due to the utilize of the Simple VR shield.

Rani et al. proposed a framework that utilizes common dialect handling (NLP) and employments a portable phone for voice input and handling, as outlined in Figure 4 [8]. The commands are at that point sent to the Arduino, that acts as a controller in a keen plug through Wi-Fi. Be that as it may, a noteworthy disadvantage of this framework is its dependence on a versatile phone.

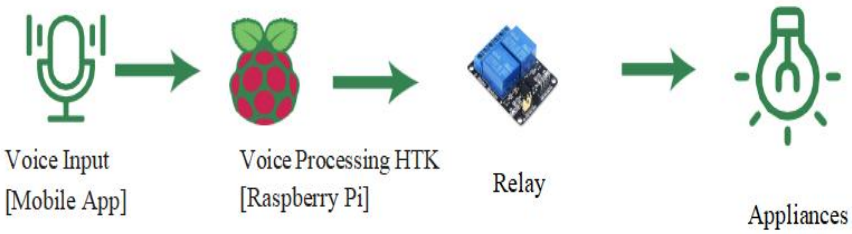
Our proposed offline domestic computerization framework conveys a noteworthy progression in the field of savvy homes. One of the essential headways of our framework is the noteworthy execution advancements over existing domestic mechanization frameworks. Our framework highlights quicker reaction times, higher precision, and productive utilization of assets. This empowers clients to control their shrewd homes rapidly, without encountering disappointing delays or wrong responses.

Once the voice command is gotten, it experiences preparing utilizing the Covered up Markov Show Toolkit (HTK) on the Raspberry Pi. HTK is a broadly utilized discourse acknowledgment framework that changes over talked words into content. The Raspberry Pi acts as the central handling unit, analyzing the voice command and deciding the suitable activity to perform. This step is significant in guaranteeing exact acknowledgment and execution of the given command, permitting for an productive and responsive domestic computerization system.

After preparing the command, the Raspberry Pi sends signals to a hand-off module, which serves as an interface between the microcontroller and family machines. The hand-off works as an electronic switch that flips the associated gadgets on or off based on the handled voice command. This component plays a pivotal part in guaranteeing secure and productive control of electrical machines by overseeing voltage and current flow.

Once the transfer is activated, it enacts or deactivates the apparatuses, such as lights, fans, discuss conditioners, and other electronic gadgets. This computerization disposes of the require for manual intercession, advertising clients a hands-free approach to overseeing their domestic environment. Furthermore, coordination IoT-based checking and control components upgrades vitality effectiveness, decreasing superfluous control utilization and giving a more feasible living space.

**Figure 2.** Online next generation home automation system based on voice recognition.



The increasing integration of technology into everyday life, smart home automation has become a revolutionary concept. The ability to control household appliances using voice commands enhances convenience, energy efficiency, and security. The given image illustrates a smart home automation system utilizing a Raspberry Pi, voice input via a mobile app, the Hidden Markov Model Toolkit (HTK) for speech processing, and a relay module for controlling appliances. This system bridges the gap between users and electronic devices, offering a seamless and efficient way to manage home automation.

The process begins with voice input from a mobile application, where the user speaks a command to control various household appliances. The mobile application records the spoken command and transmits it to the Raspberry Pi for further processing. This method enables remote control, allowing users to operate their appliances from anywhere within the network range. The use of a mobile app for voice input eliminates the need for dedicated hardware-based voice recognition systems, reducing costs and increasing accessibility.

## 3. System Architecture

The Raspberry Pi serves as the central controller of the system, processing voice commands received from Google Assistant or Alexa and user inputs from a mobile application via Wi-Fi or Bluetooth. This configuration allows users to remotely control home appliances, such as lights, fans, and air conditioners, through spoken commands or a smartphone interface. Wireless connectivity ensures seamless operation, making the system easy to use and deploy in various environments, including urban and rural settings.

