The Design Model of Solar Powered Automatic Bell System Integrated with Smoke Detection for Educational Institution Application

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Abstract – *The work presents a design model of renewable energy based automatic bell system integrated with smoke detection, which uses solar energy as main power source. This design model is highly recommended to be installed in schools and learning institution, particularly in rural area as the power supply is the main constraint. In this work, the design which incorporates of the bell system, smoke detection and LCD display are presented using design software and their function is initialized using a programming language. The system model is designed to trigger bell at prescribed interval hours during school sessions. On the other hand, the design also includes a smoke sensor integrated with the bell system which triggers the bell during fire break out. The results outcome of this system is discussed accordingly. This design model is expected to save costs and enhance efficiency in power utilization using renewable energy as the main source of energy. In addition, the safety feature of the smoke detector is expected to safeguard school or institution from losses and damages caused by fire outbreak.*

I. Introduction

Renewable energy sources are one of the alternative solution to replace the fossil fuel for energy resources as the non-renewable energy resources have been decreasing rapidly. Our world energy demand has reached a high level of use and researchers predicted the fossil fuels are to be depleted in 50 years of time [1]. The renewable energy is given foremost importance as the energy from the burning of fossil fuel contributes to environmental issues such as global warming [2]-[4]. Of all the renewable energy resources, solar energy has become potential resources to generate electricity. In this work, solar energy is used to design an automatic bell system integrated with smoke detection during an emergency for schools or institutions. A bell is an important instrument used in schools to indicate the students and teachers when it is time to go to class in the morning and when it is time to change class session during the day [5]-[6]. The bell is an essential instrument in both primary and secondary schools and even in the industries and other businesses where the bell timer plays a critical role in running the day [5]. The technological development has brought the conversion of manual bells into electronic automatic bell system particularly for school applications. An automatic school timer system reduces the need to turn on or off an electric bell manually, which provides an alarm for certain intervals of time according on school timings [7]-[8]. Apart from bell system, this project also proposes a smoke detection system integrated into the overall system. The system uses the real time clock to determine the time and the bell rings based on set up time. The LCD in this system displays current time and displays fire if the smoke detector detects a smoke. For different sessions, the bell will ring different numbers of times. The system is expected to continuously display the time by using real time clock and monitor the situation of the school during the day and night with power generated by solar energy [9]. By using solar energy as a power source, the system is uninterrupted during power supply failure from the main energy department. In addition, the energy can be used efficiently during day time and stored energy in the battery can be utilized during night time. This designed bell system integrated with smoke detector integration is expected to safeguard the institution from damages and losses particularly during an outbreak of fire.

II. Methodology

This model is designed with various inputs and outputs such as real-time clock (RTC), smoke sensor, buzzer for ringing the alarm and LCDs for displaying the messages.

Meanwhile the ARDUINO MEGA is used to program the output for each specified situation. In addition, this model is also added with solar cells and solar controller, which supplies power to ARDUINO. Thus, the process of ARDUINO will not be interrupted if conventional power supply from the main energy department is not available.

Fig. 1 shows the general flowchart on how the solar powered automatic bell for educational institution works. There are two types of input, which are RTC and MQ7 smoke sensor. RTC acts as a clock in this project. RTC functions to send the input to ARDUINO and the ARDUINO processes the output which is the buzzer. The buzzer acts as a bell, therefore, the buzzer rings depending on the alarm setup time through ARDUINO via the RTC. The type of bell rings is assigned accordingly to help the students and people in school identify the current session such as class session or break session. In this project, MQ7 acts as a smoke sensor. It will continuously monitor the condition of surrounding air. If smoke occurs, the MQ7 will able to detect it and sends an input to ARDUINO. Thereafter, the ARDUINO will process the input and sends signal to the output, which is the bell and an LCD. The LCD displays current date and time. The bell rings as soon as the MQ7 detects smoke. It is necessary for MQ7 to have high sensitivity and fast response because it will help in the evacuation process during a fire outbreak. This will enable the relevant authority to take fast response in saving people, school building and important equipment in the school.

