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Design and Analysis of Intelligent Home Automation Using the IoT Applications

Pooja Ranganathan [a], Manoj Bhattacharya [b], Anita Deshmukh [c]

[a] *Natural Language Processing Lab, Hyderabad AI Research Centre, India.*
[b] *Edge Computing Lab, Calcutta Digital Research Institute, India.*
[c] *Edge Computing Lab, Calcutta Digital Research Institute, India.*

Abstract

The Home Automation System (HAS) is increasingly popular because of advancements in communication technologies. A smart home is a component of the Internet of Things (IoT) that enables the control of household equipment via the Internet through an automated system. This study presents an economic Wi-Fi-based automation system that allows Smart Homes (SH) to control household appliances remotely using an Android application. An Arduino Mega microprocessor equipped with a Wi-Fi module is utilized to construct the automated system. Moreover, multiple detectors monitor the home's weather, humidity, and motion. The relay board is used to link the HAS with household appliances in a controlled manner. The suggested HAS effectively and efficiently manages electrical devices over Wi-Fi and the Virtuino smartphone app.

Keywords: Smart Home, Internet of Things, Home Automation, Home Automation.

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Introduction

Automated homes have garnered significant interest due to advancements in communication technologies. A Smart House (SH) (Amiribesheli et al., 2015) is an Internet of Things (IoT) (Gupta & Quamara, 2020) application enabling users to control and monitor household appliances in real time via the Internet. A SH is a residence equipped with a computerized system that includes actuators, sensors, and controls to improve comfort, robotics, safety, and security, enhancing the quality of life for its inhabitants. In contemporary society, intelligent technologies, including smartphones, smart TVs, dishwashers, smart fridges, and intelligent sensors, have permeated every facet of individuals' daily existence. These clever devices interact and communicate with one another to create an innovative environment. A system for automation must be established to oversee communications among smart devices inside SHs.

Various automation technologies have been created, with several being utilized as commercial items in the marketplace (Perera et al., 2015). Certain products are utilized to manage appliances at home either physically or remotely. The advent of chips significantly reduced electronic control expenses by the late 20th century, leading to the emergence of home automation. Home automation technologies remain underutilized and are predominantly perceived as the province of enthusiasts or affluent individuals. Diverse technologies for automation, including remote controls for televisions, fans, cooling units, and audio devices, have been used to furnish home equipment with necessary systems for efficient control and surveillance (Gunarathne & Kalingamudali, 2019). The extensive integration of power in residences and the swift progress of information technology have initiated a new epoch in managing household appliances using handheld devices utilizing short-range communication protocols like Bluetooth and ZigBee, as well as Wi-Fi networks and Global System for Mobile (GSM) components (Jalilian et al., 2016). All these methods and gadgets facilitate indoor management of home appliances but do not enable residents to track and operate their homes remotely. While these systems facilitate contact with barriers to ensure simplicity, security, and energy savings, they have numerous functionality and communication distance restrictions. Many of these devices fail to leverage the robust capabilities of emerging IoT technology, which seeks to link billions of intelligent objects (such as phones, computers, detectors, and motors) to the World Wide Web (WWW).

This study offers an integration of both remote and locally operated automated homes to address design difficulties and mitigate the limitations of such systems. The suggested system will offer a locally managed residence automation solution using a Wi-Fi interface and an economical Arduino microprocessor alongside the application of IoT ideas for remote management (Barbon et al., 2016). This enables the system to operate independently of the user's position and cellphone provider. The created automation system can be utilized locally on different smartphones running Android via Wi-Fi or online via a networked IoT system, enabling consumers to administer, track, and remotely regulate their appliances and devices over the Internet.

Background

SHs denote a concept rather than tangible structures. Fantasy literature has conceptualized home automation for decades, exemplified by the United States Association of House Owners in 1985, establishing smart homes. A SH is the amalgamation of technology that allows consumers to enhance their quality of life. SH is a voice-activated companion for the remote control of all home appliances. SH can improve safety, convenience, and control of energy. SH assists aged and disabled individuals by offering them a comfortable and secure atmosphere. SH can be classified into two categories: wireless and wired technologies. Wired systems utilize optical fibers, bus paths, and electrical wiring (Chowdhury et al., 2020). Wireless networks consist of a transmitter and a receiver. Numerous innovative applications use wireless technologies, including radio waves or infrared light, for interaction with other gadgets. SHs can operate concurrently on both wireless and wired networks. SH systems for automation have evolved into versatile handheld controllers that enhance ease in daily activities.

