MODELLING A SECURED, ENERGY EFFICIENT AND COST-EFFECTIVE INTERNET OF THINGS INFRASTRUCTURE ARCHITECTURE FOR SMART HOME OR SMALL OFFICE (MSEECIIASHSO).

BY

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A thesis submitted in fulfilment of the requirement for the degree of Master of Computer Science and Information Technology

Kulliyyah Of Information and Communication Technology
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ABSTRACT

IoT applications are mostly developed in Office, Industries, Hospital, Public Stations and Houses. Future applications would benefit from service-oriented communications. This research aims to create a model which is very important for developing future programs, including hazardous area for workers safety, smart user interface for developed cities for automation, e-health, smart transportation systems and specially in remote areas. Furthermore, the challenge for researchers and service providers in the IoT climate is to cover the idea without compromising user comfort with less energy usage IoT infrastructure. Aftermath, user comfort can be enhanced with reducing energy consumption. This thesis will offer an infrastructure architecture for smart home or small office of electrical components with a very friendly user interface where the existing electrical devices can be controlled remotely by weblink or IP address. The researcher will follow the method of analyzing the performance of intelligent IoT services. In addition to the methodology, this thesis is performing a critical examination for the Centre of Cyber Security Excellence at Kulliyah of ICT, International Islamic University Malaysia and this system has been providing uninterrupted support since 2019 without any hassle. As a result, the research created new opportunities and choices to provide users secured, hassle-free living facilities with automation and energy efficient, cost effective IoT infrastructure. To make this architecture sustainable, I used Raspberry Pi as server and NodeMCU as controller for end devices. This technology can be used by the people to decrease electrical energy loss by monitoring household equipment on a regular basis or appropriately programming for automaton, and by enabling trigger, timer for the devices on and off by using mobile apps or weblink.

Keywords

IoT server, Automation in hazardous area, Smart Home, Smart Office

ملخص البحث

يتم تطوير تطبيقات إنترنت الأشياء في الغالب في المكاتب والصناعات والمستشفيات والمحطات العامة والمنازل. وستستفيد التطبيقات المستقبلية من الاتصالات الموجهة نحو الخدمات. يهدف هذا البحث إلى إنشاء نموذج مهم جدا لتطوير البرامج المستقبلية ، بما في ذلك المناطق الخطرة لسلامة العمال ، وواجهة المستخدم الذكية للمدن المتقدمة للأتمتة ، والصحة الإلكترونية ، وأنظمة النقل الذكية وخاصة في المناطق النائية. علاوة على ذلك ، فإن التحدي الذي يواجه الباحثين ومقدمي الخدمات في مناخ إنترنت الأشياء هو تغطية الفكرة دون المساس براحة المستخدم مع بنية تحتية أقل لاستخدام الطاقة في إنترنت الأشياء. بعد ذلك ، يمكن تعزيز راحة المستخدم من خلال تقليل استهلاك الطاقة. ستقدم هذه الأطروحة بنية تحتية للمنزل الذكي أو المكتب الصغير للمكونات الكهربائية مع واجهة مستخدم سهلة الاستخدام للغاية حيث سيتبع الباحث .IP يمكن التحكم في الأجهزة الكهربائية الحالية عن بعد عن طريق رابط الويب أو عنوان طريقة تحليل أداء خدمات إنترنت الأشياء الذكية. بالإضافة إلى المنهجية ، تقوم هذه الأطروحة بإجراء فحص نقدي لمركز التميز في الأمن السيبراني في كلية تكنولوجيا المعلومات والاتصالات ، الجامعة الإسلامية الدولية في ماليزيا ، ويوفر هذا النظام دعما مستمرا منذ عام 2019 دون أي متاعب. ونتيجة لذلك، خلق البحث فرصا وخيارات جديدة لتزويد المستخدمين بمرافق معيشة آمنة وخالية من المتاعب مع الأتمتة والبنية التحتية لإنترنت الأشياء الموفرة للطاقة والفعالة من حيث التكلفة. لجعل هذه البنية مستدامة ، كوحدة تحكم للأجهزة النهائية. يمكن NodeMCU كخادم و Raspberry Pi استخدمت استخدام هذه التقنية من قبل الأشخاص لتقليل فقدان الطاقة الكهربائية من خلال مراقبة المعدات المنزلية على أساس منتظم أو البرمجة المناسبة للأتمتة ، وعن طريق تمكين المشغل والمؤقت للأجهزة التي يتم تشغيلها وإيقافها باستخدام تطبيقات الجوال أو رابط الويب.

الكلمات الرئيسيه

خادم إنترنت الأشياء، الأتمتة في المناطق الخطرة، المنزل الذكي، المكتب الذكي

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Computer Science and Information Technology.