Fig. 2 shows the process of RTC in the morning session. The process begins with RTC determining the current time and decides the output. In this model, the first class session starts at 7.30 am and ARDUINO detects the input. RTC will provide the clock time to ARDUINO. When it reaches the needed time, which is 7.30 am, then the buzzer acts as a bell and ring 2 times with a gap of 1 second. After that, the ARDUINO will continuously monitor the time. When it reaches 8.30 am, it rings again 2 times with a 1 second gap. Therefore, the students and teachers are aware that the first class session has ended and the second class session has begun. After the second class session ended at 9.30 am, the bell ring again 3 times with a 1 second gap to inform the beginning of next session which is the breakfast session. Students and teachers are aware of the breakfast session because the bell ring 3 times which is different from the other sessions. The next class session starts at 10.30 am and bell rings twice when it reaches the time. In the designed model, the last class hours during morning session starts at 11.30 am and bell ring 2 times with a 1 second gap. When the time reaches 12.30 pm, the school dismisses and bell ring four times with a 1 second gap to inform students and teachers that the school session has ended.
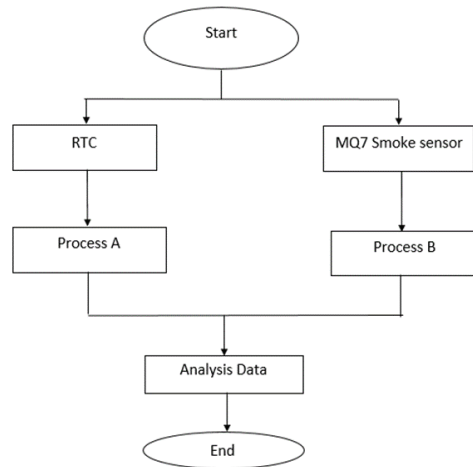

Fig. 1: Figure shows the flow chart for the overall model which are divided into two models which are process A and B depending on the input
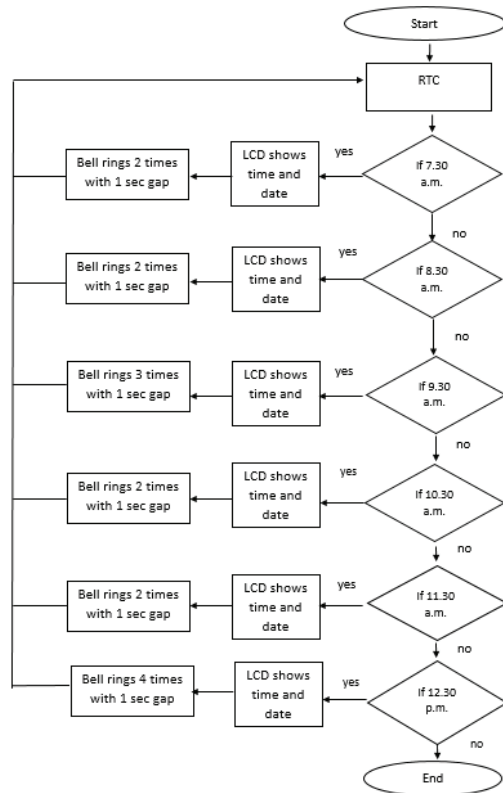

Fig. 2. Figure shows the flow chart for Model Process A using RTC as input which applies to morning school session

