Challenges in Control and Monitoring of Home-based Electronic Devices: A case for IoT-based Automation system

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Abstract

 Internet of Things (IoT) is a concept that envisions all objects around us as part of internet. IoT coverage is very wide and includes variety of objects like smart phones, tablets, digital cameras and sensors. Home automation provides many kinds of services such as; reducing human labor, effort, time and errors due to human negligence. The increase in consumption of energy and population, has led to a grave need to conserve energy in every way possible. The inability to access and control the appliances from remote locations is one of the major reasons for energy loss hence, contributing to the need for a smart solution. This paper presents a survey on the challenges homeowners face in controlling and monitoring of home-based electronic devices. Forty questionnaires were administered to people with residential houses, and from the findings of the survey presented in the results section of this paper, 94.6% of the homes control and monitor their living room electronic devices manually which comes with many challenges. We therefore propose an IoT-based device living room automation system to overcome the challenges presented.

Keywords: IoT; home automation; living room; remote control; SPSS.

1. Introduction

The way people live and behave has dramatically changed over the last decade. The concept and notion of the "home" has changed. Today, the home is no longer seen as a simple and passive place for sleeping and eating, but as a dynamic and lively place that has to be comfortable, secure, sophisticated, and energy efficient. Through the development of new technologies, people are constantly looking for solutions that could

make their home life easier, greener, more comfortable and functional [1].

While automation has already been implemented in commercial buildings for security purposes, automation in private homes is still in its infancy [3]. This therefore gives a foundation for this study to investigate the different challenges homeowners face in monitoring and controlling electronic devices in their living rooms and how automation of the devices can be implemented so as to overcome these challenges.

Homeowners today face challenges in monitoring and controlling the electronic devices in their living rooms. The most noted challenges from the survey are: too much time is taken to operate electronic devices; lack of the remote control; high risks for electric shock; the physically challenged people find a big challenge to operate the devices manually; kids when left alone at home feel very lonely because they cannot operate the devices by themselves; high electricity consumption by the devices especially in situations where power comes back and no one is at home to turn off the devices when the power source was accidentally left on.

This paper aims to perform a research study on how homeowners control and manage electronic devices in their living rooms and the challenges they face in the process. The paper will analyze the results of the study to aid in generating the functional and nonfunctional requirements of the IoT-based living room device automation system which seeks to overcome the challenges identified.

2. Related Work

Smart House Monitor & Manager (SHMM) System was based on the ZigBee wireless network to connect all sensors and actuators [4]. The user can use the PC or Android phone to monitor or control through the Internet to power-saving of the house. The system is highly flexible and scalable and expandable [5]. However, the system was implemented with ZigBee wireless network which puts the entire system at a risk of crashing, in case of any damages due to rupturing of the cable [2].

Cloud-based home appliance monitoring and controlling System was implemented with Raspberry Pi to collect metadata from home appliances and send to the cloud-based data server to store on HDFS (Hadoop Distributed File System), process them using MapReduce and use it to provide a monitoring function to Remote user [6]. The

system is interactive, efficient and flexible [7]. However, the system is too complex, this requires the user to have some technical background and electronics basics; it also requires time to learn how to use it; it is very expensive especially to the local people since it was built specifically for corporate homes [2].

3. Methodology

The research was aimed at finding the requirements for the IoT-based living room device automation system. For this goal, a quantitative research methodology, based on structured questionnaires for data collection and descriptive statistics for analysis was applied to obtain a broader view of homeowners on how they monitor and control their electronic devices and the challenges they face in the process.

The questionnaire had a total number of fourteen (14) questions. These were both open-ended and closed ended. The tool was designed with four sections i.e. introduction section was aimed at describing the purpose of the study; bio data section, to capture the demographic characteristics of the respondents; public opinion about home automation, to obtain information about the electronic devices found in people's living rooms, the challenges they face in the process of monitoring and controlling the devices and how they would want these challenges to be addressed using home automation technologies; System function, was aimed at capturing the requirements for the IoT-based living room device automation system.

