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Smart Home Controller for Household Electric Appliances

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Abstract

This article involved the smart home controller. It was designed to cater to individuals who have a passion for technology and seek convenience in their daily lives. It also aims to empower individuals with disabilities by enabling them to independently perform tasks, thanks to the near-automatic nature of commands and operations. Everything has been approved. The main components can be categorized into two parts: the microcontroller control circuit and the electrical equipment control circuit. The working principle revolves around the use of a relay as the primary device. In general, the system operates by having the microcontroller respond to a signal from a push-type switch. Whether it's connected to the control box or controlled through a switch in the Visual Basic window, the microcontroller will process and transmit the output signal in two ways: sending the signal to the Visual Basic program to turn on the LED indicating the status. And the alternative method will be transmitted to the control circuit to activate the relay.

Keywords: Smart Home, Controller, Visual Basic, Relay Control Circuit

1. Introduction

In today's modern era, computers have become a common fixture in almost every household. Many individuals utilize it for a variety of purposes. However, there are many individuals who purchase computers primarily for entertainment purposes such as watching movies, listening to music, and playing games. It varies based on how satisfied the buyer is with the various objectives. With the rise of computers, new tools were developed. To further enhance the capabilities of computers for increased usage. This project aims to further enhance the capabilities of computers.

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In today's fast-paced world, people are constantly racing against the clock, spending countless hours in front of their computers at home or in the office. It can be challenging to find time for other activities amidst the demands of this digital age. You have the ability to manually control the lights and water the plants. We understand the significance of individuals with mobility limitations who desire to engage in independent activities while at home. However, if there were only a computer and a few devices connected to it. I can easily handle tasks like turning on and off lights, among other things.

An innovative home design called a "smart home" enables the convenient remote control of gadgets and appliances from anywhere using a smartphone or other networked device [1]. Smart homes offer a range of impressive features, including advanced security, remote monitoring capabilities, a smart environment, health tracking, and smart home appliances [2]. Various technologies are available for wireless home automation systems, such as GSM, Bluetooth, ZigBee, and Wi-Fi. [3]. Various technologies such as voice-activated assistants, sensors, programmable controllers, and wireless home automation systems work together to create a sophisticated automation system for smart homes. Energy management, security management, entertainment management, cooling management, and other automation system applications are commonly utilized in smart homes [2]. Ensuring seamless integration with the existing internet infrastructure for a wide range of smart devices poses a significant challenge [7]. An important barrier to home automation is the violation of smart home applications, such as unauthorized data collection, which can decrease user confidence and willingness to use it [8].

2. Control Circuit (Hardware)

To establish an automated control system for a smart home, it is necessary to have devices that can interface with a program known as Intelligent Electronic Devices (IEDs). These IEDs facilitate the various functions of the smart home. A smart home system requires hardware at the operational level and software at the operational or logical level. The hardware is a switching circuit capable of controlling the activation and deactivation of different devices solely by ON/OFF signal levels. The software is a user-friendly tool that features a graphical user interface (GUI) as follows.

2.1 Relay Switching Circuit

The equipment was built and assembled with the ability to be divided into multiple elements, including various electrical systems, relays, and relay driving circuits, which are crucial components of this work. A switch is employed to establish contact with the electrical current being supplied to the circuit. When selecting a switch, it's important to take into account the current that will pass through it, which in this case is 5 A, this rated current is suitable for household applications. Hence, the switch being utilized should have the capacity to endure a minimum current of 5 A. There is a wide variety of switches available. This project utilizes a press-on, release-off switch. A relay is a device that functions similarly to a switch, allowing for the interruption of electrical current. However, the usage characteristics vary. The circuit will be

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broken or connected by the relay when voltage is applied to the relay coil. When choosing a relay, it is important to consider the capacity of the relay contacts to handle the current. It's similar to choosing a switch. Considering the voltage required to operate the relay is crucial. The hardware component features a functional circuit, as depicted in Figure 1. The central component of this circuit is the 8051 Microcontroller, which functions as a data receiver and computer. Data transmission between the computer and other devices is facilitated using a serial connection. As previously stated, there is an MAX232 and a standard device that transforms data into signals based on the RS-232 standard for transmission to a computer. The configuration of this project allows for communication with the computer in the following manner: The baud rate is set at 9600. The communication protocol does not include any parity bits. It uses 8 bits for data transmission, along with 1 start bit and 1 stop bit.

