Development of an Automated Control for Household Electrical System

Engr. Aristotle F. Musni, MIT

Introduction

Technology is transforming people's lives in the most modern and convenient way. Researches are being conducted and innovations are being developed in increasing number to simplify and to mitigate the condition of living in terms of comfort and needs.

One major role of Information Technology is related with automation. It is the act of implementing the control of equipment with advanced technology, usually involving electronic hardware (Carsten, 1990). In general usage, automation can be defined as technology that is concerned in performing a process by means of programmed commands combined with automatic feedback control to ensure proper execution of the instructions. The resulting system is capable of operating without human intervention. The development of this technology has become increasingly dependent on the usage of the computers and computer-related technologies. Consequently, automated systems have become increasingly sophisticated and complex. One of the innovations that is being considered is the home automation.

In this era of fast-paced living, prices of commodities, water bills and electric bills are getting higher and higher. People are doing everything to sustain the needs of the family. Time is treasured so much especially by those who are paid on a per hour basis. In those busy days, the time for preparing coffee in the morning, switching the lights and other electrical appliances on/off, and doing other household chores is

hard to manage. People need a helping hand for convenience and security purposes. Since electricity wastage is a common scenario among households due to the appliances that are left working which consequently lead to a higher electricity bill, homeowners are burdened with an additional stressful task of looking for somebody to entrust such simple housework.

In view of the problems cited, the researcher came up with the concept of improving such home management system. Since majority of household appliances use electricity, a system has been designed to meet a variety of individual needs including convenience, energy savings and safety. By integrating automation in home management, an answer is provided to the busy lifestyle of working individuals who mostly depend on others to perform even the simple tasks for them.

Objectives of the Study

The main objective of the study is to develop an automated control for household electrical system.

Specifically, the study aims to design a circuit using microcontroller unit that automates home appliances; to create a system that can control the on and off operation of electric appliances; and to evaluate the performance of the system.

Scope and Limitation of the Study

This project is limited to the development of an automated control for household electrical system. The prototype output is composed of a microcontroller. It is a computer on a chip that is optimized to control the home appliances. It also acts as the brain of the system. A sensor converts a physical parameter into a signal that

can be measured electronically. It sends a signal to microcontroller when a specified condition is encountered. The system is designed to control all household appliances. It acts as a care taker of the house when switching operation is concerned. This project is limited only for appliances using electricity.

Project Design

The project uses a microcontroller for an automated control for household system. This project is expected to be useful to homeowners as it shows how a microcontroller unit can be used to control the operation of lights and home appliances. The project uses electrical and electronic materials such as relays, transistors and transformers. The device is made up of microcontroller and sensors. The interface circuits are connected to the microcontroller control flow of current to the lights and appliances. Through this project, people will realize and appreciate the significance of automation in everyday life. A microcontroller unit can be used to control and sequence the operation of home appliances and lights.

Block Diagram. This diagram shows the physical configuration and connection of the presence of the owner or setting switch, microcontroller and different hardware components.

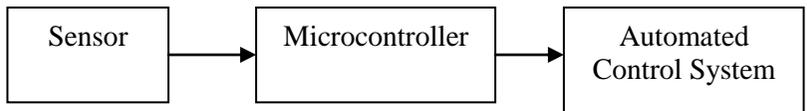| Sensor | → | Microcontroller | → | Automated Control System |

Figure 1
Block Diagram of the Project

The microcontroller has an input device, which is a sensor. A sensor is a device used to trigger the microcontroller. It also functions as the brain of the

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whole system. It is the one responsible for giving out instructions and activates the system that was programmed through it.

And finally the output is an automated control system.

Once all the parts and components of the project are identified, the design of the physical appearance of the project is considered. The location of every major component is carefully planned so as to provide the best connections during wiring. The design of the project is important in the realization of the benefits the homeowner can get from the system.