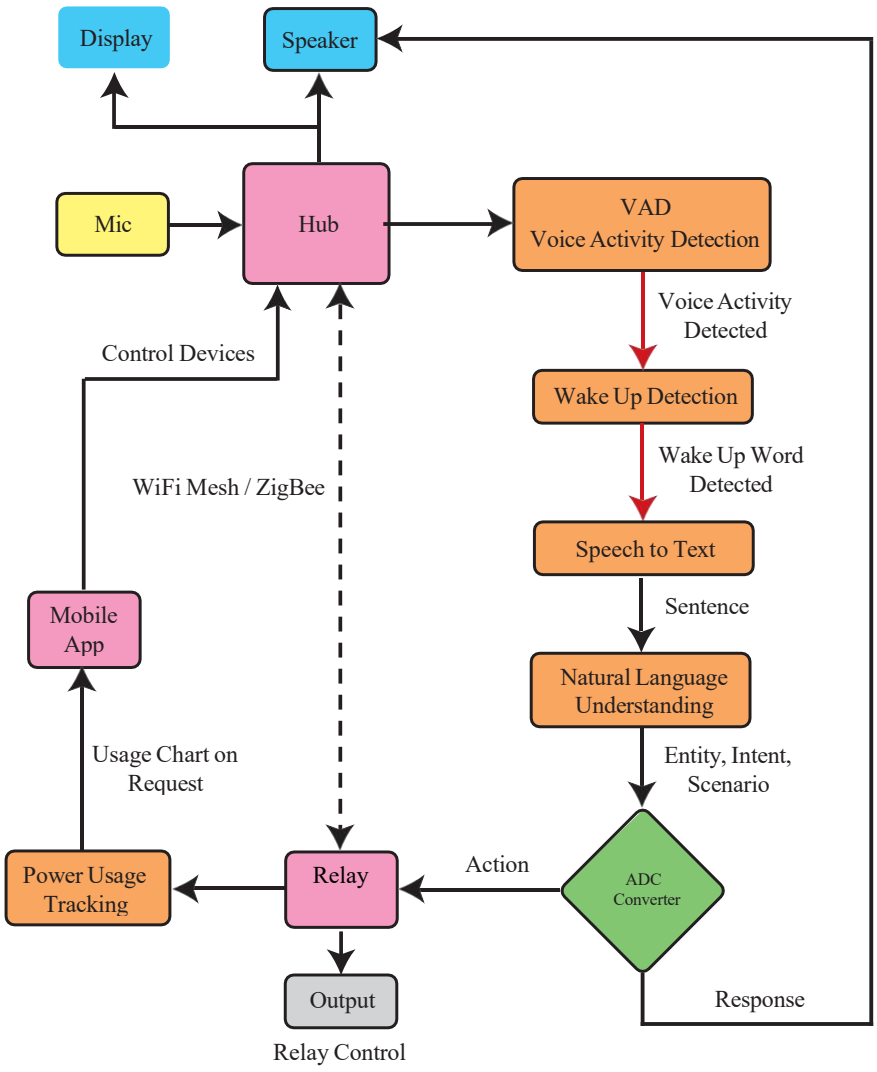



**Figure 3** System architecture.

This area is separated into three subsections. The to begin with subsection portrays the shrewd center component. The moment subsection depicts the Hand-off component, and the third subsection portrays the communication conventions and mediums utilized for connectivity.

*3.1. Smart Hub*

In a domestic computerization framework, the keen center serves as the central control point for interconnect among components. There can be one or more savvy domestic center points or none at all. Regularly, shrewd center points depend on cloud handling to handle the requests of voice colleagues, which can result in inoperability if cloud administrations are inaccessible. To overcome this, ThingView Free's savvy center highlights an on-device speech-based client interface, that permits clients to communicate with the framework without the require for third-party services.

appears an outline of the discourse acknowledgment framework utilized in ThingView Free. The sys- tem comprises of four components: a voice action discovery (VAD) demonstrate, a wake word location show, a speech-to-text show, and a normal dialect understanding show. The VAD demonstrate has an calculation that always screens the environment for discourse sig- nals and employments VADs to distinguish discourse fragments with lower vitality consumption.

Various analysts have proposed offline voice-assisted mechanization frameworks that utilize mouthpieces associated to microcontrollers or single-board computers like Raspberry Pi. Errobidart et al. presented an offline household framework utilizing a amplifier for voice acknowledgment. Be that as it may, the nonappearance of Common Dialect Preparing (NLP) limited its capacity to get it energetic client commands, requiring predefined informational for execution. Also, taken a toll imperatives and constrained communication run postured challenges to far reaching adoption.

To address the confinements of offline frameworks, analysts have investigated versatile app-based mechanization, leveraging web network for improved control. Rani et al. proposed a framework that coordinating NLP for voice handling through a smartphone, transmitting commands to a Raspberry Pi-based controller. Whereas this approach permits for energetic and complex intelligent, its reliance on web network makes it defenseless to arrange disturbances. The combination of offline voice commands and portable app control guarantees a more vigorous and versatile keen domestic computerization system.

Our proposed framework coordinating both offline and online control components for consistent and proficient domestic mechanization. By utilizing a receiver associated to Raspberry Pi 4, clients can issue voice commands without depending on an web association, guaranteeing continuous operation. At the same time, the online portable app interface gives inaccessible control capabilities, permitting clients to oversee machines from anyplace. The joining of progressed NLP procedures improves precision, responsiveness, and flexibility. Moreover, real-time checking and security upgrades contribute to a more secure and more energy-efficient domestic robotization arrangement. This dual-mode framework speaks to a noteworthy progression in keen domestic innovation, advertising clients more prominent control, unwavering quality, and efficiency.