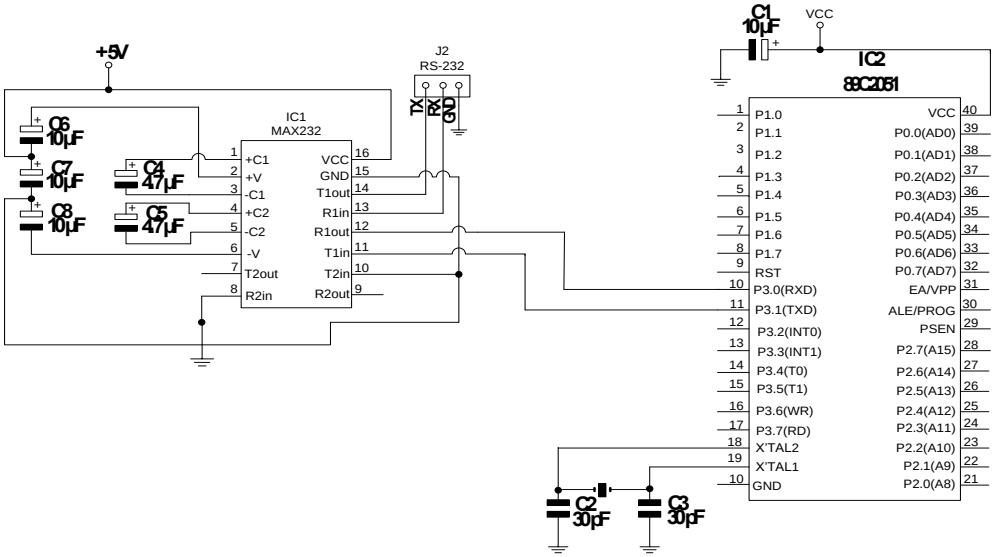

Figure 1. Functional diagram of the microcontroller board

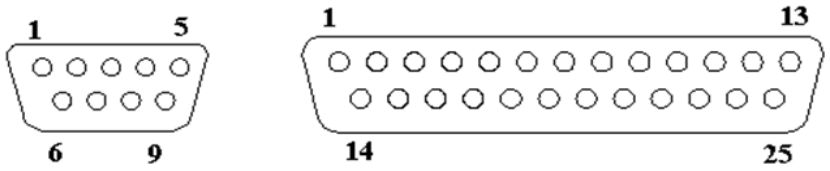

Figure 2. RS-232 connector diagram

Serial communication in computers has a reduced communication speed compared to parallel communication due to the fact that serial data transfer occurs one bit at a time, while parallel ports are capable of transmitting many bits simultaneously. Consequently, the pace of serial data communication is slower compared to parallel communication. Serial data transfer offers distinct

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advantages compared to parallel data transmission. Enabling the transmission of data across greater distances compared to parallel transmission. Furthermore, there is a reduced number of signal lines employed for parallel data transfer. The RS–232C standard is a specification intended to ensure compatibility between peripherals produced by various manufacturers. Various categories of standards are being created more frequently. The RS-232C standard, released in 1969 by the Electronic Industries Association (EIA), is the most popular and widely used standard. The RS-232C interface was originally developed to facilitate the connection between a terminal (DTE: Data Terminal Equipment) and a modem (DCE: Data Communication Equipment) during its early stages. This is to avoid the transmission of data on the same line. Equipment is divided into 2 types according to the RS-232C standard. There are two types of equipment: DTE equipment, which is used for sending data (output), and DCE equipment, which is used for receiving data (input). DTE connectors are typically male, while DCE connectors are usually female. The connectors utilized are D-Type, 9-pin and 25-pin as shown in Figure 2, and they are situated at the rear of the computer. Table 1 presented the pin list of D-type connectors. The voltage level varies between negative 3 volts and negative 15 volts. There will be a voltage level between +3 V and +15 V for Logic High and Logic Low. Data can be transmitted and received within a maximum cable length of 50 feet or 150 meters. However, if we aim to establish communication with distant devices, there are certain challenges to overcome. We can utilize additional devices, like a modem, to assist with our needs.

