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INTELLIGENT HOME ENERGY MANAGEMENT SYSTEM USING LABVIEW – MYRIO

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Abstract. *Households consume 40% of global energy and produce 21% of greenhouse gases (GHG). Subsequently, energy management in the domestic sector is a significant part for establishing a maintainable climate and cost decrease. In this paper, an intelligent home energy management system (IHEMS) is established to control home appliance load. The motivation of this work is to decrease the power cost and power consumption of all the appliances. Home energy management systems (HEMS) have been widely used in recent years to reduce electric power usage in home appliances. Substantial research has been done to make household energy use more efficiently to control electricity demand and supply. The main goal of a home energy management system is energy saving, reduces the energy consumption and limits the consumption to maximum demand. This paper discusses about energy saving by minimizing the energy wastage and brings the advantages of technology into the homes by automating their household and to provide a solution to prevent wastage of electricity and thus help in overcoming the problem of scarcity of electricity. Energy saving is done by controlling the room lights and fans depending upon the number of people present inside the room. The proposed concept is implemented in LabVIEW using myRIO.*
Keywords: Intelligent home energy management system (IHEMS), Energy consumption, Power saving, Energy management, Home automation, Household load

1. **Introduction.** In recent years the energy crisis has become a problem which the whole world must confront. Home power consumption makes up the largest part of energy consumption in the world. In particular, the power consumption of lamps in a typical home is a factor which cannot be ignored. The typical user needs different light intensities in different places. The required light intensity in a home can be varied depending on different factors. Sometimes consumer forgets to turn off the electrical appliances which lead to wastage of energy. Therefore, some power management method is necessary in order to save energy.

Major part of the world power consumption and gas emissions are due to household load [1]. The key component that can make grid power consumption decrease is to implement sustainable improvement programs. Global energy demand is expected to rise by more than 2.3% by the end of 2035, according to International Energy Agency (IEA) [2]. Global warming and power storage have increased attention on building energy management system (BEMS). The home energy management system (HEMS) helps decrease in demand for power at peak load periods [3]. Different control techniques are developed for controlling home appliances for HEMS frameworks. In domestic homes, HEMS can be carried out to help, deal with the energy supply by collaborating with building loads and utilities, controlling power utilization, and get information (for instance, traffic costs) to limit power use by planning the utilization of building appliances [4]. HEMS

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developments can give a typical satisfaction between buyers by understanding their solace tendencies and the utility by aiding energy saving strategies [5]. The smart home is one of the usages of smart developments in building that can offer opportunities to improved energy management, reduced energy utilization, energy-saving decreased greenhouse gas, and improved home automation. Energy use in domestic homes relies upon various components, including the quantity of occupants living in the structure, individuals at home or away, and electrical power rating [6]. Energy management systems can achieve energy consumption savings in the range of 16%-20% [7,8]. In [9], the authors proposed a system that would help users to view their energy consumption by logging into a webpage.

The continuous increase in home energy tariffs has led to the effort by homeowners to search for the solutions to reduce their electricity bills. In this context, minimizing power consumption can contribute to the sustainability of energy and environment [10]. Therefore, the appropriate management of energy in the domestic area is a crucial component for establishing a sustainable climate and cost decrease [11]. The futuristic plan regarding HEMS is in support of self learning AI techniques which may replace the user position and access in system settings supporting the venture of HEMS into different levels of power electricity management all together [12]. The emersion of smart grids and the rising power demand have introduced new benefits for HEMS with the goal of reducing power use. Earlier works in scheduling domestic appliances focused on power saving and reducing energy costs without considering user comfort. Thus, saving of the power is the main concern. Home automation system is developed using IoT based on multi-modal application that can be operated using voice recognition [14]. Human-centric appliance rescheduling behavior for residential homes is developed. The results show improvement in energy savings [15]. In the reviewed literature the development of energy management system at domestic level with minimum investment and accurate behavior is not analyzed. Therefore, there is scope for development of appropriate system for smart, energy efficient home automation system to save the power consumption. The proposed work is executed with LabVIEW interfaced NI myRIO [13].

The remaining paper is structured as follows. Section 2 explains the architecture of the proposed system. Section 3 presents the study of results and analysis of the proposed system and the final conclusions are summarized in Section 4.

