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Design of Load Control System Using DTMF

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Abstract. In agricultural sectors, one of the problems faced by the farmer is the water usage for watering schedule sometimes was wasted. With inefficient irrigation system, the water wastage could occur and resulting the excessive moisture for the soil and damaging the crops. The load control system in agricultural sectors especially for irrigation system is very important since it can affect the efficiency and the productivity of the operationsThe agricultural sectors also have many latest technologies implemented to the system such as irrigation system, temperature and humidity detection system and many other systems in order to operate efficiently so it can give profitable outcome. So, a desired load control system using Dual-Tone Multiple Frequency (DTMF) will be design for irrigation system in order to overcome the inefficiency of manual irrigation system. By using DTMF to control the irrigation system, it will consume less time and it can be control in a wide range. Firstly, by using Arduino IDE software, the coding for this control system is written with C++ language. Then, it will be compiled to make sure the coding working without any errors before it is uploaded into the Arduino Uno board. The coding will then be uploaded by connecting the Arduino Uno board to the computer via USB. Next, the schematic layout design of this control system will be simulated using Proteus 8 and Fritzing software. After the simulation of the circuit is successful, the construction of the hardware will take place. The hardware of this load control system that be assembled first is connecting the cell phone to the DTMF decoder by using 3.5mm jack. Then, from the DTMF decoder it will be connected to the Arduino Uno board. The 4 channel 12V relay then connected to the output port of the Arduino Uno. In conclusion, this irrigation control system works when the user sent the signal using cell phone and it will be received by the other cell phone that attach to the DTMF decoder

1. Introduction

Nowadays, most of the application or a system are control and work wirelessly. This can increase the productivity and efficiency of the system with less time consumed and also less manpower needed. In agricultural system, manual system sometimes may contribute to many problems such as inefficiency of the operation. The basics idea behind this project is to control the functioning of agricultural load using wireless technology. The wireless technology that will be apply into this project in Dual-Tone Multiple Frequency (DTMF).

With the presence of DTMF in the load control system, the agricultural load can be control from a distant by simply making a phone call [1]. The DTMF decoder the decode the input signal from the phone call and channel it to the Arduino Uno as the microcontroller [2]. From the Arduino Uno, it will control the outcome of the load control system. The agricultural sectors play a huge role in the society such as the production of foods and export activity of the product. In the agricultural sectors, the usage

of tremendous amount of water are frequently concerns many parties. This is because in Malaysia there is a certain time when drought occurs, it will affect the watering schedule for agricultural crops. So, with an inefficient manual irrigation system, the water wastage could occur and it is also consumed lot of time and man force. The evolutions of technology in the agriculture sectors able to solve many problems hence, it can increase the efficiency of operation and the productivity of the agricultural product. The implementation of the technology in load control system helps to control various load in agricultural fields. With this advance technology, a load control system using Dual-Tone Multiple Frequency for irrigation system can be design.

2. Methodology

This project will focus on the software simulation using Arduino IDE and Proteus then developing hardware part. From the combining hardware and software part, the result will produce. The Figure 1 shows the flowchart of operation of the load control system. It is known that this load control system can be controlled from a distant since it is control by simply making a phone call. This load control system was meant to control load in agricultural sectors such as water pumps and lamps since the case study is regarding those sectors.