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I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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This thesis is dedicated to my parents for laying the foundation of what I turned out to be in life.

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LIST OF ABBREVIATIONS

IIUM	International Islamic University Malaysia
IT	Information Technology
RFID	Radio Frequency Identification
IoT	Internet of Things
IP	Internet protocol
MQTT	Message Queuing Telemetry Transport
LAN	Local Area Network
PAT	Port Address Translation
DNS	Domain Name System
3G	Third Generation
PVC	Professional Virtual Communities
ELLIOT	Experiential Living Lab for the Internet of Things
RESTful	Representational State Transfer
GSM	Global System for Mobile Communications
ISSP	Integrated Semantic Service Platform
CPU	Central Processing Unit
VO	Virtual Objects
CVO	Composite Virtual Objects
WoO	Web of Objects
SHE	Smart Home Energy
PC	Personal Computer
TD-SCDMA	Tie Division-Synchronous Code Division Multiple Access
CCDF	Complementary Cumulative Distribution Function
MD	Mobile Device
SOAP	Simple Object Access Protocol
SQL	Structural Query Language
RLD	Realtime Link Data Base
oBIX	Open Building Information Exchange
CoAP	Constrain Application Protocol
XMPP	Extensible Messaging and Presence Protocol

RWK	Real World Knowledge
HVAC	Heating, Ventilation and Air Conditioning
GUI	Graphical User Interface
RTC	Real Time Clock
DTIM	Delivery Traffic Indication Message
Wi-Fi	Wireless Fidelity
PIR	passive Inferred Sensor
MSEECIIASHSO	Modelling a Secured, Energy Efficient, Cost-effective Internet of Things Infrastructure Architecture for Smart Home or Small Offi

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In the IT sector, businesses remain competitive by emerging technology, market methods and new facilities to maximize efficiency and save costs. The conventional supply chain is focused on deals between vendors and producers. Using intelligent technology like active RFID, it can be anticipated that products can be shipped from factories to suppliers, without human interference. With goods going in and out, factories become automatic; the goods are transmitted using intelligent decision-making, relying on information gathered by readers and positioning systems. In medical services, hospitals switch from healthcare in hospitals and clinics to remote patient self-monitoring. The intelligent grid and metering systems allow the entire life cycle of electricity production, transmission, delivery and usage to be monitored and managed. In automobile industry there have been changing developments to provide vehicles with a dedicated short distance connectivity to improve vehicle safety. vehicle-to-vehicle (V2V) communications. Consider a planet that can feel, distribute, and share data across thousands of millions of objects, interconnected over the Internet. The machine products that people meet not only are ordinary things like food, clothing and utilities. These daily needs are blended into the virtual world, facilitating real-time connectivity everywhere [1].

1.2 STATEMENT OF PROBLEM

IoT is the system that enable to connect things with internet/intranet. This thesis found that different IoT researchers have identified some similar findings in IoT field. Such as, it was hard to find the connection between business, social activity and knowledge before 20 years. There are few amazing protype have been developed by the previous

research which enable the connection with knowledge, business and society. The communication and IoT system have been developed gradually in this field. However, the IoT system had been started with radio frequency now reached in WIFI communication system to LIFI but the items still expensive for the users after ten years of its innovation. The server for IoT started using in computer and it is becoming flexible to use it in some tiny board in rotation of time like raspberry pi is using as a server instead of PC. The researchers focused to connect bulk number of devices when the server problem minimized to control from a single middleware and device.
However, the overall energy efficient system including server is a potential area for further research. The researcher of this paper identified that IoT service failure can be occurred due to electricity disruption and failure of ISP will be the cause of disable of IoT service.

The IoT system has been changed in 20 years of time period which was to connect things and now it has migrated to power consumption. Currently, the researchers are studying on high level of energy consumption with less time responsive, fine accuracy signal transmission, security of IoT as well as IoT user satisfaction. It has been identified in several studies that IoT networks are facing a variety of challenges.

This thesis will find out the way can provide cost effective IoT system whereby some other studies shows costly infrastructure [2], expensive smart switch, smart sensor between appliances and server [3], [4]. There are few research introduced high response time [5], more energy consumed [2], [6],[3], unstable local servers whereby logs and controlling activity could not be recorded [7],[8]. In previous research also stated the difficulties of controlling appliances for authorization in case of absence of admin verification [9], [10], narrow area coverage and limited number of devices are connected in a server [11], [10], [12], [13], [14]. Although some research are based on internet with wide range of variety devices and paid cloud-based subscription [15], [16]. There are some research found with uniform user interface whereby presently users need a variety of interface such as, mobile apps, browser based interface and local network interface [17],[18].