Fig. 3 shows the emergency response with smoke sensor, MQ7. MQ7 is installed to monitor the surrounding air. It will continuously monitor the air and detect smoke. If the sensor detects smoke, then it will send the input to ARDUINO. ARDUINO will process the input and trigger the output, which is the bell. The bell will ring without a gap. The LCD screen shows "FIRE" message continuously. This will inform the students, teachers and staffs around that there is a fire has outbreak in the school building. Staffs in the school building can take early action, such as evacuation of students and inform the firefighters. Hence, it can reduce damage and losses caused by the fire. If the fire occurs at night, the passerby around school building can inform the firefighters as well. Therefore, it is important for MQ7 to be installed because it can continuously monitor the school environment. Fig. 4 shows the overall circuits in this project. The circuits were tested in the Proteus software with the desired output.
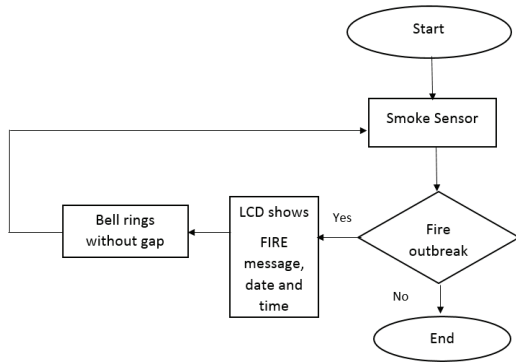

Fig. 3. Figure shows the flow chart for Model Process B using smoke sensor as input which applies during fire outbreak
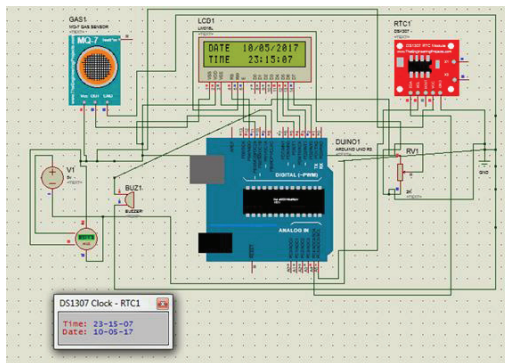

Fig. 4. Overall design model with Proteus software

A. ARDUINO Coding

The program was created by using the ARDUINO software. Fig. 5 shows the coding example used in the project. It shows that the pins were declared in the section which represents inputs or outputs. Hence, it is utmost important to declare pins in the coding correctly and matched well with the circuit designs.

Fig. 5: ARDUINO coding example

III.   Results and Discussions

A. Model Design of RTC connected to ARDUINO

RTC circuit to ARDUINO circuit is shown in Fig. 6. +5v pin of ARDUINO is connected to +5v RTC and GND pin for the RTC is connected to the GND pin of ARDUINO. SDA of RTC is connected to A4 pin on ARDUINO and SCL of RTC is connected to A5 pin on ARDUINO.
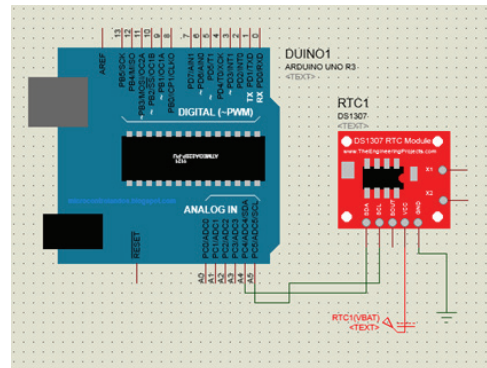

Fig. 6. RTC to ARDUINO circuit

B. Model Design of LCD connect to ARDUINO

Below is the connection of the LCD to ARDUINO pin:
- LCD RS pin to digital pin 12
- LCD Enable pin to digital pin 11
- LCD D4 pin to digital pin 5
- LCD D5 pin to digital pin 4

- LCD D6 pin to digital pin 3

- LCD D7 pin to digital pin 2

Additionally, wire a 10k port to +5V and GND, with its wiper (output) to LCD screens VO pin (pin3). A 220 ohm resistor is used to power the backlight of the display, usually on pin 15 and 16 of the LCD connector. The connections of circuits were shown in Fig. 7.
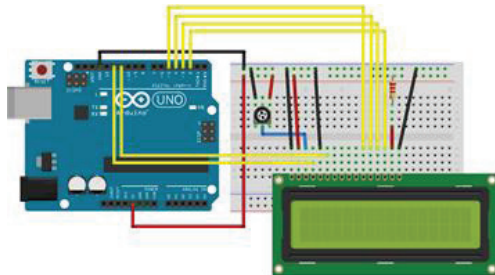