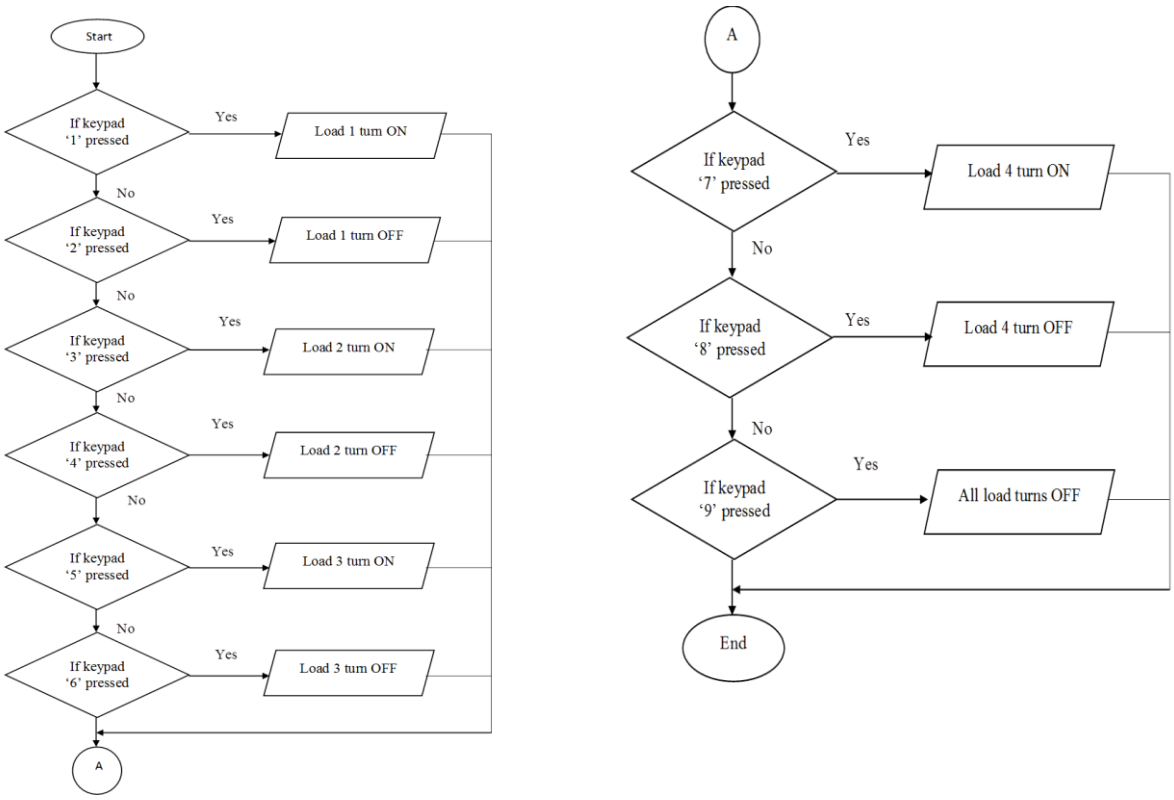

Figure 1. Operation flowchart diagram

This load control system can control up to four load which is mark as load 1, 2, 3 and 4. The working principle of this project is by pressing the keypad on the cell phone that act as the transmitter. Then, the signal will be received by the receiver phone that will trigger the Arduino Uno to turn ON the load. For load 1, keypad '1' is pressed to turn ON the load and keypad '2' to turn OFF the load. It is same to load 2, 3 and 4 as it is control by specific key as shown the flowchart. For safety purposes, if there any emergency or faulty happen to the load, all load can be turn OFF immediately by pressing the keypad '9' [3].

2.1 Block Diagram

Figure 2 show the block diagram of this project which is Load Control System using DTMF. This project is assembled with two cell phones, a DTMF decoder Arduino Uno and relay [4]. This is the model of a load control system. The first cell phone will transmit signal to the receiver cell phone. Then, the DTMF will decode the signal and send it to Arduino Uno to control the input and output.

The relay acts as the bridge between the microcontroller which is Arduino Uno and the load. Since, Arduino Uno can supply only 5 V, then an external power supply needed in order the load to operate. This load control system can be control by using a cell phone as the controller devices and can control more than one load. In order to give supply to the load, the system is connected with a single-phase system that mostly used in modern day domestics used [5].

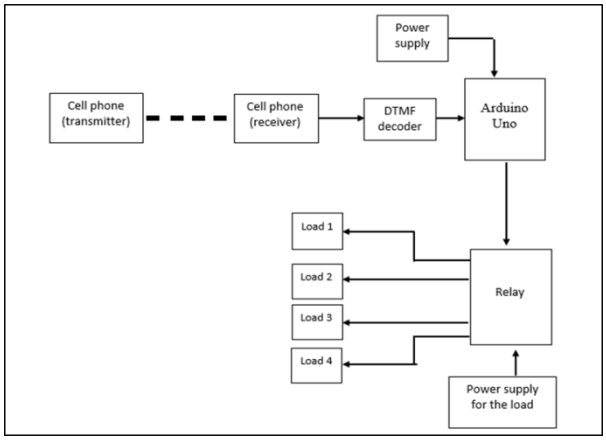

Figure 2. Block diagram of the project

2.2 Circuit design

Figure 3, show the design of the circuit using Fritzing software. The circuit of load control system using DTMF consist of Arduino Uno, DTMF MT8870 decoder, relay, and the load. The function of the DTMF decoder is to send input signal from the keypad in the cell phone to the Arduino [6]. Each key in the keypad has their own specific frequency so, the DTMF decoder is responsible to decode the signal from the keypad and sent it to the Arduino Uno.

The actual relay that be used in the project is 5V 4 channel relay that can control four loads. However, in this circuit design it is represented by single relay with a LED representing the load [7]. The relay present in the circuit can be described like a bridge between the microcontroller which is Arduino Uno and the load. The load for this project is water pump and lamp.

