

**PERFORMANCE ANALYSIS OF IOT BASED HOME
SWITCHING SYSTEM VIA TELEGRAM**

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DEDICATION

To my dearest parents, supervisor and friends.

ABSTRACT

Nowadays, the Internet of Things (IoT) becomes ubiquitous in engineering field and is perceived as paradigms for applications such as a home automation system where data can be exchanged and shared easily across the Internet. This project focuses on the implementation of the home automation system with Telegram using Wireless-Fidelity (Wi-Fi) network access on any smart-phone and laptop devices. It is highly beneficial for senior citizens and physically-challenged people to control home appliances effortlessly. This system aims to solve the limitation faced by the technology used in the existing home automation system such as Bluetooth -distance issue, Global Standard for Mobile Communication (GSM) – cost issue and Zigbee – power and bandwidth constraint. In fact, this system provides an interactive graphical user interface (GUI) on both web and Telegram platform where data can be interchanged and synchronized between both GUI in which sensor's readings and status of home appliances can be monitored and manipulated consistently. The analytical findings based on temperature sensor's accuracy and system latency showed that the performance of the system is viable, and the system proved to be more prominent than other home automation systems.

ABSTRAK

Pada masa terkini, Internet of Things (IoT) telah menjadi semakin popular dalam bidang kejuruteraan dan dilihat sebagai paradigma untuk aplikasi seperti sistem automasi rumah di mana informasi boleh dikongsi secara mudah melalui rangkaian Internet. Projek ini akan menumpukan perhatian kepada pelaksanaan sistem automasi rumah melalui akses Telegram dalam telefon pintar dan komputer riba. Ia akan memanfaatkan warga emas dan golongan kurang upaya dalam penggunaan perkakas rumah tanpa usaha. Matlamat sistem ini adalah untuk menyelesaikan kelemahan yang dihadapi oleh teknologi yang sedia ada dalam sistem automasi rumah seperti Bluetooth – isu jarak, GSM- isu kos dan Zigbee – kekangan dalam kuasa dan jalur lebar. Selain itu, sistem ini juga berfungsi untuk menyegerakkan ukuran sensor dan status perkakas rumah dengan ciri-ciri iaitu antaramuka pengguna dalam web dan Telegram. Analisis yang berkaitan dengan ketepatan sensor suhu dan latensi sistem telah membuktikan prestasi sistem lebih stabil dan terkenal jika berbanding dengan sistem lain.

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CHAPTER 1

INTRODUCTION

1.1 Thesis Overview/Contribution

The purpose of writing this thesis is to conduct the performance analysis of IoT based home switching system via Telegram. For senior citizens, the access of home appliances can sometimes pose difficulties and restrictions as senior citizens have low tendency to move around agilely. To alleviate these restrictions and difficulties, IoT based home switching system with Telegram can be implemented. [1] Equipped with data encryption and ability to create Telegram Bot, Telegram messenger can be integrated with Arduino compatible Wi-Fi board (NodeMCU) to allow people to machine communication which can serve the purposes as stated above. Besides, Telegram Bot API also made the platform more dynamic and user friendly due to its versatile supports in various programming languages such as Python, C, Java and Lua. Chapter 2 will discuss the basic background of home automation system and

technologies used, while pointing out the limitations faced and alternatives to overcome the issues.

When it comes to remote access to home automation system, operability of the technology over distance will certainly be main contributor in the system design. This is particularly crucial especially when a person will be away from his/her households for a period of time where safety and security is unmonitored. The integration of NodeMCU and Telegram will be the major contribution in this thesis, as presented in Chapter 3.

The second contribution of the system will be in terms of cost. Arduino and Telegram Bot API are open source and have vast online resources and community support, which will help any average user to understand and code without the need of any advance programming knowledge in the subject. In other words, the implementation of this system is minimal in terms of its software's expenses and difficulty.

Besides, Chapter 3 will also entail the incorporation of web user interface (web UI) for the system. It is to allow user to not only access the home appliances using Telegram, but also authorized user to control the home appliances via web browser. To simply put, two ways communication are generated where the user can opt to control the home appliances from both methods.