Our proposed offline domestic computerization framework presents noteworthy enhancements over existing arrangements. By leveraging progressed NLP procedures, the framework guarantees higher exactness and quicker reaction times, empowering clients to connected consistently with their savvy domestic gadgets. Also, the framework decreases memory and computational necessities, coming about in lower equipment costs and control utilization. This makes it more open and reasonable for a more extensive extend of clients. Besides, the integration of upgraded security highlights and real-time checking guarantees a secure and energy-efficient shrewd domestic environment. These headways position our framework as a more proficient and versatile arrangement in the field of shrewd domestic computerization.

Upon identifying a voiced fragment, the wake word location show is activated. If the wake word is recognized, the speech-to-text demonstrate changes over the sound signals into sentences. The nat- ural dialect understanding motor decides the situation, aim, and substance from the sentence. This is passed on to the control framework to make a choice.

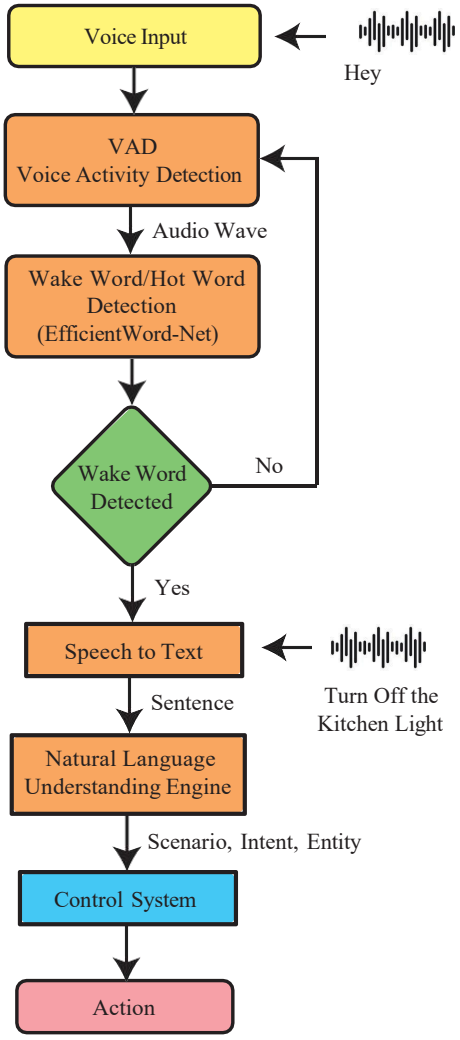



**Figure 4.** Overview of the speech recognition system.

### 3.1.1. Voice Activity Detection (VAD)

Voice movement location (VAD) is an fundamental component of numerous discourse flag master- cessing programs that isolates sound streams into periods of discourse action and periods of hush. It works ceaselessly when the gadget is on. Subsequently, its calculation ought to have a moo vitality utilization. VAD recognizes when a individual is talking to the gadget and makes a difference decide when the individual has ceased talking. The VAD calculation utilized in this proposed domestic computerization framework is based on the open-source Google WebRTC voice movement finder, composed in C dialect for real-time web communications [9]. The framework employments Gaussian blend models (GMMs) to recognize between voiced and voiceless discourse portions. The VAD as it were bolsters 16-bit mono PCM sound with a few preset test rates and outline intervals.

### 3.1.2. Automatic Speech Recognition (ASR)

Since the discourse acknowledgment in ThingView Free takes put on the gadget, the models utilized must be optimized for little sizes and moo computational requests. In arrange to accomplish this, the discourse acknowledgment framework is partitioned into two fundamental components: the speech-to-text show and the common dialect understanding (NLU) demonstrate..

The objective of the speech-to-text (STT) demonstrate is to examine an sound flag, break it down, digitize it into a machine-readable organize, and create the most suitable content representation. In arrange to accomplish this, the speech-to-text frameworks depend on two sorts of models: acoustic models and dialect models. Our usage of STT utilizes a straightforward convolutional neural organize (CNN), as appeared in Figure 7. The show predicts the letters articulated by the client, and once there is a quiet between words, the anticipated letters are passed through a connectionist worldly classification (CTC) bar look decoder with dictionary limitations and a dialect demonstrate to get the best appraise of the sentence. the demonstrate was prepared on Mozilla's common voice English dataset that contains 2886 h of sound information named by 79,398 distinctive voices. For the dialect demonstrate, a pre-trained KenLM demonstrate is utilized.

**Figure 5. The Output**

The input sentence must be deciphered into a machine-readable organize for the keen center to get it and execute the instruction. In the past, straightforward if-else explanations were utilized to check for particular terms in the content, but these strategies cannot capture key angles, such as time, area, and deliberate. With progressions in NLP and ML, it is presently conceivable to extricate significant data from a sentence. Our framework employments a pre-trained bidirectional encoder representations from transformers (BERT) demonstrate. The outline of this demonstrate is appeared in Figure 8. It extricates the cover from the input sentence, that is at that point sent to an manufactured neural arrange (ANN), that decides the situation, deliberate, and substance from the input sentence [10,11]. An case of this would be the sentence "Turn off the light in the kitchen", where the situation is "IoT", the purposeful is "Turn OFF", and the substances are "Kitchen: location" and "lights: device". These factors can at that point be utilized in control rationale to perform the wanted errand. The show was prepared utilizing open-source information.