2. Architecture of the Proposed System.

The process of execution is shown in Figure 1. The proposed method is executed by interfacing some components such as sensors, and motors, with NI myRIO. Besides the main aim of the system to save energy in smart home system, the system also has the following features.

- Wireless Monitoring: The state of home can be realized through myRio and LCD Display.
- The number of persons inside the building can be realized at any time.
- Automatic control of switches can be realized by use of sensors.

The operation is categorized into two parts: 1) hardware design; 2) software design.

2.1. Hardware design.

Figure 2 shows the block diagram of IHEMS. Adapter is a circuit which converts the AC supply into DC supply which is required for myRIO device. The sensors are given signal as input to the myRIO and the device is operated under the program designed by the user. The relay is operated as electrical switch to turn on/off the light automatically. The input to NI myRIO is IR sensors and outputs are signals to relays and display on the LCD screen as viewer which shows the status of the intelligent home energy management system.

2.2. Software design.

Conditional case structure is developed in LabVIEW and is dumped into myRIO for execution. A case-structure consisting of nine cases is developed. Figure 3 shows the flowchart of execution process in NI myRIO.

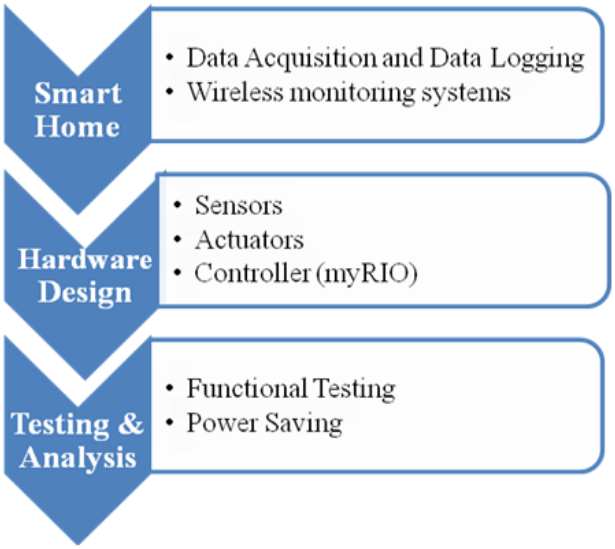

FIGURE 1. Architecture of the proposed system

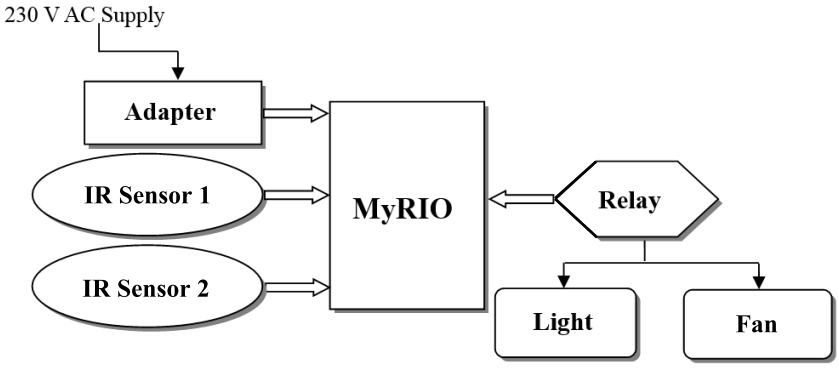

FIGURE 2. Block diagram of intelligent home energy management system

The flowchart shows the process of execution of an intelligent home energy management system (IHEMS). The proposed system is modelled to count the number of persons entering into the room and it lights up the room based on the light intensity of the room and turns on fan automatically. This process is automated by using its sensors. In this work, the principle components are sensors, controller, counter display, and gate. The sensor observes for interruption continuously. The output signal of sensor provides an input to the controller viz., myRIO to execute either increment or decrement case depending on whether the person is entering or exiting the home and count is displayed on an LCD through the controller. IR sensors are operated such that if any one of the sensors is activated by object detection then other sensor introduces a time delay in the circuit to avoid conflict with first sensor signal.

The circuit takes the task of controlling the room lights and fans depending upon the persons count present inside the room. The number of persons inside the room is displayed on the LCD display. The signals received to myRIO as input are converted to digital pulses and are given to a control structure developed in LabVIEW software.