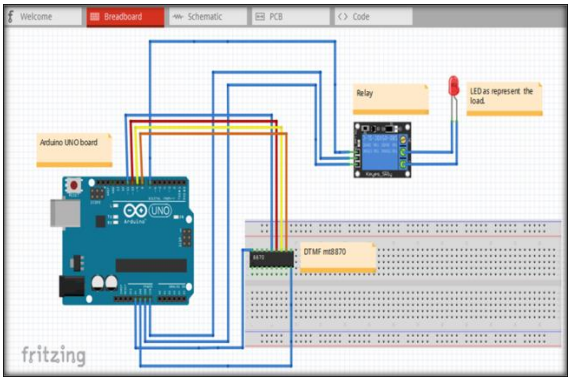

Figure 3. Circuit Design

2.3 Hardware construction

The construction of hardware includes the construction of single-phase supply system and assembling the single-phase system with the control system with Arduino. The single-phase system consists of a few components that have very specific function to make sure the safety of the load control system. The Figure 3.7 shows the components that have been assemble to form a distribution board. The major components are the main switch 32A, RCCB 40A and MCB 20A & 6A.. The main switch current rating used is 32A suitable for this load control system because the total load is not to large and exceed the current limit. The RCCB current rating used is 40A [8]. The incoming for this sing phase is 230 Vac. The wire used in the system has different colour to distinguish the wire connection. The black wire is for connection Neutral, while the red wire is for Life connection and lastly, the green wire is for Earth/Ground connection.

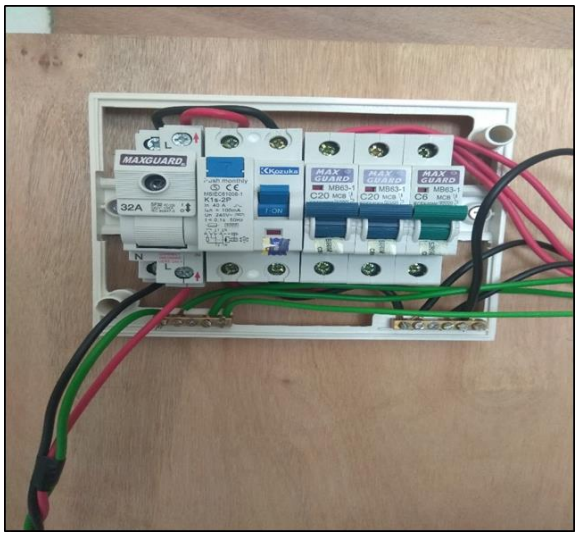

Figure 3. Distribution board

In order to give the power supply to the loads for this project, the selection of the circuit breaker also known as the Miniature Circuit breaker (MCB) must be selected carefully and the standard criteria must be followed according to Malaysia standard. The MCB is very important in this load control system because it will protect the loads if fault happen.

The Table 1 shows the specific current rating of the MCB according the suitable load that will be used [9]. For the project the load used is water pump and lamps. From the table below, it stated that the load that classified in motor type such as the water pump with 200W power must use the MCB with current rating of 20A. While for the lamps with 18W power, the current rating for MCB is 6A.

Table 1: MCB current rating selection

No	Type of load	Power (W)	MCB current rating (A)
1	Water pumps (Motor)	200 W	20 A
2	Lamps	18 W	6 A

After completing the selection of the main component such as main switch, RCCB and MCB, it can be proceeds with the installation of the load. It is important for the load to be connected with the 5V relay in order to control the load via Arduino Uno. The connection of the load relays must be the Life connection. The Figure 4 shows the connection between the loads and the 5V relay. It is noted that the relay act as the bridge between the load control system and the loads used in the project [10]. The working principle within the load and the load control system is the DTMF will send the signal to Arduino Uno weather to turn ON or turn OFF the load.

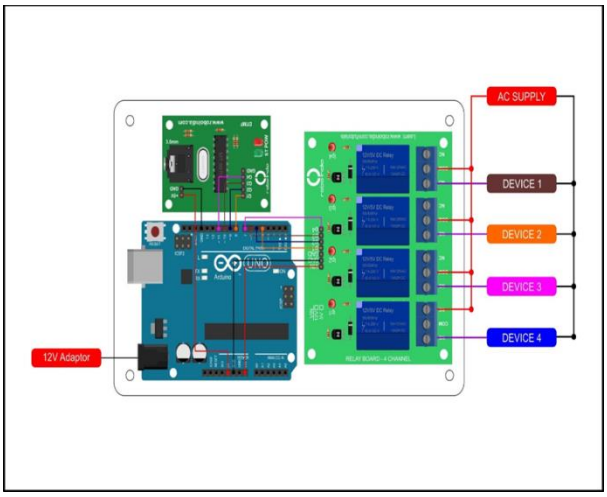

Figure 4. Distribution board

The final product of the project is shown in the Figure 5. In this load control system, it can be summarised that the load control system using DTMF is connected with the loads where the loads get supply from the single-phase AC system. The DTMF will received the signal from the transmitter cell phone, then DTMF module will sent the digital signal to Arduino Uno [11]. The Arduino Uno will control the loads weather to turn on or off with the help from the 5V relay. The load got the power supply from the single-phase system. For safety precaution, every connection by the wire must be make sure that it is tight to prevent risk and electrical hazard.