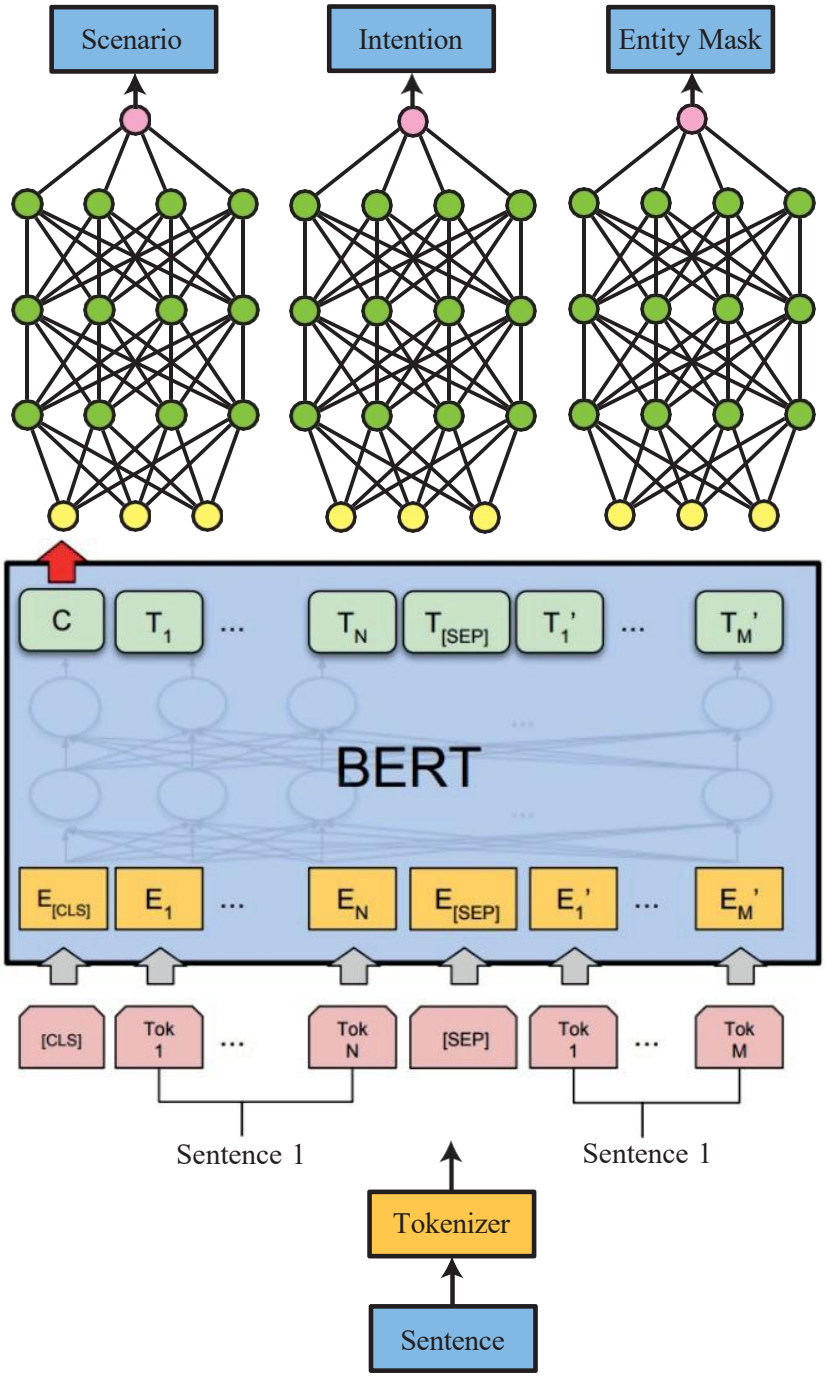



**Figure 6.** Natural language understanding model.

3.1.3. Device Power and Security Management

The ThingView Free framework incorporates a highlight to screen the control utilization of the associated gadgets. This is finished through an on-device database that tracks control consump- tion and temperature readings from sensors on savvy gadgets, and gives real-time overhauls to the client. This data can be utilized to set plans and rules for exchanging on and exchanging off of the gadgets. The work network's security is guaranteed through a two-layered security channel, where a client must know the username and watchword for the shrewd center and the decoding key for each associated gadget to get to it.