1.3 RESEARCH QUESTIONS

a. How to establish a cost effective IoT in existing appliance instead of expensive smart switch, smart sensor, smart device and paid cloud-based subscription?
b. How to establish a secured, energy efficient internet of things infrastructure architecture for smart home or small office.
c. How to develop a variety of user interface based on user's different scenario?

1.4 RESEARCH OBJECTIVES

a) To establish an cost effective IoT in existing appliance instead of expensive smart switch, smart sensor, smart device and paid cloud based subscription.
b) To establish a secured, energy efficient internet of things infrastructure architecture for smart home or small office
c) To develop a variety of user interface based on user's different scenario.

1.5 SIGNIFICANCE OF STUDY

Current technology maintains monitoring with sustainability as well as user preferences. To sustain in the dynamic market and in a rapid world automation with IoT is required. Intelligent device for monitoring, user preferences, recording and tracking users, automatic electric switching in existing devices are includes in this mechanism. Internet, an electric switch and GUIS are the fundamental keys of this controlling unit. But the device which can control the existing electrical system that has to be low cost, user friendly and easy to install in home or office. The end users can enjoy the technology by not paying monthly charges for the device, can be used for monitoring, controlling based on required situation or automation for reducing electrical energy consumption with a sustainable programming. Presently, the popularity of Nodemcu is being high and left behind other controllers due it's market availability, cost and obviously its performance. NodeMCU ESP8266 connect with in two different ways zone and Pin, and the built-in Wi-Fi module help people to connect

by phone and internet. Then, controller needs a server, some researchers are using third party freeware or paid sever such as, Blynk cloud server, here developer need to depend on Blynk cloud services and features [16]. Arduino application and Arduino based board now days implementing in IoT smart application [19]. MQ Telemetry transport server is also using as middleware server in IoT smart facilities [8]. For User Interface, previously researchers are using android technologies to control and connect their desire unit [17]. Smart switch is one of the solution of IoT what found expensive but easy to install[4]. In this project, Hassio image has been used as local server which can be access by websites, local IP, Apple app store and google play store's app and Nodemcu esp8266 with Konnected OS. Here Nodemcu can be controlled through the configured Hassio server. A server can be built in existing home used PC or a wireless, LAN connected Raspberry Pi which will work as server to make the house and office automated. This power consumption server is connected with local server and local IP addresses, so authorized personnel can control the low power controller to end devices via web browser by that IP address or iOS and Android phone application.

In this thesis the discussion will be elaborate about the electricity bill consumption and minimize the cost of electricity bill. The size of the implemented tactic is in Figure 1 what is 9" X 12" with 12V battery backup which is ensuring to user emergency door lock unlock system with safety during load shedding or emergency electric failure. Because this tactic is connected to local server there will be no disruption during failure if ISP service. The opportunity in global market will be explained at the end of this chapter. It is not limited only for small house or office. Wireless networking solutions that provide long distance communication through WiFi provide a final, profitable solution. Low power and energy efficiency are accomplished by carefully planning the hardware and user interface. The tactic, which runs the multiple devices, does not perform a static control algorithm. The use of PAT(port address translation) protocols or DNS (Domain name system) servers enables long distance contact too.

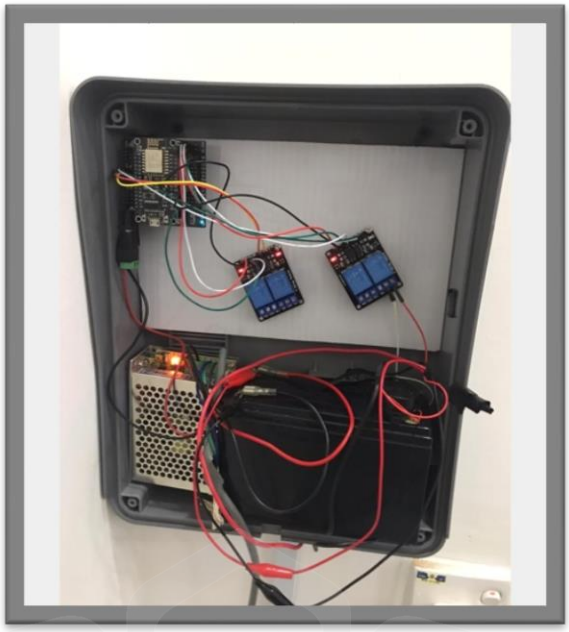

Figure 1 MSEECIIASHSO: 12V battery backup ESP8266 connected with relays to control and monitor electric devices