A Bluetooth and GSM module-based automated control system was proposed. This research aims to assist disabled and elderly individuals in remotely controlling home equipment. Individuals utilized Bluetooth and GSM mobile phones to manage their homes. Bluetooth was used for inside appliance control, while GSM was employed for exterior appliance management. Wireless can lower system expenses as most mobile devices and notebooks are equipped with this integrated application. Users can monitor and control devices remotely by transmitting Short Messaging Service (SMS) via GSM (Mahmood et al., 2015). This system exhibits constraints in both instances. Bluetooth exhibits a constrained range and data transfer rate, whereas GSM incurs high expenses due to SMS charges. The study advocated the automation of SH utilizing sensor technologies to enable the automatic management of household appliances via Android-powered cell phones as remote controllers. The researchers employed Raspberry Pi as the microchip and

Wifi as the connection protocol. The smartphone was connected to the Raspberry Pi controller via Wi-Fi, which was linked to intelligent devices on the same internet connection point. All sensors transmit information to a local server through Raspberry Pi. The user cannot contact the server and directly utilize their phone to communicate instructions to the Raspberry Pi control system when beyond the Wi-Fi access point's range.

A home management and environment monitoring gadget was created utilizing the Arduino Mega 2560 microcontroller with a Bluetooth chip. Various electrical switches and sensors were used to manage household devices via websites or apps for Android. The internet address governs Arduino by transmitting data to it through codes. The Mega version of the Arduino is costlier than the NodeMCU, and Wireless is inappropriate for SH purposes due to its restricted capabilities.

Proposed SH Automation Using IoT

Conceptual Framework

This section delineates the theoretical structure and methodology employed in this study, encompassing the methodically arranged research stages with the suggested system's comprehensive implementation characteristics. It elucidates the structural elements of the proposed system and how they are combined to fulfill the study objective. Fig. 1 depicts the research processes undertaken in the current study. The home sample's design for layout is presented, succeeded by the modeling phase, during which all requisite tools and supplies are utilized to construct a smart home sample.

The cabling and hardware installation is executed. The programming portion of Arduino Software is completed. To improve and optimize design, any issues arising throughout project construction are detected and resolved throughout the testing process. Enhancements have been implemented to prevent the recurrence of the same problem. The comprehensive design of the work is assessed.

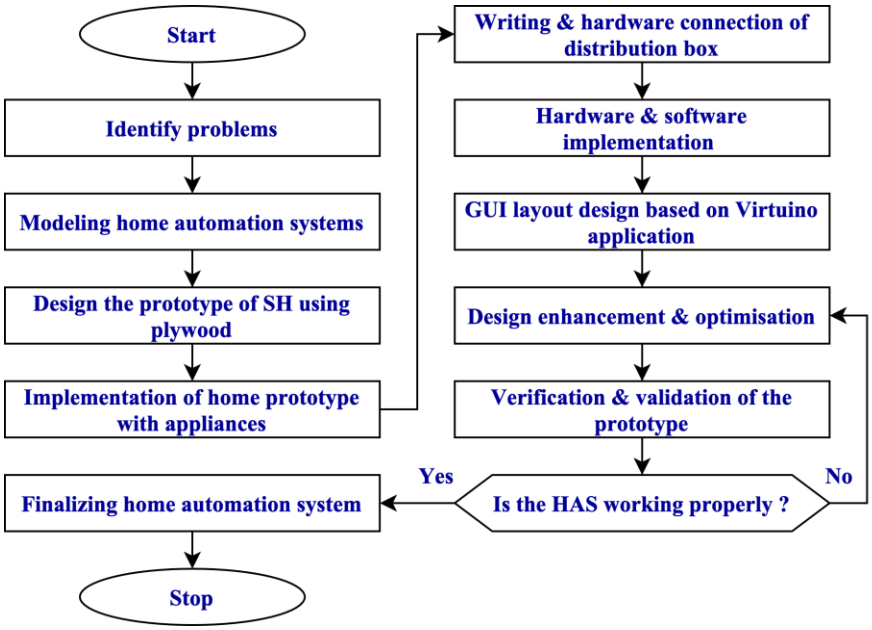


Fig. 1: Workflow of the Design

Principal Elements of a Home Automation System (HAS)