### *3.2. Relay*

A transfer is an electrically worked switch that plays a pivotal part in keen domestic robotization by controlling high-power machines utilizing low-power signals. In a Raspberry Pi-based framework, the hand-off acts as an interface between the microcontroller and family gadgets, permitting consistent exchanging on and off of electrical loads. When a flag is gotten from the Raspberry Pi, the hand-off enacts or deactivates the associated machine by opening or closing its circuit. This instrument guarantees secure operation, as it separates the low-voltage control circuit from high-voltage apparatuses, avoiding potential risks. Transfers are broadly utilized for computerizing lights, fans, discuss conditioners, and other domestic machines, upgrading comfort and vitality effectiveness. Furthermore, they bolster numerous channels, empowering control of different gadgets at the same time. The integration of transfers in domestic mechanization frameworks altogether moves forward operational adaptability and safety.

#### 3.2.1. Power Usage Tracking

According to a consider by Ahmed et al. in 2015, a control hub was created to screen the control utilization in shrewd plugs [13]. It comprised of a voltage sensor, a current sensor, and a Zigbee microcontroller. In any case, this plan has restrictions, such as a moderate testing rate, destitute communication scope, and tall cost.

The proposed savvy plug plan incorporates a include to screen the real-time control utilization of an electrical apparatus. In the plan, HLW8012, a single-phase vitality observing coordinates circuit, is utilized to accumulate information, such as RMS current, RMS voltage, and RMS dynamic control. This IC is specifically associated to an ESP32 Hub MCU, that permits for quick control utilization calculations. The utilize of an HLW8012 control sensor instep of partitioned current and voltage sensors makes the plan more compact and cost-effective.

#### 3.2.2. Relay Operation

The savvy plug employments a 5 V electro-mechanical hand-off to control the associated machines. The transfer is actuated by a DC current, that opens or closes the switch contacts. The ESP32 Hub MCU gets commands from the client, either through a voice command or a control activity utilizing the portable app, and works the transfer contacts accordingly.

### *3.3. Connectivity*

The network between the center and gadgets is a significant perspective of any domestic automa- tion framework, as it decides its unwavering quality. Communication conventions, such as BLE, Zigbee, Z-Wave, and Wi-Fi are commonly utilized by domestic robotization frameworks, each with its possess advertisement- vantages and drawbacks [14]. Variables, such as run, transfer speed, obstructions resistance, and vitality utilization, affect the soundness of the association. The cost-effectiveness, security, and ease of setup are imperative contemplations for clients [15].

When choosing a communication convention for ThingView Free, which is an offline domestic robotization framework that prioritizes security and unwavering quality, components, such as resistance to outside assaults, adequate transmission capacity for real-time information collection from power-monitoring gadgets, and ease of association, must be considered. Subsequently, a Wi-Fi-based remote work organize is the best communication arrangement for ThingView Free.

In arrange to relieve the inborn limitations of stand-alone organizing frameworks, such as flag misfortune as gadgets move absent from the switch and obstructions from electrical hardware, work organizing was chosen. Work systems can self-organize and arrange powerfully, coming about in diminished establishment time. Self-configuration empowers energetic workload dispersion. This is valuable if a few hubs come up short at the same time and comes about in an progressed blame resilience and support costs. The utilize of work organizing in domestic computerization, combined with a reasonable communication convention, makes a dependable, low-maintenance, and fault-tolerant device-to-device or hub-to-hub association that can work well indeed.

Message lining telemetry transport (MQTT) is a standard IoT informing convention created by the Organization for the Progression of Organized Data Measures (Desert garden). The outline of the convention is appeared in Figure 9. It is a broadly utilized informing convention in the IoT field since of its effortlessness and security highlights. It has a moo overhead for both coding and arrange activity. It employments transport layer security (TLS) encryption and verifies clients utilizing an open-standard authorization (OAuth) convention to guarantee secure communication between gadgets [16]. In the ThingView Free framework, MQTT will be utilized as the informing convention due to its ease of utilize and compatibility with the programming dialects utilized in the keen center and keen gadgets.