Evaluation Procedure

The evaluation process was done by conducting a survey on the functionality and acceptability of the project. A survey questionnaire with a set of 4 criteria namely Functionality, Reliability, Safety, and Accuracy was designed using a scale of 1 to 5. The acceptability of the project was evaluated by a group composed of six (6) ordinary people and six (6) professional/experts.

People classified as ordinary are maids, students and parents. Professionals/experts, on the other hand, are people who are knowledgeable in the field of Science and Engineering. These are professionals with degree in computer engineering, electronic engineering and electrical engineering.

Prior to evaluation, a demonstration on the actual operation of the project was carried out in the presence of the evaluators.

Results and Discussions

      A.   Project Description. The project is an Automated Control for Household Electrical System used to automate lights and home appliances. Relays are used to convert direct current that comes out to the microcontroller into alternating current used by lights and appliances. It has 4 buttons to choose from and each button has its own function and corresponding sockets. Sensors and seven-segment LED are needed in order to have an accurate monitoring inside the house. A sensor served as an input to the microcontroller. A seven-segment LED is used signifying the presence of the owner or a number of people inside the room where the main system is located. The project is operated using 220 volts source.

      B.   Project Structure. The prototype is made up of the following major parts: Electrical and Electronic Components; Microcontroller Unit; Power Supply for Microcontroller; Power Supply for the Relay; Circuit Board Switching the Sensor and Seven-Segment LED.

      1. Electrical and Electronic Components. The electrical parts are composed of transformers, relays and sensors. Transformer and power supply circuit board are used in converting alternating current to direct current. The relays in the circuit are used to convert the 5 Volts current comes from the microcontroller to 220 Volts alternating current used by the lights and home appliances. The electronic materials are made up of the microcontroller circuitry,

different interface circuits, sensors and the push button switch and LED circuitry.

2. <u>Microcontroller Unit.</u> The microcontroller unit is the circuit responsible for sequencing the operation of the system which is automating the home appliances. The circuit consists of microcontroller unit, , analog comparator programmable timer, RAM and flash memory. One of the terminals placed on the board is used to connect on the power supply. The other terminal is used to connect to other devices and circuit boards.

3. <u>Power Supply Circuit Board for Microcontroller Unit.</u> This interface board is used to give the voltage supply needed by the microcontroller unit. The circuit consists of transformer, rectifier circuit and voltage regulator. The transformed voltage from the transformer is connected directly to the board. This voltage is rectified through the diodes and regulated through the voltage regulator. The voltage supply is sent to the microcontroller unit circuit board.

4. <u>Power Supply for the Relay.</u> This interface board is used to give the voltage supply needed by the relay and is used to switch the lights and appliances on/off.

5. <u>Circuit Board Switching the Sensor and Seven-Segment LED.</u> This circuit board is used by the sensor and seven-segment LED

in order to accomplish its task, and as an input to the microcontroller and indicator of the project. The circuit consists of transformer, rectifier circuit and voltage regulator. The transformed voltage from the transformer is connected directly to the circuit board. This voltage is rectified through the diodes and regulated through the voltage regulator. The voltage supply is sent to the sensor circuit board connected to the microcontroller unit.

C.   Project Capabilities and Limitations.

The project is designed to perform as caretaker of the house when electrical and electronics switching is concerned. There are four different selections to choose from namely: Manual, Away, Stay1, and Stay2.

Under the Manual option, the operation of lights and home appliances are all relying on the manual switching of the on/off function by the user. In this case, all sensors are deactivated. The Away option triggers the appliances in ON state at a certain time specified in the system. The Stay1 choice operates the appliances in ON state at a specified time and will turn OFF and ON another appliance. The Stay2 choice is same as the Stay1 except the entire sensor circuit are deactivated. The operation of each choice is controlled by the microcontroller unit.

The project is limited only for home appliances using electricity. The system is designed only to switch ON and OFF the supply voltage used by lights and home appliances.

Project Evaluation

The acceptability of the project was evaluated in terms of its Functionality, Reliability, Safety and Accuracy. There were 10 respondents who filled out the questionnaire.