Table 1. Pin list of D-type connectors

D-Type 25 Pin	D-Type 9 Pin	Abbreviation	Name
Pin 2	Pin 3	TD	Transmit Data
Pin 3	Pin 2	RD	Receive Data
Pin 4	Pin 7	RTS	Request To Send
Pin 5	Pin 8	CTS	Clear To Send
Pin 6	Pin 6	DSR	Data Set Ready
Pin 7	Pin 5	SG	Signal Ground
Pin 8	Pin 1	CD	Carrier Detect
Pin 20	Pin 4	DTR	Data Terminal Ready
Pin 22	Pin 9	RI	Ring Indicator

Computers often talk to each other through serial communication. Basically, it's asynchronous data transfer. Both data must be sent over a single signal line as well as the part that controls sending data. All of this means that every bit of data read from serial transfer, they need to be set apart based on what they are used for. They can be separated into 4 parts as 1. Start Bit (size 1 bit), 2. Data bit (Data Character) (size 7 or 8 bits), 3. Parity Bit (size 1 bit) and 4. Stop Bit size 1 or 2 bits. There is a start bit, a data bit, a parity bit (with or without it), and an end bit in every character that is sent as a group. In order for two gadgets to talk to each other. Each device must work at the same speed. Bits per second are used to measure baud rate, which is the speed of

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asynchronous communication. For the RS-232C standard, the following serial connection speeds are available: 110, 150, 300, 600, 1200, 2400, 4800, 9600, and 19200 bits per second.

2.2 Graphic User Interface by Visual Basic (Software)

Because Visual Basic (VB) is a GUI-based computer language, making a graphical user interface is the first thing that needs to be done when making a VB app. Pogrammers need to add controls from the toolbox to the form and then set their settings in order to make a graphical user interface. As a control in its own right, the default form lets you change its settings before you add any other controls. The next step after adding controls to the form is to write code for each one so that it can react to events caused by the user, like when they click the mouse or press a key on the computer. Visual Basic is also an event-driven computer language because of this. See Figure 3 for an example of how the IDE will show the default form, the Solution Explorer window, and the form's Properties window when starting a new Visual Basic project.

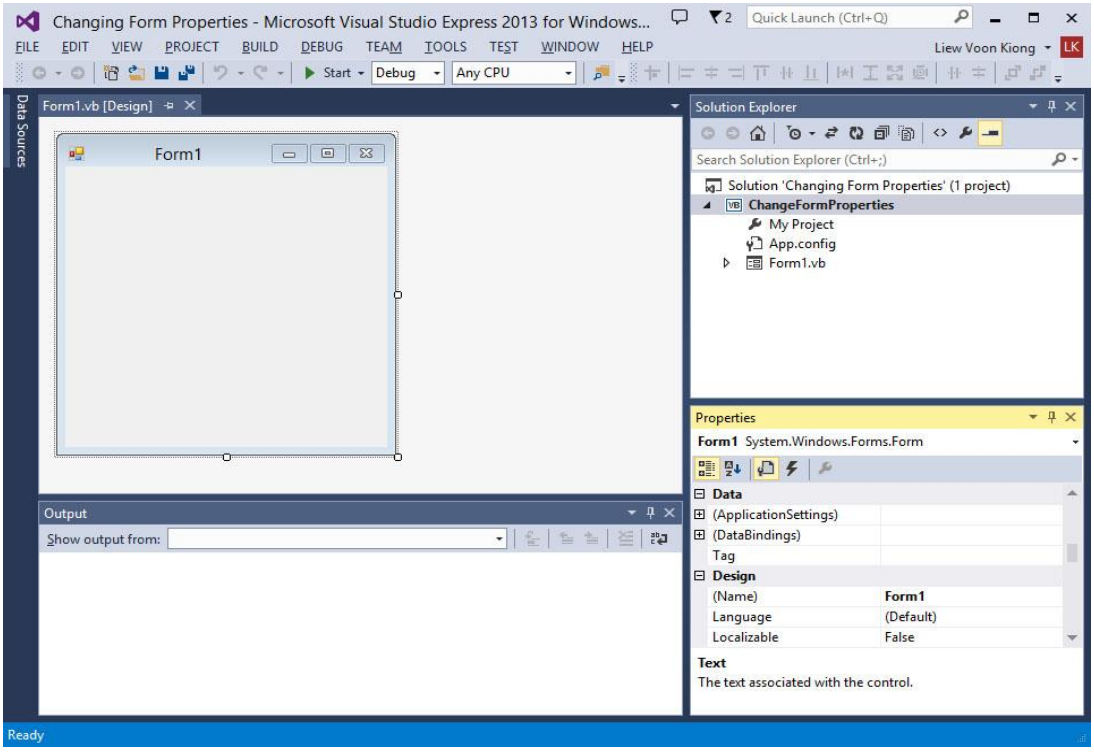

Figure 3. Default-Form on Visual Basic User Interface

The MSComm control, which is not a standard control, is the main one that lets Visual Basic talk over a serial port. So, to use MSComm, we need to add this tool to the Visual Basic window's Toolbox. To do this, right-click on the Toolbox and choose the Components menu, as shown in Figure 4. After that, the Components text box will show up. Then a phone icon will appear in the Toolbox. the icon of the MSComm control shows up so that it can be chosen.