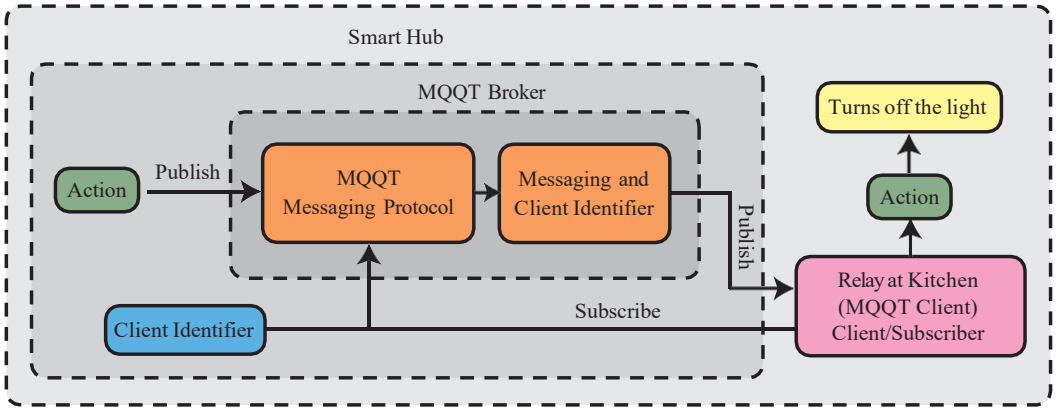



**Figure 7.** Connection between the smart hub and Relay using MQQT.

## 4. Implementation

The proposed framework comprises of two isolated gadgets, a savvy center and a Transfer that were made independently and were tried for communication. The model incorporates an offline discourse acknowledgment framework, control checking capability, and the capacity to control the savvy plug through a transfer. The two components are talked about in detail in the taking after subsections.

### *4.1. Smart Hub*

#### 4.1.1. Hardware Implementation

The keen center gadget comprises of a Raspberry Pi 4 with 4 gigabytes of memory, a 5 V/2 A control connector associated to its USB-C harbour, and a ReSpeaker 2-mic Cluster Pi Cap as the microphone.

#### 4.1.2. Software Implementation

The arrangement of the discourse acknowledgment framework is optimized for the most elevated accu- suggestive conceivable. The voice action discovery show runs persistently whereas the gadget is on. All of the other models (wake-word discovery, speech-to-text, and common dialect preparing) are executed in a single script. The firmware components are put away on an SD card, since the Raspberry Pi module does not have an inside memory. The receiver audience occasion is executed in a partitioned string and upgrades a worldwide circular line. The VAD takes chunks of sound from the line utilizing a particular chunk estimate and decides if the chunk contains discourse. If there are 10 continuous chunks without discourse, the handle stops and the full command, counting the wake-word, is deciphered to content and parsed through the common dialect preparing for substances, aim, and situation. These are at that point sent to the controller to carry out the craved assignment.

*4.2. Relay*

Transfer operation in a shrewd domestic computerization framework includes utilizing a low-power control flag to switch high-power electrical machines on or off. In a Raspberry Pi-based setup, the hand-off gets commands from the microcontroller, which at that point energizes an inside electromagnet to flip the switch. When enacted, the transfer closes its circuit, permitting current to stream and controlling the associated gadget. On the other hand, when deactivated, the circuit opens, cutting off control to the apparatus. This instrument gives electrical segregation between the control unit and high-voltage machines, guaranteeing security and unwavering quality. Transfers can be utilized for different domestic robotization applications, counting controlling lights, fans, and security frameworks. Their capacity to handle numerous gadgets at the same time improves proficiency and comfort in keen domestic environments.The Transfer employments the HLW8012 breakout board for vitality estimation. A schematic and a printed circuit board have been planned for the Transfer, where all of the modules can fit in a little space. The schematic chart of the Hand-off is appeared in Figure 10. The savvy attachment plug is planned to screen the control utilization when it is not associated to the center, and to transmit the recorded information when it is associated to the center.

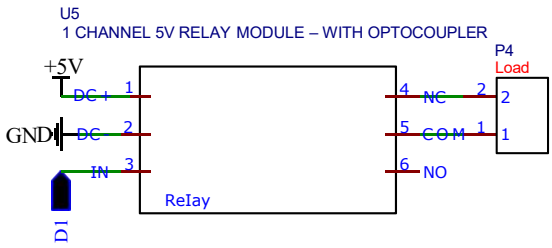




**Figure 8.** The schematic diagram of the Relay.

*4.3. Connectivity*

The communication between the savvy center and the Transfer is encouraged by Node-RED introduced on the Raspberry Pi. The Raspberry Pi capacities as the server, whereas the ADC(MCP 3008) capacities as a client. The MQTT convention is utilized to empower two-way communication with the MQTT broker found in the savvy center, and acts as the server that gets messages from the clients (the Transfer) in the arrange. The mac address of the ADC(MCP 3008) in the Hand-off is utilized as the identifier to set up associations inside the Wi-Fi work arrange. To interface a modern Transfer to the center, a client needs to filter a QR code or enter the mac address through a versatile app made to interface gadgets and show the vitality utilization. At that point, they can allot the gadget a title (e.g., “kitchen light”), sort (e.g., “light”), and area (e.g., “kitchen”), that permits them to control the particular Transfer through commands.

*4.4. Dashboard*

The framework incorporates a dashboard made utilizing Python as the central interface for clients to interface with the keen center and Transfer. The interface of the dashboard is appeared in Figure 9. Figure 10 appears the measured control utilization information of a chosen apparatus. This dashboard serves as a apparatus for overseeing gadgets and checking them, and runs locally on the shrewd center. It can be gotten to from any gadget that is associated to the same Wi-Fi work arrange and gives the taking after user-friendly highlights to make the operation of the domestic mechanization framework easier.