Fig. 7. LCD to ARDUINO circuit

C. Model Design of Solar controller connect to ARDUINO

Fig. 8 shows solar panels were connected to solar controller. Energy from solar panels were stored in the battery connected to solar controller. From the solar controller, the required output voltage for the load can be selected. The load for this project is ARDUINO. Since the output voltage from solar controller is 12 V, the DC converter was used to supply 5V DC to the ARDUINO.
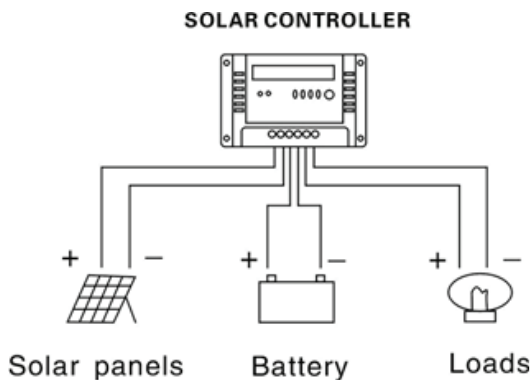
SOLAR CONTROLLER

Fig. 8. Solar controller to ARDUINO circuit

D. Model Design of MQ7 connect to ARDUINO

Fig. 9 shows the circuit of MQ7 to ARDUINO. GND on MQ7 connected to ARDUINO GND pin and +5V pin of MQ7 connected to +5V pin on ARDUINO. For the
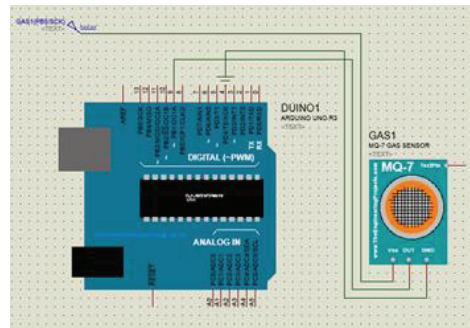
output pin of MQ7 DOUT connected to D9.

Fig. 9. MQ7 to ARDUINO circuit

E. Model Design of Buzzer connect to ARDUINO

Fig. 10 shows the connection of the buzzer. The positive pin of buzzer was connected to D8 on ARDUINO while GND pin is connected to the ground. When the buzzer is in operation mode, it will use source from ARDUINO through D8 pin on ARDUINO.
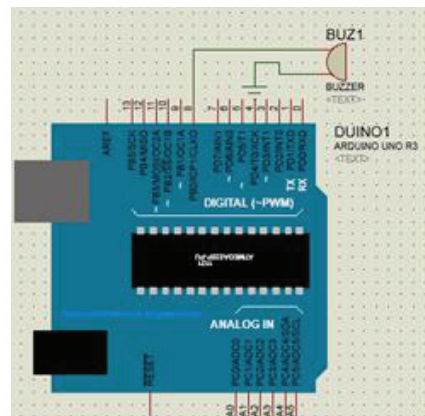

Fig. 10. Buzzer ARDUINO circuit

F. RTC as an input

RTC is dependent on time and it is processed by the ARDUINO to define the output. The results for the school session is shown in Table I. The outputs are the assigned ring for the bell and an LCD screen to show the time and date.