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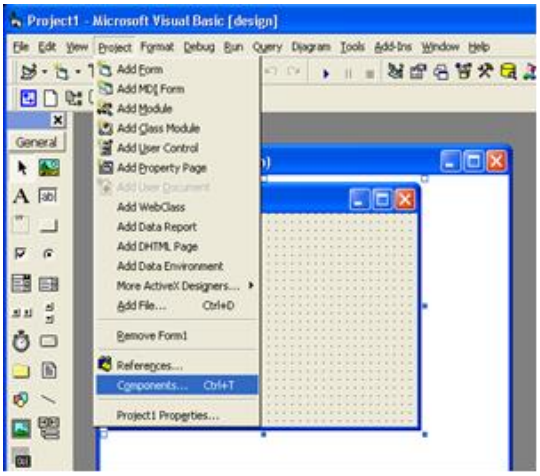

Figure 4. Adding the MsComm into Visual Basic User Interface Form

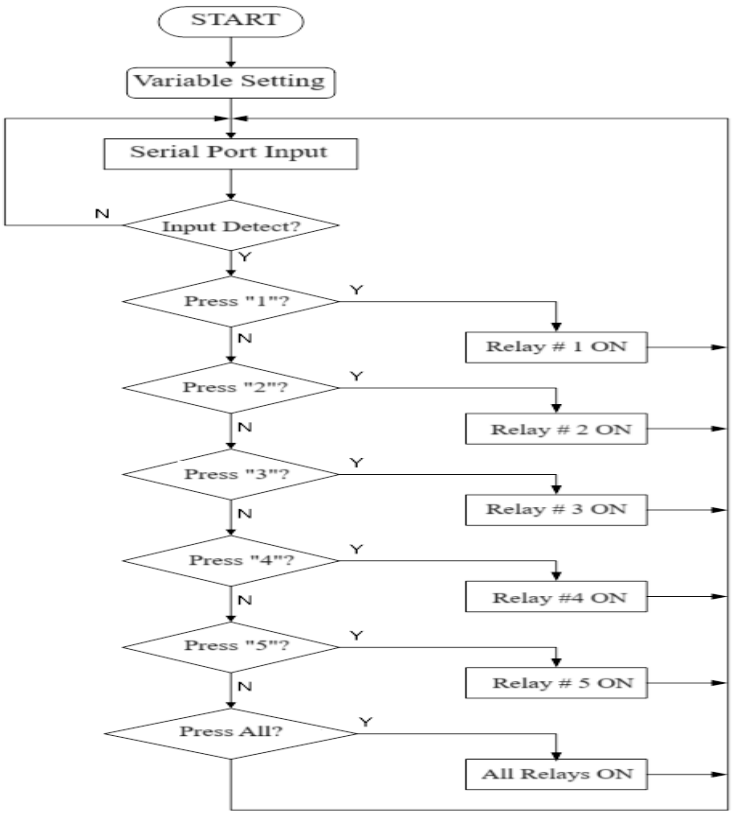

Figure 5. Relay Control Flow Diagram

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The microcontroller will process a set of orders that it gets from the computer. Figure 5 showed the flowchart of the input port scanning interfaces. The microcontroller then passes "high" logic through the port to drive the ULN2803 IC, which is part of the Eight groups of transistors in the ULN2803 IC are linked together to make a Darlington circuit. The base pin of each transistor is connected as an input pin, the collector pin as an output pin, and the emitter pin of the internal transistor to ground. So, when a logic "1" is sent to one of the pins, it is compared to the transistor being pushed at the base pin. And it will look like the output pin is linked to ground. This makes electricity move from the +12 V power source to ground through the relay coil and LED. Because of this, the switch moves from normally closed (NC) to normally open (NO), and the LED turns on. It shows which relay is working at the moment. Every diode that is linked across the relay coil stops the reverse current from making the magnetic field of the relay coil grow or shrink.

The UL 280 has been filled out. We use 5 relay outlets in this project. Port 1 is used by the processor. All of the ports except for P1.0, P1.6, and P1.7 are used as ULN2803 receivers for relays. Each one has its own name. Once the microprocessor gets the information, it processes it and then sends a signal to ULN2803 telling it to turn the relay on or off. The project's power source must come from a 9-volt transformer. The circuit can accept the transformer without worrying about its orientation because diodes D1–D4 are already set up in a rectifier circuit. as it goes through the rectifier circuit The coils of the 5 switches are powered by this voltage. It is also fed into the microprocessor and the ULN2803 IC.