Forty (40) questionnaires were administered to people with residential houses in four areas i.e. (Busega, Nalukolongo-Rubaga division) in Wakiso district, and (Kyengera, Kireka-Kira Sub-county) in Kampala district. The sample size selected was manageable and cost effective. The study areas were within the researchers' premises. At the end of the data collection process, thirty-seven (37) questionnaires were satisfactorily filled and collected by the researchers. This represented an overall successful response rate of 92% confidence interval.

SPSS tool was used to analyze the results of the study. This tool was chosen because the researchers were familiar with it and still allowed them to automatically generate descriptive statistical tables and graphs.

The different challenges that we faced during the study included: 1) financial costs to reach to respondents' premises 2) most of the homeowners were not at home during day, making the study to be conducted late in the evening 3) some of the respondents took the

study lightly, they misplaced the questionnaires 4) time constraint, 5) some respondents were not contented with the confidentiality of the study even after explaining to them the intention of the study hence, kept some important information to themselves.
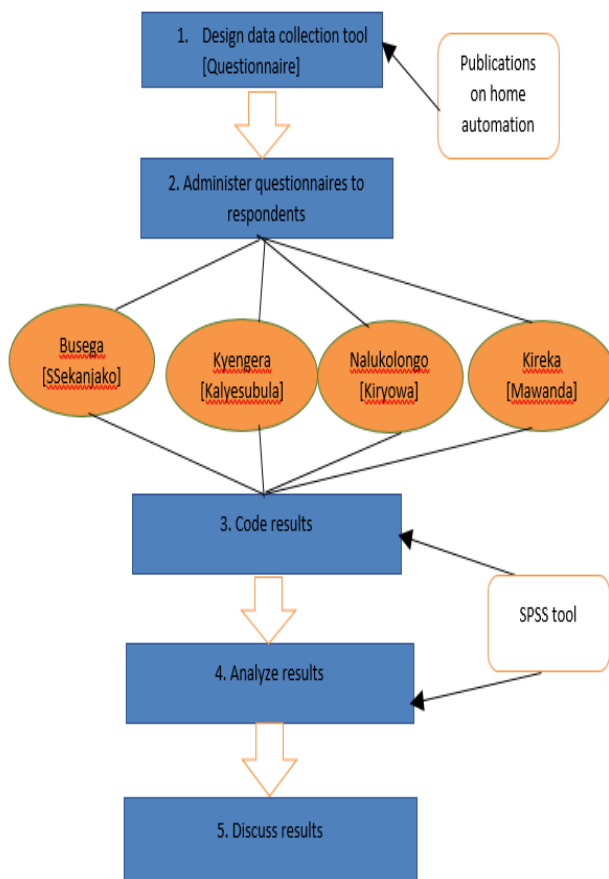
Methodology key activities

Figure 1: Methodology activities

4. Results

The results presented in this section were obtained from the thirty-seven (37) questionnaires which were collected at the end of the data collection process.

Any challenges faced in control and monitoring living room

This question was intended to find out if homeowners face any challenges in controlling and monitoring devices and the activities in their living room. Results are given in the figure below.
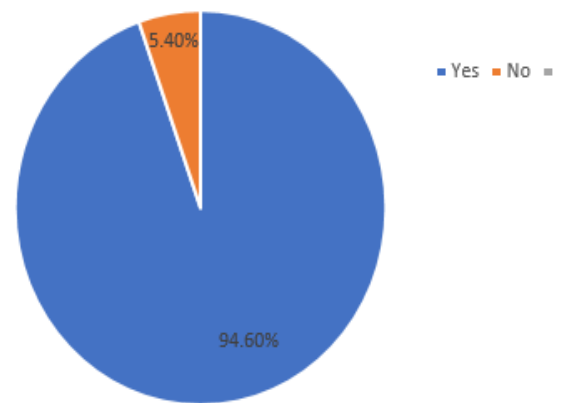

Figure 2: Any challenges faced in controlling and managing devices in the living room devices

From the figure above, 94.6% of the respondents face challenges in controlling and managing electronic devices in their living rooms. This indicates that the project will create a very big positive impact to the community

Challenges faced in controlling and monitoring devices in the living room.