TABLE I
RESULTS FOR RTC IN THE MORNING

Time	Output	
	LCD	Bell
7.30am	Shows current time and date	Bell rings 2 times with 1 second gap
8.00am	Shows current time and date	Bell does not ring
8.30am	Shows current time and date	Bell rings 2 times with 1 second gap
9.00am	Shows current time and date	Bell does not ring
9.30am	Shows current time and date	Bell rings 3 times with 1 second gap
10.00am	Shows current time and date	Bell does not ring
10.30am	Shows current time and date	Bell rings 2 times with 1 second gap
11.00am	Shows current time and date	Bell does not ring
11.30am	Shows current time and date	Bell rings 2 times with 1 second gap
12.00am	Shows current time and date	Bell does not ring
12.30 pm	Shows current time and date	Bell rings 4 times with 1 second gap

From the table, the LCD will continuously show the date and time. At 7.30am, 8.30am, 10.30am, and 11.30am the bell ring 2 times with a gap of 1 second for class session. At 9.30am the bell ring 3 times with a 1 second gap for the breakfast time. At 12:30pm, the bell rings 4 times to inform that school session has ended.

G. MQ7 as input

For MQ7 as input, a programming was constructed to make the MQ7 sensor continuously monitor the condition of surrounding air. When the sensor detects an occurrence of smoke, the input triggers the bell. From Table II, when MQ7 detects smoke, the bell will ring without gap till the smoke disappears. The LCD will display date and time. If smoke is not detected by smoke sensor, the bell does not ring and LCD displays date and time.

TABLE II
RESULTS FOR MQ7

Time	Output	
	LCD	Bell
Smoke detected	Shows current time and date With FIRE message	Bell rings without gap
No smoke detected	Shows current time and date	Bell does not ring

Conclusion

This work describes the design model of automated solar powered bell system integrated with fire detection, which its usage is highly recommended in educational institution particularly in schools. This system model designed to trigger bell during prescribed interval hours in the morning session. On the other hand, the design also includes a smoke sensor integrated with the bell system which triggers the bell during a fire outbreak. This designed bell system is operated by solar energy and it is independent from main power supply, hence, the system is uninterrupted during power supply failure from a main source. Since it is generated from solar energy, thus, the energy can be used efficiently during day time and stored energy in the battery can be utilized during night time. This model system is recommended to be installed in rural schools as power supply is the main constraint. This designed system which also consists of the bell system with smoke detector integration enables to safeguard the institution from damages and losses particularly during an outbreak of fire.

Acknowledgements

References

[1] Siddharth Singh, *How long will fossil fuels last? Business Standard, September 23, 2015*. [Accessed on 6 June 2018] Available from World Wide Web: https://www.business-standard.com/article/punditry/how-long-will- fossil-fuels-last-115092201397_1.html

[2] International Energy Agency (IEA). Beyond Kyoto: Energy dynamics and climate stabilization. Paris: OECD/IEA; 2002.S. Bilgen et al. / *Renewable and Sustainable Energy Reviews 12 (2008) 372–396 393*

[3] Lee R. Environmental impacts of energy use. In: Bent R, Orr L, Baker R, editors. *Energy: science, policy, and the pursuit of sustainability. Washington:* Island Press; 2002. p. 77.

[4] Wolfson R, Schneider S.H. *Understanding climate science. In: Climate change policy: a survey.* Washington: Island Press; 2002. p. 3–52.

[5] Ohize,H.O., Onwuka, E.N. and Ibrahim, A. *Design of Microcontroller-Based Automatic School Bell, AU J.T. 15(2): 121-128 (Oct. 2011)*

[6] Uddin,S.N. , Nawaz, M.O. Raj , T.K and Rasool, S.M, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,* Automatic School Bell with User defined Time Schedule, *Vol. 6, Issue 2, February 2017*

[7] Agarwal, T. *Microcontroller Based Project on Automatic Bell System for Schools,* [Accessed on 6 June 2018] Available from World Wide Web: https://www.elprocus.com/microcontroller-based-project-on-automatic-school-bell-timer/

[8] Automatic Bell System for Institutions, Edgefixkits & Solution [Accessed on 6 June 2018] Available from World Wide Web: http://www.edgefxkits.com/blog/automatic-bell-system-institutions- applications/

[9] Choudhary,S., Shrikant and Sharma , P. Automatic college bell system, *International Journal of scientific research and management (IJSRM), Volume 2, Issue 3, Page 668-673 ,2014.*