The Arduino Mega is the primary controller in this endeavor due to its affordability, cross-platform compatibility, user-friendly programming surroundings, open-source nature, and extensibility. Electrical gadgets and sensors are linked to the pin of the Arduino Mega. The Arduino board has functions to take inputs and convert them to outputs, receive and send serial data, activate interrupts on low values, and provide 8-bit output, among other capabilities.

The ESP8266 Wi-Fi component, including eight pins, is attached to the Arduino Mega. This particular module is suitable solely for 3.5 V logic levels. The ESP8266 is selected due to its affordability and extensive characteristics, rendering it an optimal module for applications within the IoT.

In the present task, a relay board establishes connections among two or more places according to the input signal. It is linked to the blower and lamps that function as outputs. Relays are utilized in numerous applications due to their comparative simplicity, longevity, and high reliability. The task is to safeguard, monitor, and manage the authorities. Many sensors and devices watch or regulate the SH alongside these three primary parts. These include a voltage regulator, heat sensor, moisture sensor, movement detector, buzzer, and sampling for electrical items such as lighting and fans.

System Architecture and Execution

This study examines the application of the Arduino Mega microprocessor in conjunction with a Wi-Fi module for controlling domestic devices inside a HAS. A local system of control utilizing Wi-Fi and an external controller is built through IoT technology. An appropriate Wi-Fi-enabled Android program, Virtuino, is employed due to its simple design and efficient compatibility with Arduino Mega for control and monitoring through a mobile device. The controller for the Arduino has been configured to interface with the Virtuino software. The Wi-Fi component, buzzers, and moisture and temperature sensors will be attached to the Arduino Mega microprocessor. The detectors provide the microprocessor's signals. The relay on this board receives inputs from the Arduino Mega, while the lighting and fan, serving only as examples of household devices, are attached to the relay outlets. This process enables the control and monitoring of selected electrical equipment and house settings via a cell phone.

Results

The research has compared nonlinear Support Vector Machine (SVM) classification methods with existing classification algorithms, including K-Nearest Neighbours (KNN), Decision Tree (DT), and Random Forest (RF). The SVM demonstrates superior performance among all these classification algorithms, as illustrated in Fig. 2. The proposed methodology employs a linear SVM classification to determine the state of domestic appliances. In Fig. 2, the SVM classifier exhibits an accuracy of 91.63%, surpassing all other machine learning classification algorithms: KNN at 84.6%, Naïve Bayes (NB) at 82.7%, RF at 83.79%, and DT at 87.5%.