This question was intended to capture the different challenges homeowners face in controlling and monitoring the devices and activities in their living rooms. Research findings for this question are given below.
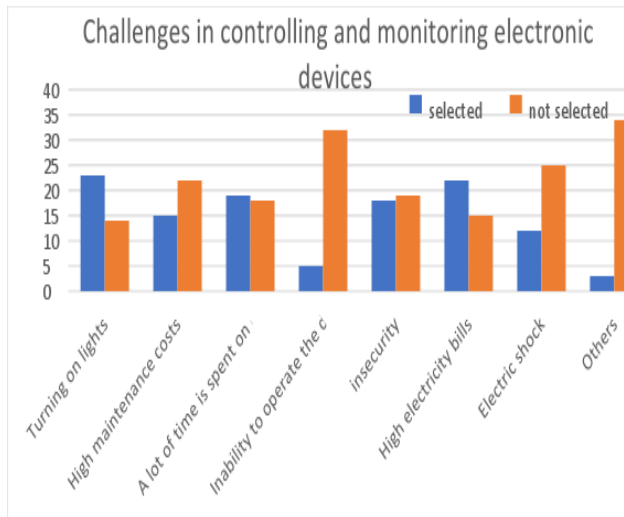

Figure 3: Challenges in control and monitoring electronic devices

From the figure above, the most occurring challenges that homeowners face in controlling and monitoring electronic devices and activities in their living rooms are; turning on lights (62.2%), high electricity bills (59.5%), a lot of time spent to operate the devices (51.4%)

 Devices found in a living room

This research question was intended to know the different devices found in the living room. Results are reflected in the figure below.
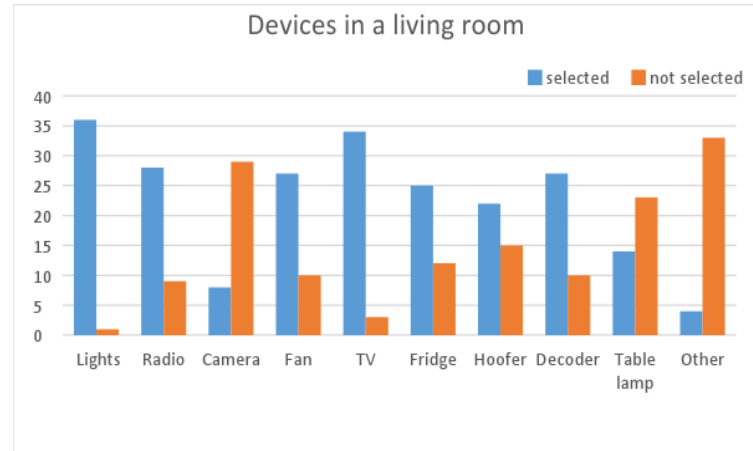

Figure 4: Devices in the living room

From the figure above, the most selected devices found in the living room are; lights, TV, radio, fan, decoder.

How to automate a living room

The goal for this question was to get public view on how they would want to automate their living room so as to help project developers know what their stakeholders prefer. Research findings for this question are given below.
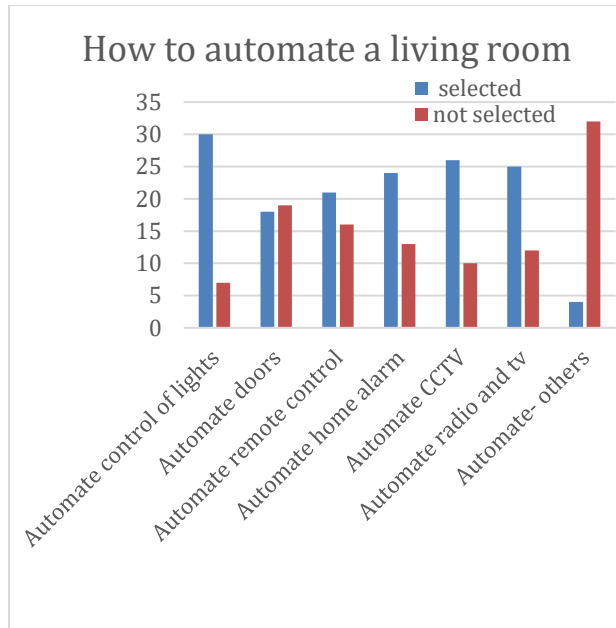
Figure 5: How to automate living room

From the figure above, most people prefer automating control of lights, followed by automating CCTV, automating radio and tv.