Chapter 4 will discuss the performance analysis of home switching system using Telegram. The recorded results such as from the simulations and prototype testing will be observed and analyzed. The main analysis will include the accuracy of sensors' readings as well as system latency of Telegram and web UI.

Last but not least, Chapter 5 will conclude the thesis by summarizing the outcomes and achievements of the work and advocating recommendation for future work. Appendices included consist of the codes compiled for the system as well as the datasheets of the components used.

1.2 Problem statement

In general, the home appliances are either being controlled manually or with the aid of existing communication technology based home switching system such as Bluetooth [2] [3] [4] [5]-[6], Zigbee [7] and GSM [8]-[9]. These methods, however, have certain shortcomings such as the range of distance [2] [3], low data transfer rate and call tariff [8]-[9]. For instance, the operability of Bluetooth's network is bound by distance and will be unaccountable beyond line of sight of 100m while GSM inflicted short messaging service (SMS) charge which can be costly to use in home automation system. In addition, Zigbee has lower transfer rate of 250kbps and not ideal for remote monitoring application[10].

Hence, the limitations in these technologies based home switching system inflicted negative impacts on especially ailing senior citizens or physically challenged people to access home appliances and travellers to monitor the status of their household remotely such as current status of home appliances and well-being of pets.

A more reliable and feasible method can be introduced by using the wireless or mobile based network as a medium of communication for home switching system in order to send or receive Telegram messages to manipulate home appliances and

implement remote home monitoring on pets and elders, which will be more beneficial for the consumers who are beyond the range of distance.

1.3 Objectives

- To develop a smart home automation that can be remotely controlled by senior citizens.
- To monitor the status of home appliances and apply changes to it.
- To analyze the system performance such as accuracy of sensor's readings and system latency.

1.4 Scope of Work

The project is comprised of both hardware and software parts. The software part for the integration of Telegram and NodeMCU is compiled with C high level language on Arduino IDE, whereas web UI is built with HTML 5, Bootstrap, JQuery and php programming language. For hardware development, prototype is finalized and assembled after multiple circuits testing and configuration on breadboard. Limitations faced here are that interaction between both user and main controller can only maintain within the accessibility of Wi-Fi network and the effect of network bandwidth on system latency.

CHAPTER 2

BACKGROUND STUDY

This chapter will discuss and compare a variety of past and present home automation system and technology employed in each particular system while emphasizing on their advantages and disadvantages.

One of the prominent journals related to home automation theme is mobile phone controlling home appliances' application implemented in [2] with PIC 16F877A micro-controller and relays in main control panel to control two-state switches and interfaced with Windows Graphical User Interface(GUI), Android GUI and home appliances. The technologies incorporated in the smart home system are wireless (Bluetooth, Wi-Fi) and wired connection; wireless connection will run from home appliances to main control panel while wireless connection is applicable between User Interface(UI) platform (Windows and Android).

In short, the home appliances can be controlled via Android device, as long as it is in the proximity of Bluetooth module on the main control unit. In addition, the server's application is also capable of retrieving and performing user commands sent from email periodically with PC or laptop connected to main control unit and Internet. A two-way communication is portrayed between GUI and the micro-controller where temperature and humidity sensors are interfaced to micro-controller to monitor the desired parameters periodically.

Similarly, in [2] [3], both of the home automation systems were working on Bluetooth connectivity and aimed to improve the lifestyle of physically challenged people and senior citizens. Though resembling in terms of concepts and architecture, PIC 18F2550 micro-controller is used instead due to its capability to perform both Universal Serial Bus (USB) and serial connection to GUI. Moreover, low-voltage activating switches are used to replace current electrical switches for safety purposes[3]. As for Windows and Android GUI, it can be interfaced to PIC via Bluetooth and USB module respectively[3].

However, unlike in [2], Windows GUI in [3] is more simple and less complex; appliance mapping is extended in [2] but not in [3] which made it more explicit which thus indicated that algorithms used in developing main server application required advanced networking(XML,VB.net) and programming knowledge. Another difference is that referee [2] had the capability to communicate via e-mail which obviously did not feature in referee [3]. As for the interactivity on Windows and Android GUI, both interfaces are designed to be user-friendly, flexible and fun to engage with. On the nutshell, the system developed in [2] and [3] relied strictly on Bluetooth communication and therefore provided a shorter range of wireless network

to operate with which can be improved via remote access of Telegram messaging service platform on Android device.