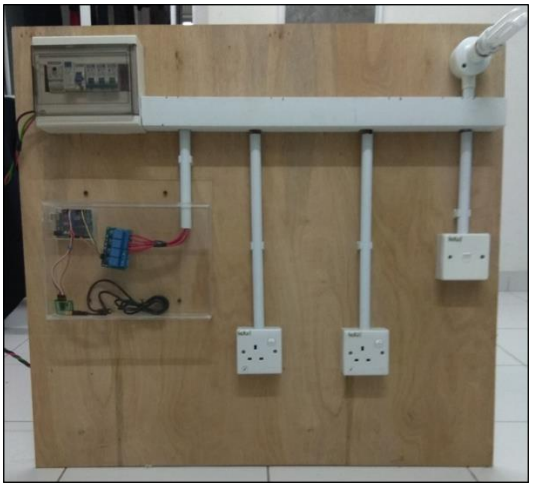

Figure 5. Distribution board

3. Simulation and hardware results

The hardware was simulated by connecting the power supply so that the load will function. The incoming voltage of the single-phase system is 230Vac. As stated in methodology, the load can be control by using cell phone by pressing the keypad that has been program in the coding. The Table 2 shows the output of the hardware when the keypad was pressed. This load control system can control up to four loads. Load 1 and 2 is for water pump while load 3 and 4 is lamp. To turn on the load 1, keypad '1' was pressed while keypad '2' was pressed to turn off the load 1. Same go with load 2, 3 and 4 as shown in the table below. For safety purposes, when key '9' was pressed, all of the load will turn off simultaneously.

Table 2: Key pressed and its output of the load.

Key pressed	**Load**	**Output from the load**
1	Load 1 (water pump)	Load 1 turn ON
2	Load 1 (water pump)	Load 1 turn OFF
3	Load 2 (water pump)	Load 2 turn ON
4	Load 2 (water pump)	Load 2 turn OFF
5	Load 3 (lamp)	Load 3 turn ON
6	Load 3 (lamp)	Load 3 turn OFF
7	Load 4 (lamp)	Load 4 turn ON
8	Load 4 (lamp)	Load 4 turn OFF
9	All load	All load turns OFF

To illustrate more clearly output and result of this project, the output load was analysed by taking its picture as the data for the results. For load 1 and 2, the table fan was used as the load to illustrate the water pump as it should be. While load 3 and 4, the 18W lamp was used as the load to analysed the output and result. The Figure 6(a) shows the load 1 when the keypad '1' was pressed. The table fan turns on and functions perfectly. The Figure 6(b) shows the load 2 after keypad '3' was pressed. The table fan turns on and works normally. For load 3, the lamp turns on and light up when keypad '5' was pressed as shown in Figure 6(c). It can be concluded that the load control system using DTMF function well.

a) Load 1 b)Load 2 c) Load 3

Figure 6. Result from 3 load

3.1 Test for distance range for the load control system

The fundamental component in this project is DTMF. It able to receive the input signal sent by the cell phone and decode the input signal before sent it to Arduino Uno for further control actions. It is aware that the load was control by cell phone (transmit and receive).

In order to test the distance range limit for the load control system, the test was done in a fixed location which is in UniCITI Alam Sg Chucuh. The input signal will be received in UniCITI Alam while the signal will be sent in four selected location around Perlis which is Padang Besar, Beseri, Kangar and Kuala Perlis, the furthest location tested is in Kota Bharu Kelantan. The distance of the location from UniCITI was measured as stated in Table 3.

Table 3: The location tested and its distance from UniCITI

Location	Distance from UniCITI Alam
Padang Besar	8.5km
Beseri	13km
Kangar	26km
Kuala Perlis	40km
Kota Bharu Kelantan	433km

4. Conclusion

In conclusion, the objectives of this project were achieved. The first objectives of this project were to design a load control system using DTMF for irrigation system. The load control system was designed by using DTMF. The load control system consists of a receiver cell phone, a DTMF decoder that will decode the input signal from the cell phone, the Arduino Uno board, 5V relay and the water pump and lamp as the load**.**

The second objectives are to develop the load control system with a single-phase supply system. The single-phase supply was designed and developed in order to give supply the power to the required load. This kind of system could be applied not only in agricultural field, also can be implied for home automotive and industrial field.

For the third objective, the load control system using cell phone as the control device was designed. For this project, two cell phones were used, one was for transmitting the input signal and another cell phone that be attached to the DTMF decoder will received the input by using cell phone as the controller devices, the can be control in a wide range.

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