3. Results

The work presented here has two parts: 1) hardware that connects electrical devices by receiving commands from software and 2) software that is written using Visual Basics. The hardware kit is designed to interface with a microcontroller. The control device is made up of a DC relay that is driven by a logic signal from a microcontroller, making the circuit very simple. Writing control commands will also be easy.

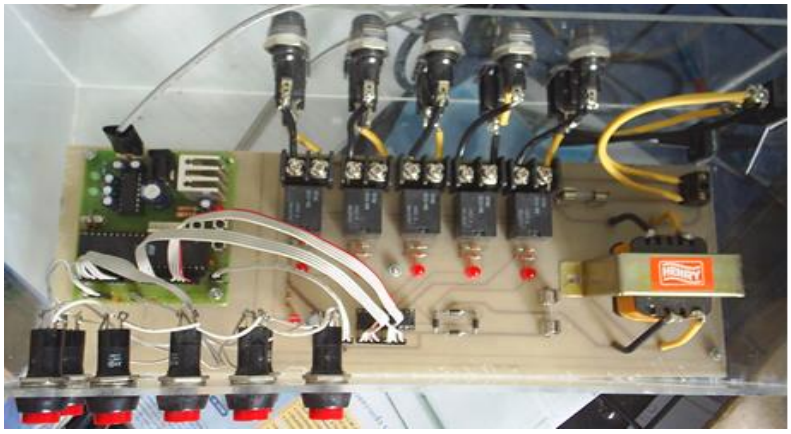

Figure 6. Relay Control Circuit Hardware Kit

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3.1 Hardware Kit

An overview of the equipment that connects to external devices is shown in Figure 6. It is a device that is equipped with 5 relays, able to control up to 5 sets of equipment. The resulting relay is a direct current type. The relay coil voltage rating is 12 V and can withstand an output current of 5 A. The rating chosen is low because the equipment used as household electrical appliances has a low power rating. Therefore, using only this current rating is sufficient. Figure 7 shows the details of the relay circuit diagram in Figure *6.* It should be noted that the number of relays in the circuit is five. It can be extended to have the maximum of eight relays as they occupy all the pins of an 8-bit digital port. Moreover, the designed printed circuit pattern is shown in Figure 8.