Here, our bidirectional visitor counter and automatic light system can be used for counting of persons who enter or exit the room at any time. When a person enters the room, the LCD which is set up shows the count of the persons entering and immediately the lights in the room get switched on automatically.

And the other purpose of this is to minimize the counts in the LCD display and if the count in the LCD becomes ZERO then all the lights in the room get switched off. In

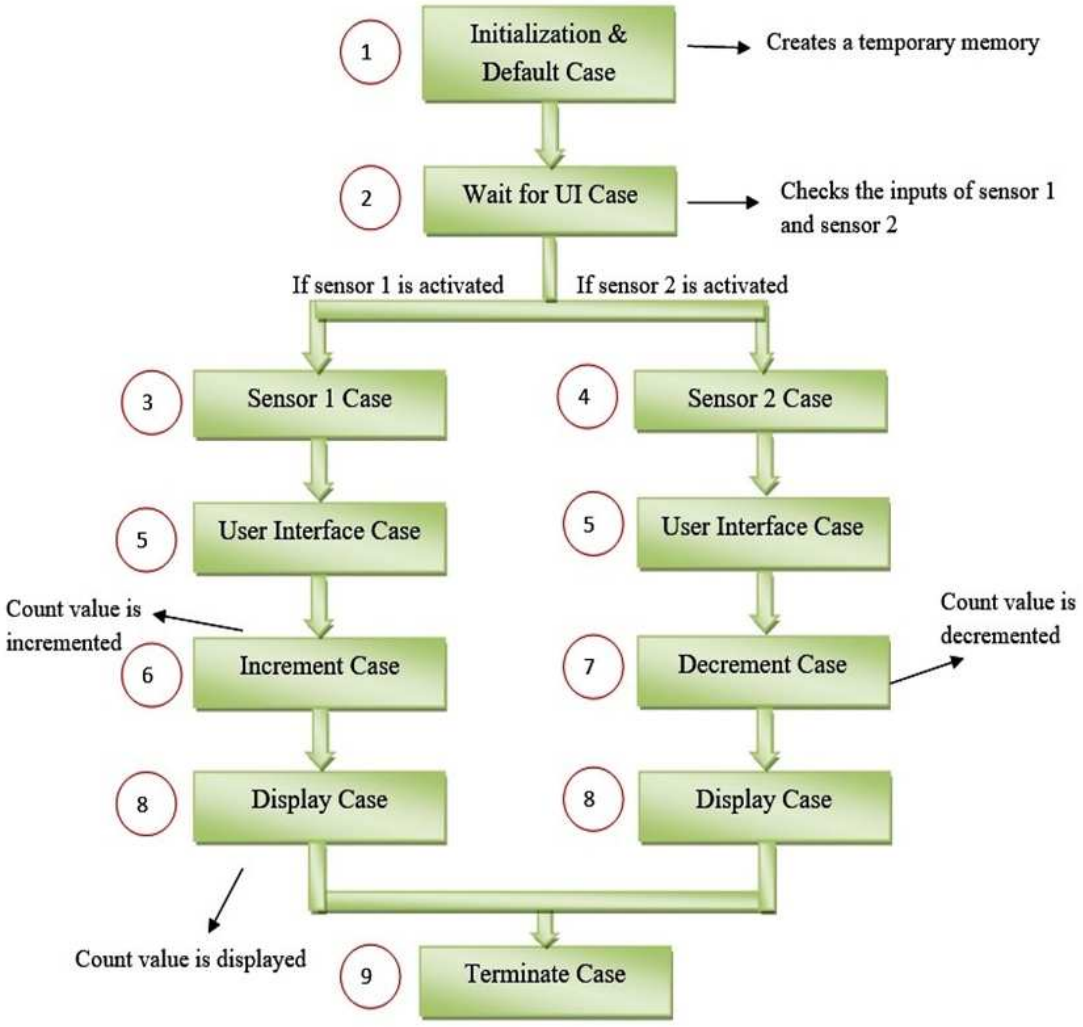

FIGURE 3. Flowchart of intelligent home energy management system

this circuit, two infrared (IR) sensor modules are used, which are low in nature. When the sensors are interrupted, if first sensor is in high then it increments the count of the persons in the room. Similarly, when the second sensor is interrupted, i.e., second sensor is in high then the count is decremented. The count value is calculated depending upon the sensor's input.