1. Ability to customize the associated gadgets to the hub;
2. Monitor/Change the on-off status of the associated devices;
3. Gives a graphical see of the vitality utilization information.

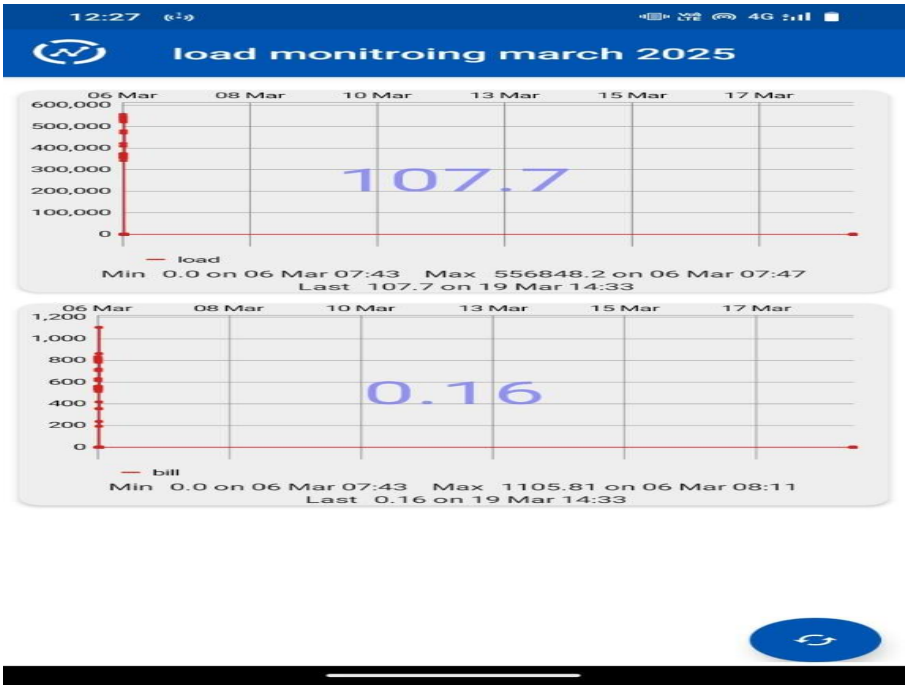



**Figure 9.** Dashboard interface.

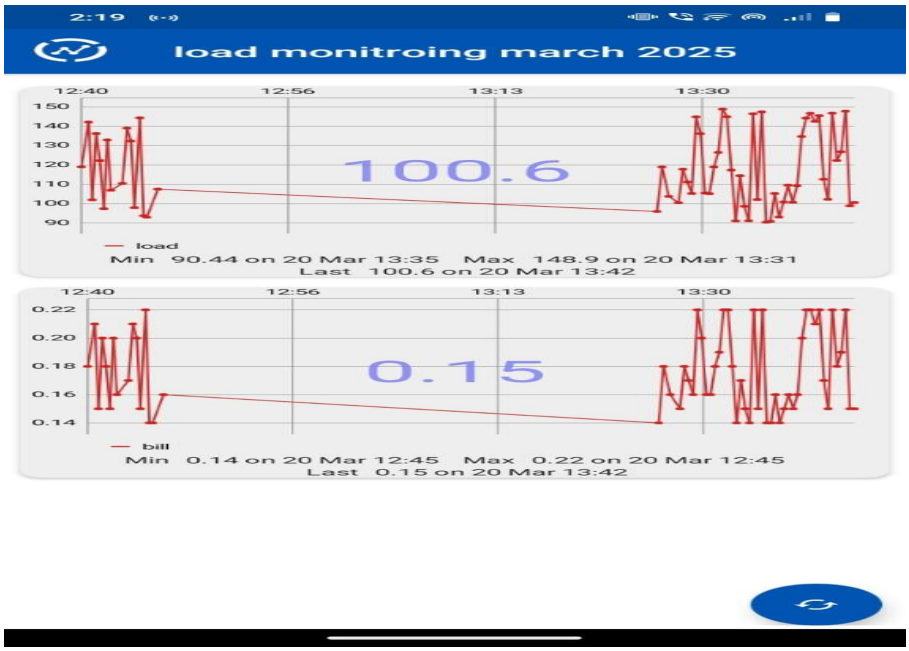



**Figure 10.** Power usage shown on the dashboard.

This user-friendly dashboard gives the client the capacity to effortlessly alter the number of associated gadgets. Gadgets can be rapidly included or expelled from the arrange, and the real-time on-off status of each gadget can be checked. The client can moreover turn the de- indecencies on or off with a basic flip operation, which empowers farther control and decreases vitality waste.