How to control devices in the living room

Respondents were required to select from the options that were provided in the questionnaire on how they would want to control the devices in their living rooms. Results are as follows:

QUESTION	OPTIONS	Frequency	%age
	Using smart phone	28	75.7%
	Using Voice	17	46.0%
	Using Gestures	8	21.6%
	Using Computer	16	43.3%

Table 1: How to control and monitor devices

From the table above, 75.7% of the respondents prefer control and monitoring the devices using their smart phones, 46.0% prefer using voice, 43.3% prefer using a computer

System functions

Respondents were required to list down the different activities that they would like the living room device automation system to provide or to do for them. This question was intended to obtain the functional and nonfunctional requirements of the system. Respondents gave the following system functions. The points are listed as per a given respondent.

- control electricity and water bills, detect specifications of home members.
- electric kettle and oven should cook breakfast in the morning immediately one leaves bed.
- security, fan.
- alerts that indicate start of programs on a TV, remote live streaming, remote automatic control of devices.
- security, saving time, power backup.
- connect homeowner to a person at the gate before they enter, alert when a person approaches a gate.
- Automatic switching on lights and ventilation system.
- automatic control of the lights, tv, radio, refrigerator.

- control of the other systems without moving from room to room.
- automatic control of lights, doors, home alarm, CCTV camera, radio and tv.
- automatic switch off tv and lights during time for sleeping.
- figure out ways to save electricity costs.
- enable parents monitor what their children watch on their smartphones in their bedrooms.
- timer to time when people should go to bed and all devices automatically go off.
- controlling tv and lights.
- automatic removal of curtains in case there is a person entering a sitting room.
- remote control of tv, radio and decoder, automatic switch off lights when not at home.
- control lights, radio, tv, curtains.
- control lights, tv, fan, radio, camera.
- ability to know user's current electricity bills and ability to tell which device consumes much power.
- automatic switch on lights, radio, opening and closing of doors.
- ability to access a living room at s less cost.
- provide expenses for appliances, reduce cost of monitoring devices.
- provide a guide on how to operate devices, keep user updated all the time, keep room organized with no cables, ensure security.
- automatic cleaning, lights, doors, cameras

5. Discussion of Results

The results presented in this paper show that 94.6% of the respondents face challenges in controlling and monitoring electronic devices in their living rooms. This is because many homeowners still operate the devices manually which is tiresome.

The most noted challenges homeowners face in controlling and monitoring electronic devices are: turning on lights, high electricity bills, a lot of time spent to operate the devices. This is because many people do not know the power consumption of their electronic devices, so they can't devise means of regulating the power consumption. Also, some do not know how to operate the devices hence end up spending a lot of time.

The findings section of this paper highlights the most common electronic devices found in people's living rooms which include: lights, tv, radio, hoofer, decoder. This is because these devices serve the most important functions to homeowners e.g. providing light in the dark, entertainment, news. Also, people are familiar with these devices and they are relatively cheap to obtain and maintain.

Results show that most people prefer control and monitoring their devices using their smart phone, this is because the percentage of

people owning smartphones especially in towns has greatly increased. Using smartphones is cheap, less time consuming and its more convenient.

The most noted functions suggested by the respondents are: providing remote control of tv and lights, alerts, instant feedback, emergency notice, automatic control of tv, lights, radio, security. This is because people are so much concerned about the security of their homes, technology has improved and people now see the relevance of having smart devices, electric shock is a major issue in homes so most people would want to get emergency notice about such cases.

6. Recommendations and Future Work

The results presented in this paper show that 94.6% of the respondents face challenges in monitoring and controlling electronic devices in their living rooms, we recommend that the project of developing the IoT-based living room device automation system should be supported by the stakeholders so as to overcome these challenges.

Future work includes; Publishing the paper; Creating a blog for the project; Implementing and deploying the IoT-based living room device automation system.

7. Conclusion

The Internet has changed drastically the way we live, moving interactions between people at a virtual level in several contexts spanning from the professional life to social relationships. The IoT has the potential to add a new dimension to this process by enabling communications with smart objects.

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