Referee [4] illustrated a low cost and intelligent home security system using Bluetooth, speech control and phone-net system. Sensors on the alarm system will detect the presence of intruders and Atmel At89C51 will ring the buzzer while transmitting pre-set code to enable auto-dial-answer protocol via Bluetooth modules to phone-net system. Dual tone multiple frequency (DTMF) will decode auto-dialed tone and notify the user with the recorded warning speech on the phone. Last but not least, user can also monitor the home security remotely on graphical interface system (GIS) on servo computer or phone.

The system concept of referee[5] is rather similar to[4] except with Internet of Things (IoT) implementation. Referee[5] described about IoT based smart security and home automation system. This system functioned with complementary roles; when the PIR sensor in smart security system detected unauthorized presence, alert will be sent to TI CC 3200 launchpad board which will send commands to web API, so that it will make a voice call to the registered phone number (user). User can then responded according to predefined digits as seen on keypad on phone to make sure the action is carried out. Same goes to the home automation system where similar concept is utilized except that the predefined digit codes are different as needed to trigger the switching status of multiple home appliances. The benefit of using this system is that end user does not require a smart-phone and Wi-Fi access as long as the TI CC3200 launchpad board is connected to Internet.

Next, smart home system in [6] is incorporated with several sub-systems, viz. security system, light-control system, remote-control system and temperature sensing system.

In each of the sub-system, different types of microcontroller such as PIC16F877, PIC16F675 and Arduino UNO are used according to its unique specifications and integrated with Bluetooth to enable wireless communication with smart-phone device. Main components used in smart security system are passive infrared sensor (PIR) and alarm system, which are integrated with micro-controller to monitor and notify users about trespassing. As for lighting-control system, Android graphical user interface (GUI) is developed for users to connect to system via Bluetooth and control the home appliances easily.

Likewise, remote control system comprised of garage door control and curtains remote control applied the same Bluetooth technology as medium of data communication. As for temperature sensing system, LM 35 interfaced with LCD and microcontroller is used to display the room temperature in kitchen and warn the user about possible fire outbreak if temperature readings rise to critical level. Otherwise, if the sensor reading exceeds threshold value due to dry weather, it will request micro-controller to turn on the fan to regulate the temperature.

In paper [11], an Android based user interface for controlling home appliances is proposed. Arduino Mega 2560 is integrated with Ethernet shield and Bluetooth module to create a web server so that user can access the Android GUI with either Internet or Bluetooth protocol in order to control the home appliances. The system can also communicate with the sensors by using nRF24L01, a wireless transceiver

that can relay the status of sensors (temperature, motion-detection and gas) to the microcontroller if unexpected incidents happened by sending alerts to user.

The benefits of this system included the implementation of user authentication prior to access the Android application. Another highlight is the voice recognition feature which can be used to trigger switching action in home appliances.

On the other hand, referee[12] illustrated the house and facility control system using a single mobile device (BlackBerry smartphone) with BlackBerry Enterprise Server (BES). This system is written in Java Language on Java Development Environment (JDE), based on API 4.2.1. The connection established by BES between BlackBerry smartphone and home network is encrypted, which is unavailable for mobile Internet access using GSM or three generation (3G) cellular network. This ensures higher security level among infrastructure at home. However, the BES needed to be setup at home or with provision of external provider. Home automations systems here consisted of ALL 4000 Ethernet sensorBoxes which can be communicated with users via HTTP request on BlackBerry smartphone in order to retrieve the status of attached sensors and switching home appliances connected to remote power outlets.

Besides exhibiting strong security within this system, the performance in terms of time delay is proven to be stable and prominent.

Moreover, referee [7] introduced IoT based smart home system with web services and cloud computing to reduce human intervention. The system architecture comprised of two Arduino UNO as transmitter and receiver, which are connected with Zigbee's sensors and actuators to monitor home conditions and manipulate