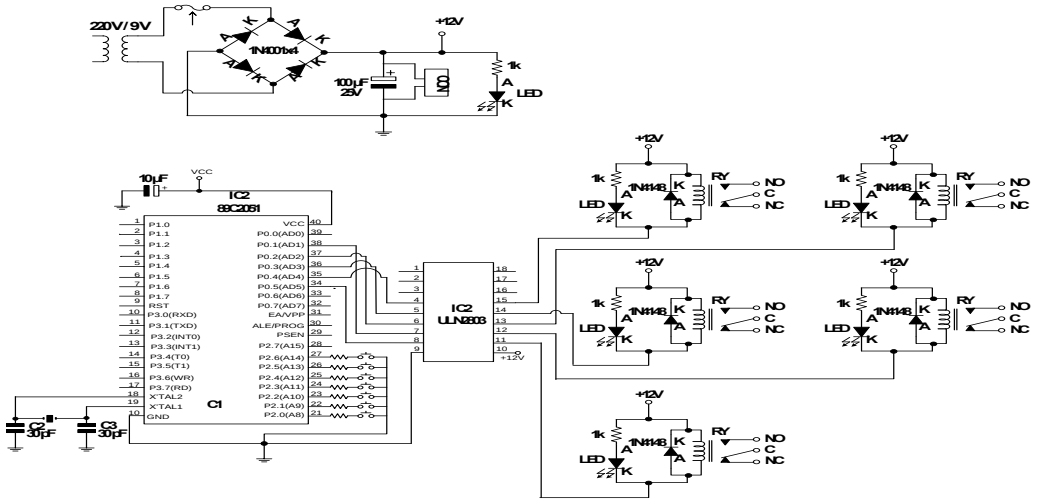

Figure 7. Relay Control Circuit Detail

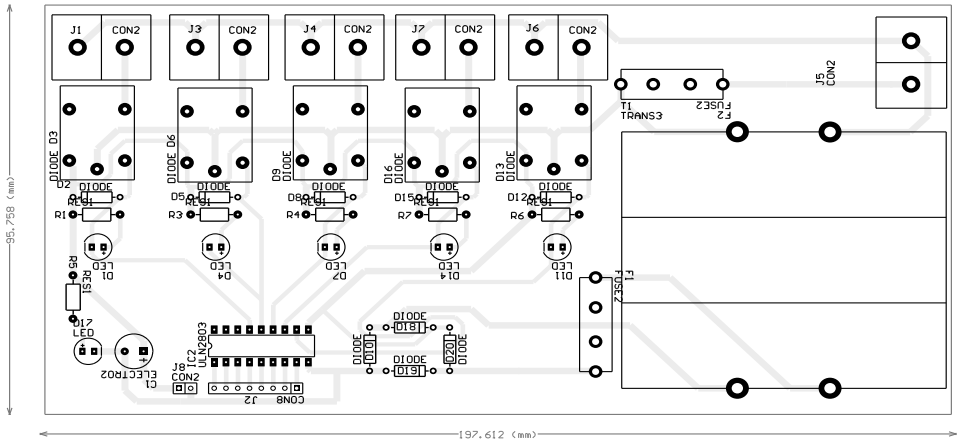

Figure 8. Relay Control Circuit Detail

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3.2 Visual Basic GUI

Programming to control equipment is designed to work in two modes: 1) Manual Mode and 2) Automatic mode. Two ways can be used to control something by hand or so-called "Manual Mode", but both will lead to the same results. In the first method, the device controlled by pressing the switch on the control box. The second way is to tell the program from the computer. That is a window that is already set up to work. A person in charge can press a fake switch on a GUI screen instead of the real switch on the control box. An LED will also show to indicate that the associated device is working. The GUI screen is depicted in Figure 9.

Figure 9. GUI for Device Control

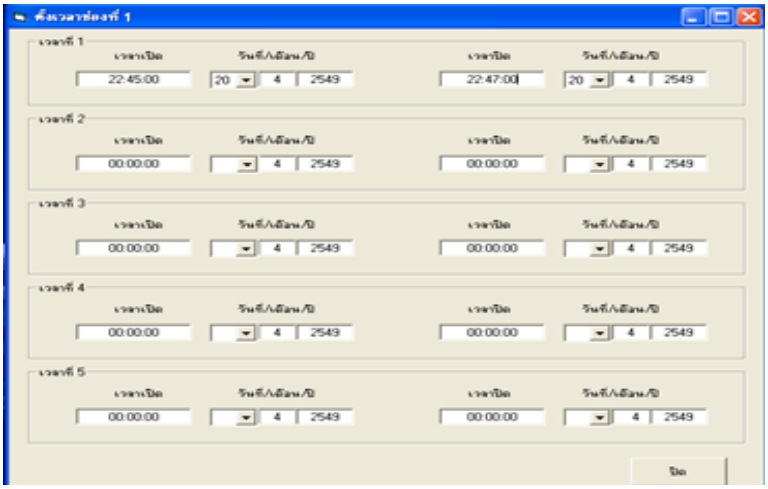

Figure 9. Pop-up Windows for Timers' setting

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Pressing the timer button starts work in automatic mode. Later, a screen like Figure 9 will show up with a timer that can be set to go off and on for up to 5 times.

4. Discussion

Through comprehensive device testing, it was determined that each gadget functions as intended and aligns with theoretical expectations in all aspects. They exhibit effective collaboration in the experiment, where commands are issued in the computer through the programmed software, and subsequently, the computer transmits the values to the microcontroller board for processing. The outcome will be directed to Output ports P1.1-P1.5, which will thereafter transmit signals via IC ULN2803. This integrated circuit filters the signals and decides the functioning of the relay. Upon arranging the devices and establishing a timer or giving a direct instruction, it was discovered that the program executed the commands successfully. After conducting extensive tests on the semi-automatic control system, it has been determined that it performs exceptionally well. This can be attributed to the seamless interaction between the Visual Basic program and the microprocessor component, as well as the essential utilization of relay properties. It serves as a connection point between low voltage and high voltage. This relay has the potential to be incredibly versatile and serve a wide range of purposes. With these features, the control system can be developed and seamlessly integrated into factories, functioning just like a PLC. The project creator is hopeful that in the future, individuals will continue to advance this system and desire its continued characteristics. This is a highly automated process. And this project aims to create a device that can assist individuals with disabilities. For individuals who are unable to leave their bed or elderly individuals who are home alone, there is a desire to engage in activities without having to physically move from their seat.

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