1. Ordinary Users – are those who determine if the device can accept input that comes from the user and process it.
2. Professionals with the degree in Computer Science and Computer Engineering – are those responsible for testing the program stored in the microcontroller unit.
3. Engineers – are those responsible for testing the hardware and software interface and interface boards.

The project prototype was tested and evaluated in terms of functionality of hardware and software, reliability, safety and accuracy. The design criteria were validated by the respondents indicated in the survey questionnaire.

Table 1 illustrates the overall mean of each criterion and the acquired descriptive rating as perceived by the combined group of respondents from ordinary users and professionals/experts.

Table 1
Ratings of the Project Prototype

Design Criteria	Rating	
	Mean	Interpretation
1. Functionality of Hardware and Software	4.62	Excellent
2. Realiability	4.67	Excellent
3. Safety	4.70	Excellent
4. Accuracy	4.57	Excellent
Overall Mean	**4.64**	**Excellent**

In terms of functionality of hardware and software, the project is <u>Excellent</u> with a mean score of 4.62. This means that the project is able to determine the setting of the users. When it comes to realibility, the project is also evaluated as <u>Excellent</u> with a mean score of 4.67. This means that the project is able to perform its function exactly without errors. The project's safety feature is likewise rated as <u>Excellent</u> with a mean score of 4.70. This means that the software, electrical and electronic components found in the device are not harmful or destructive to anything. Finally, in terms of accuracy, the project is <u>Excellent</u> as well with a mean score of 4.57. This means that the project is able to control the on/off of the lights and appliances at home.

Data showed that the project is <u>Excellent</u> to the groups of respondent. The Overall Mean Rating of the project based on the groups of respondents in terms of Functionality, Reliability, Safety and Accuracy is 4.64, which means that the project, an Automated Control of Household Electrical System, is <u>Excellent.</u>

Summary and Findings

Based on the results gathered from the series of testing and evaluations, the project prototype is excellent in and capable of automating home appliances accurately.

The outcome of the evaluation process conveyed through the interpretation of the descriptive rating of each criterion are as follows:

1. <u>Functionality.</u> The respondents perceived the functionality of the hardware and software as excellent. This means that the system of the microcontroller works accurately and the push

button choices accept the input correctly. This indicates that the device is convenient to use.

2. <u>Realibility.</u>   The respondents perceived the reliability of the project as excellent. The device can execute automating the lights or appliances attached to the choice the user has requested. This indicates that the project is functioning exactly without errors.

3. <u>Safety.</u> The respondents perceived the safety of the project as excellent. The transformers, microcontroller unit and interface circuits are found inside the device and users do not have any direct access on them. The system is also free from short circuits and loss of power. This indicates that the project has proper wiring and connection.

4. <u>Accuracy.</u>   The respondents perceived the accuracy of the project as excellent. The system is able to control the lights and appliances at home. This indicates that the system can manage to automate the home appliances.

The project prototype has an overall mean of 4.64 with a corresponding descriptive rating of Excellent. Analyses of the results of the evaluation reveal that the project should be improved on the aspects of reliability and safety. Its design characteristics should be improved based on the users' recommedations.

Conclusions

In consideration of the objectives of the study and results of the evaluation, the following conclusions are formulated:

1. The design of prototype adequately supports the automation of home appliances using microcontroller.
2. The created system has a design plan that controls the ON and OFF operation of electronic appliances.
3. The evaluated performance of the system from the groups of respondents based from the given criteria was excellent. Hence, the system can establish a great importance in the realization of the objectives of automated control for household electrical system in automating lights and home appliances.

Recommendations

For the improvement of the project, it is recommended that:

1. An additional choice for the input button be placed so as to supply a greater number of appliances.
2. The input button be changed to keypad instead of push button.
3. The output LED be changed to LCD.
4. The physical appearance of the project be changed by using other materials to cover the entire device.
5. A follow-up study be done by future researchers to prove the effectiveness of using the project in automating home appliances.

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