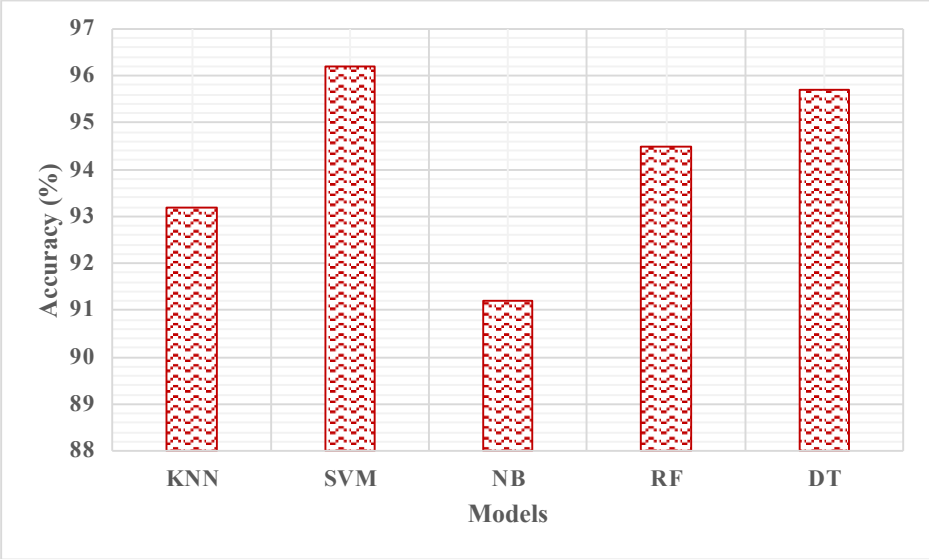


Fig. 2: Accuracy results

The implementation ensures that all devices revert to their pre-restart condition if the Raspberry Pi resumes or experiences a power disruption. This entails utilizing a database system that preserves the status of every gadget. Every gadget's most recent status record is retrieved and assigned to each device accordingly. The application will retrieve its information from the website's server. Sensors have been added to obtain updates at scheduled times. A condition is established for user comfort whereby all the air conditioners will activate independently if the home's heat exceeds the user-defined threshold. Lighting sensors constantly regulate the status of exterior lights during daylight and nighttime. The characteristics and comparisons will render this project distinct from others. Creating a working model of residence and configuring each device appropriate to the room's layout can facilitate the more effortless operation of the gadgets for those using them.

Conclusion

This research has developed, built, and constructed cost-effective Wi-Fi-based home automation prototypes for SH utilizing Arduino and an Android smartphone. It facilitates the effective control of all electrical devices, such as bulbs and fans, at home using Wi-Fi. The sensor can monitor the residence's motion, humidity, and temperature. The buzzer will activate upon detection of motion within the premises. The Smart HAS offers comfort, information, enhanced security, and improved quality of life. This intelligent home system reduces power bills, as users manage electrical equipment remotely without expending physical effort. The subsequent phase of the research will involve facilitating remote control of the established IoT-based system, allowing users to operate it via a web server even in their absence from home. The research will augment the quantity and diversity of detectors to enhance security and protection and offer the option for utterly automated SH products. The study will establish a gateway to integrate every detector with a connected device platform and substitute specific ones with wireless alternatives to address wiring issues. The final product must be an ergonomic box that can be easily connected to a standard changing board of genuine household appliances using a relay on the same page, ensuring safer control.

References

Amiribesheli, M., Benmansour, A., & Bouchachia, A. (2015). A review of smart homes in healthcare. *Journal of Ambient Intelligence and Humanized Computing*, *6*(4), 495-517.

Gupta, B. B., & Quamara, M. (2020). An overview of Internet of Things (IoT): Architectural aspects, challenges, and protocols. *Concurrency and Computation: Practice and Experience*, *32*(21), e4946. https://doi.org/10.1002/cpe.4946

Perera, C., Liu, C. H., & Jayawardena, S. (2015). The emerging internet of things marketplace from an industrial perspective: A survey. *IEEE transactions on emerging topics in computing*, *3*(4), 585-598.

Gunarathne, S. B. M. S. S., & Kalingamudali, S. R. D. (2019, February). Smart automation system for controlling various appliances using a mobile device. In *2019 IEEE international conference on industrial technology (ICIT),* 1585-1590. IEEE.

Jalilian, M., Sariri, H., Parandin, F., Karkhanehchi, M. M., Hookari, M., Jirdehi, M. A., & Hemmati, R. (2016). Design and implementation of the monitoring and control systems for distribution transformer by using GSM network. *International Journal of Electrical Power & Energy Systems*, *74*, 36-41.

Barbon, G., Margolis, M., Palumbo, F., Raimondi, F., & Weldin, N. (2016). Taking Arduino to the Internet of Things: The ASIP programming model. *Computer Communications*, *89*, 128-140.

Chowdhury, M. Z., Hasan, M. K., Shahjalal, M., Hossan, M. T., & Jang, Y. M. (2020). Optical wireless hybrid networks: Trends, opportunities, challenges, and research directions. *IEEE Communications Surveys & Tutorials*, *22*(2), 930-966.

Mahmood, A., Javaid, N., & Razzaq, S. (2015). A review of wireless communications for smart grid. *Renewable and sustainable energy reviews*, *41*, 248-260.