Figure 4 shows the initialization, default case, and user interface case. Here, the program initializes with the default case, which has buffer memory for storing values that change in regular intervals. The second block is the user interface block (UI) where the inputs from sensor 1 and sensor 2 are detected.

Figure 5 shows the execution procedure when sensor 1 is activated. If sensor 1 is high then it enters into sensor 1 case and then enters into user interface case. Next it enters into increment case, here the count value is incremented and then it enters into display case, here the count value is displayed.

Figure 6 shows the execution procedure when sensor 2 is activated. If sensor 2 is high then it enters into sensor 2 case and then enters into user interface case. Next, it enters into decrement case, here the count value is decremented and then it enters into display case, here the count value is displayed. Next, it enters into the terminate case.

Figure 7 shows the execution procedure of the whole case structure. When sensor 1 or sensor 2 case execution is completed, the termination case is executed and then myRIO again waits for sensor 1 and sensor 2 output signals.

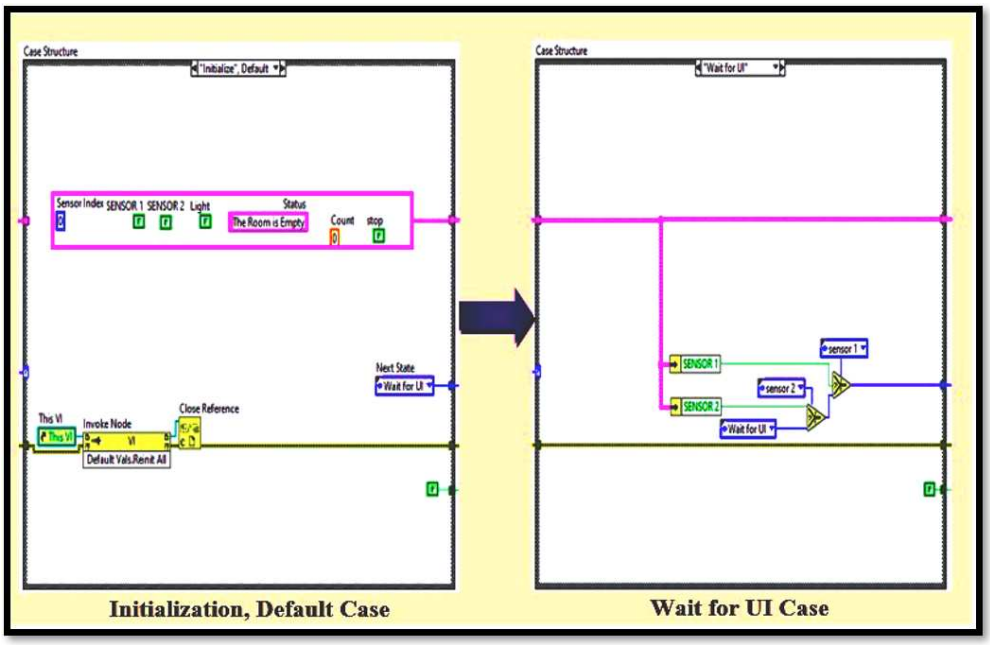

FIGURE 4. Initialization case structure in LabVIEW

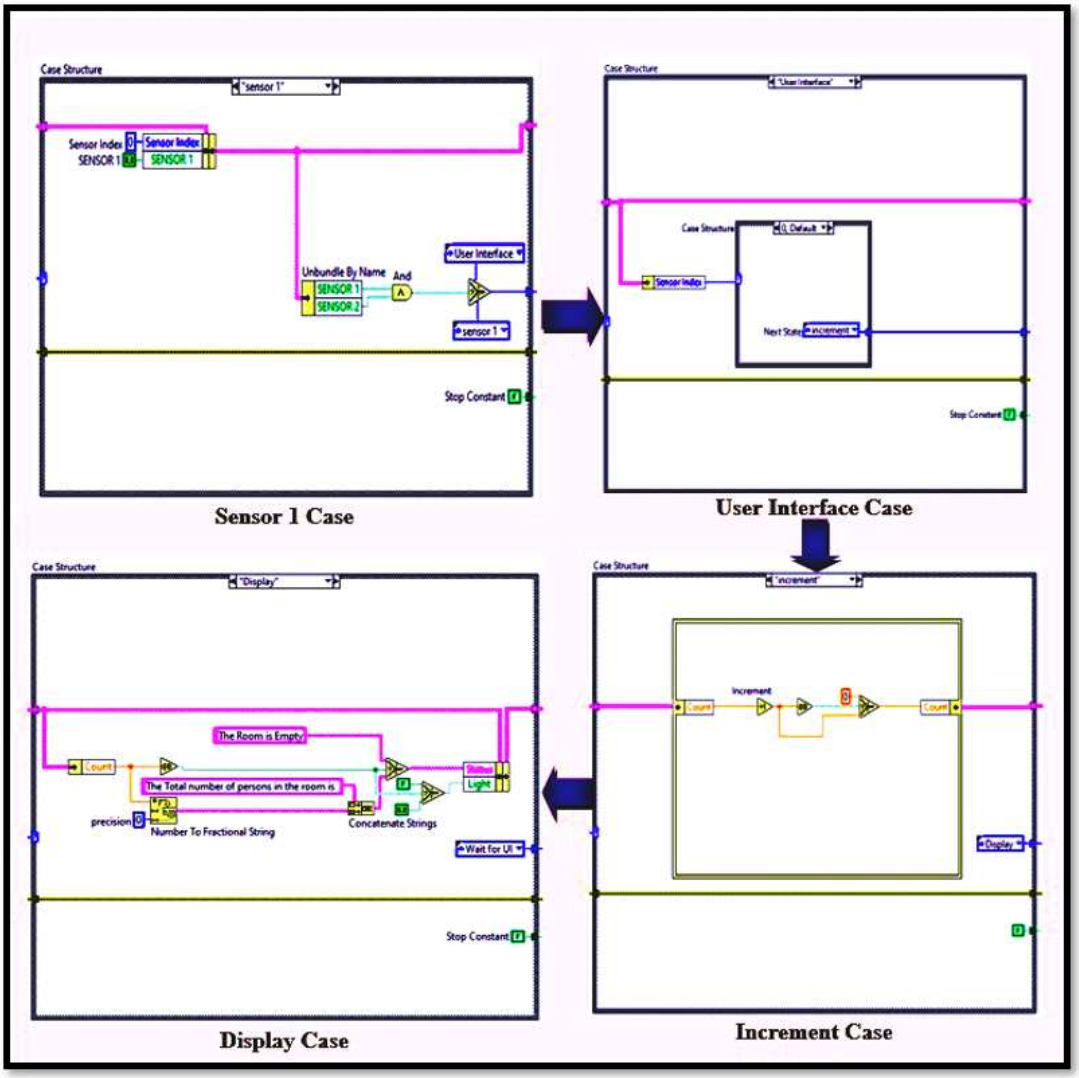

FIGURE 5. Sensor 1 activation case structure in LabVIEW

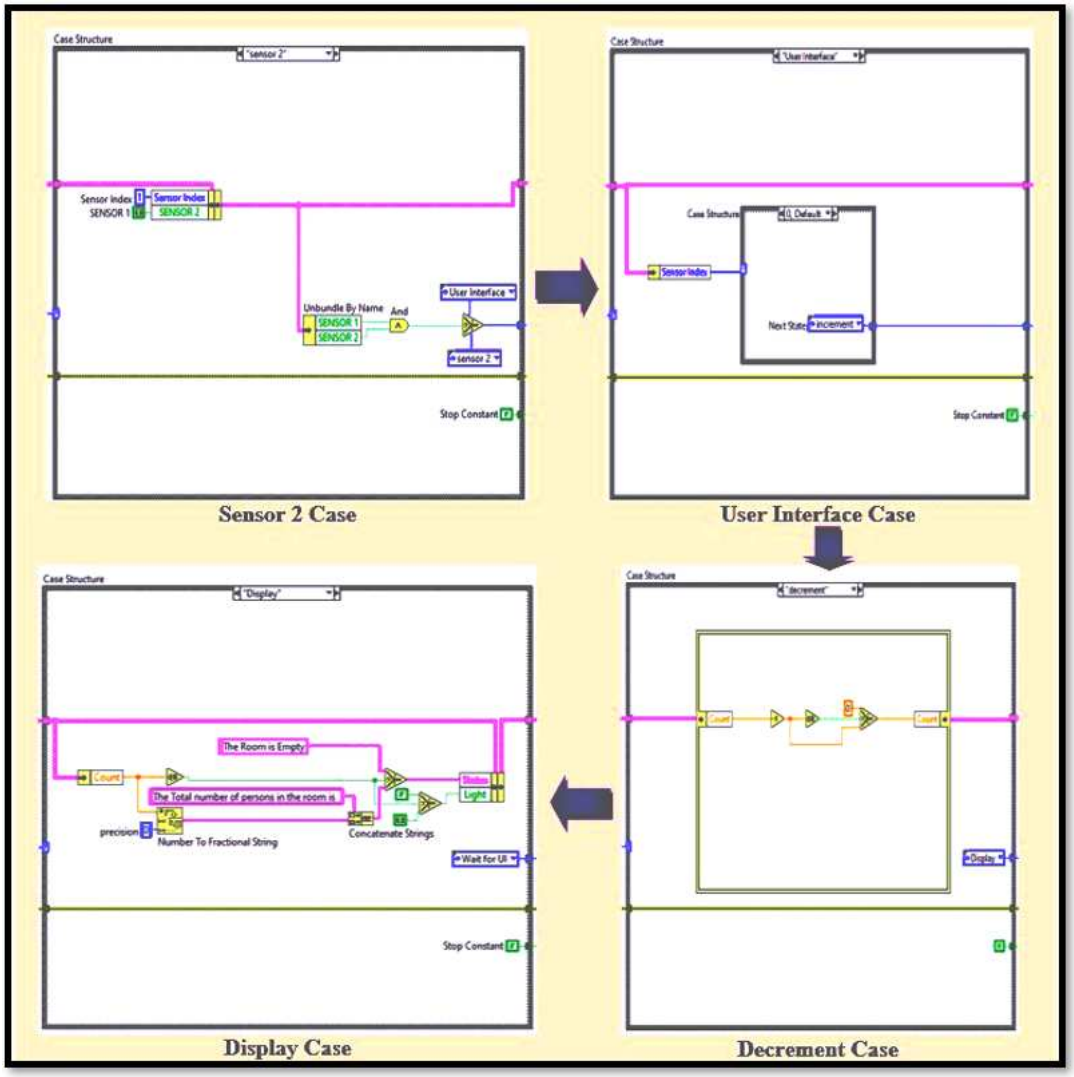

FIGURE 6. Sensor 2 activation case structure in LabVIEW

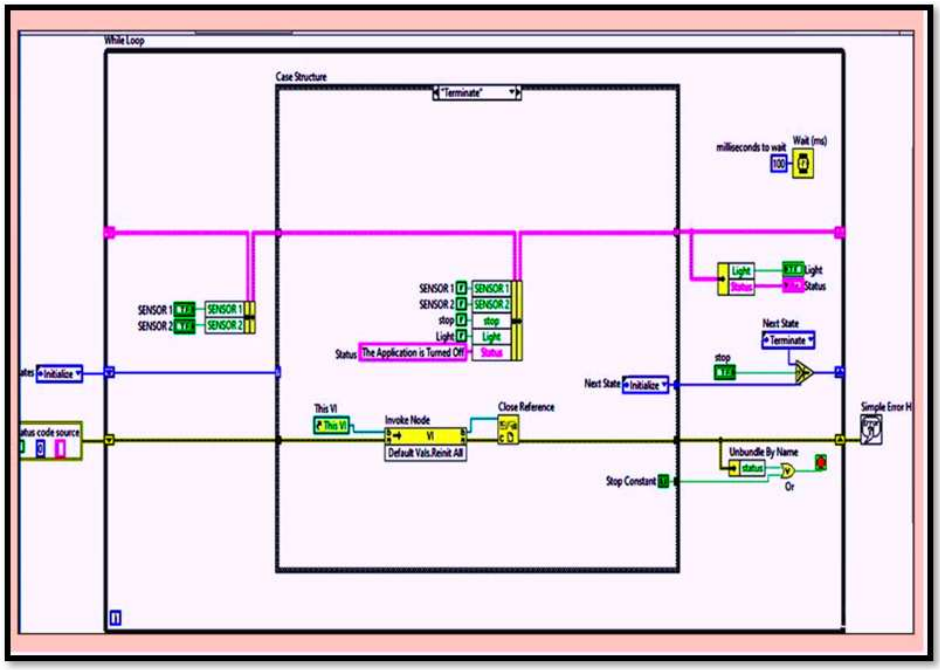

FIGURE 7. Termination case structure in LabVIEW

3. **Results and Analysis.** Hardware model is shown in Figure 8.