The dashboard plays a pivotal part in making a difference clients get it their vitality consump- tion designs by giving point by point data almost the vitality utilization of their domestic for a indicated period of time. This can help in lessening the vitality squander and advance vitality efficiency.

## 5. Evaluation and Results

Evaluation of the shrewd plug was carried out in stages, beginning with person units and at that point as a total framework. The exactness of the control estimation in the shrewd plug ranges from 90–95%. The remote work organize was able to effectively self-organize and ceaselessly transmit information without disappointment inside a extend of 8–10 m.

The programmed discourse acknowledgment (ASR) framework was introduced on a Raspberry Pi 4 with 4 GB Smash. The framework required 50% of the Slam and less than 40% of the CPU for synchronous operation of all three models, driving to quick comes about. The ASR was able to ac- curately distinguish English dialect commands and execute transfer operations. Comes about appeared that ThingView Free's STT models performed way better than other prevalent STT models in terms of word mistake rate (WER) and memory utilization, as appeared in Table 1. Compared to the existing models, our demonstrate requires essentially less memory, and has less parameters, without a critical drop in exactness. Memory prerequisites are decreased by utilizing quantization and pruning. Sluggish stacking is utilized to diminish the induction time of the neural arrange, which empowers to decrease the computational necessities without expanding the reaction time. Among the existing models, Quartz Net [17] has the most reduced word mistake rate. Be that as it may, it has 18.9 Million parameters and requires essentially tall memory and computational control. Compared to this demonstrate, our demonstrate has as it were 4.3 million parameters, which is about 75% less. This spares a part of memory and computational control, which comes about in a lower control utilization. Indeed in spite of the fact that the our show requires 180 MB of capacity, it can be put away on an SD Card, which is financially attainable. The exactness of the NLU demonstrate in a private dataset was as tall as 96%.

**Table 1.** Performance comparison of the existing STT models and our model.

| Models | Model Size (MB) | No of Parameters (Million) | WER |
|---|---|---|---|
| Jasper [18] | 1350 | 220 | 3.10 |
| Wav2Letter++ [19] | 2950 | 215 | 3.20 |
| Quartz Net 15 × 5 [17] | 90 | 20.5 | 2.85 |
| CMU-Sphinx (HMM) [20] | 75 | - | 11.0 |
| Deep Speech 2 [21] | 1150 | 50.2 | 6.50 |
| Our model (Not Optimized, No LM) | 60 | 4.5 | 7.95 |
| Our model (traced, No LM) | 20 | 4.5 | 6.10 |
| Our model (traced, with LM) | 190 | 4.5 | 4.50 |

## 6. Conclusions

The headway in the web of things (IoT) has revolutionized domestic mechanization frameworks and has made people's lives more helpful and comfortable. Voice-assisted domestic computerization frameworks have been particularly useful for elderly.

Be that as it may, the reliance on cloud-based administrations has made these frameworks defenseless to cyber-attacks, especially in creating nations where the quality of the web is moo. To address these challenges, this inquire about proposes an offline domestic mechanization framework that works free of web and cloud administrations. This framework guarantees security against cyber-attacks, gives fast reactions, and offers extra highlights, such as control utilization following and the optimization of connected devices.

There are a few potential zones for advancement that we can investigate in the future. One potential region for enhancement is the precision. Whereas our framework has as of now evil spirit- strated noteworthy comes about, we accept that there may be room for assist change. We are right now testing with diverse profound learning show models and parame- ter setups to discover the ideal setup for an robotization framework. We can too center on improving the client involvement of our framework. This includes creating a more natural client interface. By moving forward the client involvement, we can make our framework more engaging to a more extensive run of users.

Finally, we can center on upgrading the security of our framework. Indeed in spite of the fact that our framework does not depend on cloud-based administrations, it depends on Wi-FI work systems to work, which has a certain level of security concern. We can center on progressing the security of our system.

By investigating these potential zones for advancement, we can guarantee that our offline domestic mechanization framework remains competitive and proceeds to give esteem to our clients.

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## Abbreviations

The taking after truncations are utilized in this manuscript:

| | |
|---|---|
| IoT | Internet of Things |
| NLP | Natural Language Processing |
| HTK | Hidden Markov Model Toolkit |
| VAD | Voice Activity Detection |
| GMM | Gaussian Mixture Model |
| ASR | Automatic Speech Recognition |
| NLU | Natural Language Understanding |
| STT | Speech-to-Text |
| CNN | Convolutional Neural Network |
| CTC | Connectionist Temporal Classification |
| BERT | Bidirectional Encoder Representations from Transformers |
| ANN | Artificial Neural Network |
| MQTT | Message Queuing Telemetry Transport |
| OASIS | Organization for the Advancement of Structured Information Standards |
| TLS | Transport Layer Security |

| | |
|---|---|
| OAuth | Open-standard Authorization |
| NC | Normally Closed |
| NO | Normally Open |
| IDE | Integrated Development Environment |

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