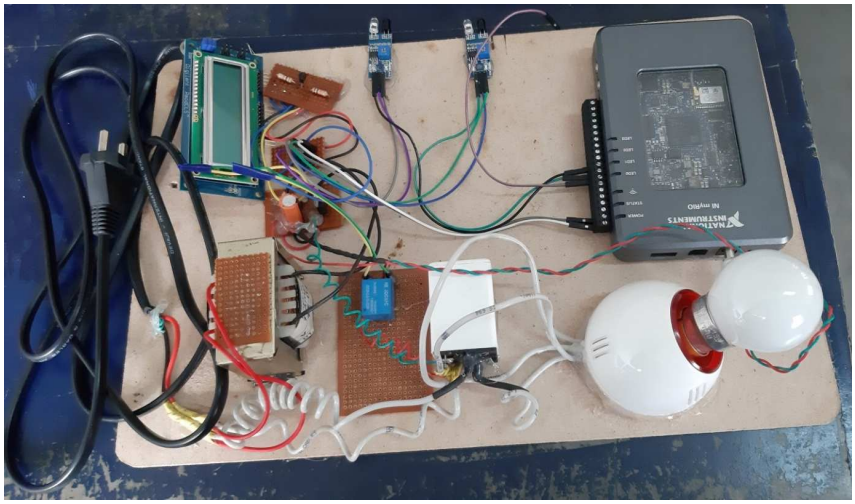

FIGURE 8. Hardware model showing execution of the proposed system

Figure 9 shows the front panel display of LabVIEW software when the room is empty, sensor 1 and sensor 2 are in off position, the light is in turned off position and the status display shows the room is empty.

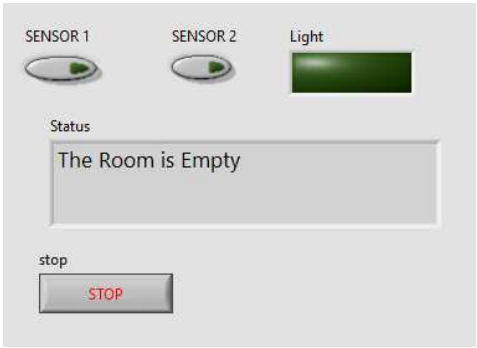

FIGURE 9. When room is empty.

Figure 10 shows the front panel display of LabVIEW software when a person entered the room, sensor 1 detects it, the light is turned on and the status display shows number of persons in the room is one. Similarly if persons leave the room, the sensor 2 detects and the LabVIEW front panel shows the corresponding value in the status display.

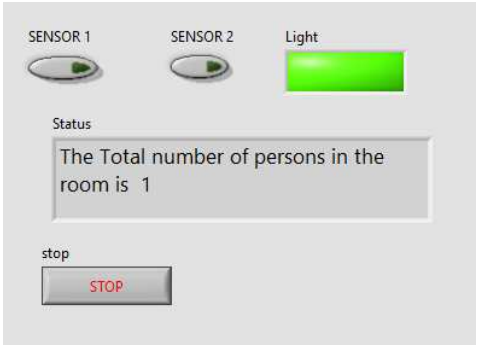

FIGURE 10. Number of persons in room is 1.

4. **Conclusion.** In this paper, a prototype is developed by using myRIO. The sensor outputs are interfaced with myRIO and a control structure is designed to count the number of persons. The LCD displays the count of the visitors to a room/building. Therefore, it is convenient to use this at highly secured places. Also, with the help of a bulb, this prototype is developed and tested. The results show that the consumption of power can be considerably reduced with the help of home automation. Further, the proposed system can be extended to turn on/off the loads depending on the strength of persons inside the room/building and can be executed on large scale systems like hospitals and educational universities for efficient energy management.

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