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Automatic Sequential Switching Using Programmable Switching Control

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ABSTRACT: Industrial process control is a very important issue in the age of industrialization. Various process control techniques can be used to improve the product quality and efficiency of the industrial process control. Programmable Switching Control (PSC) using PIC microcontroller is a simple microcontroller-based project that performs a sequential switching of load with programmable timings for repetitive work load. This operation is generally used for repetitive nature of work, electrical load controlling system is a reliable circuit that takes over the task of switch on/off the electrical loads with respect to time. In this project we demonstrate the working of this simple operation using a microcontroller of PIC family. The development of this application requires the configuration of the program through input switches. Microcontroller is programmed in such a way that the loads a can be operated in two modes: Auto mode and Manual mode. In Auto mode, through timers, the machinery/application/load works based on input time set by the user and finally in the manual mode it functions while respective switches are pressed depending on the user's need and flexibility. All the modes and operations of loads are displayed on an LCD.

KEYWORDS: Programmable Switching Control, PIC Microcontroller, repetitive work load, sequential switching.

I.INTRODUCTION

The importance of automation in the process industries has increased dramatically in recent years. In the highly industrialized countries, process automation serves to enhance product quality, masters the whole range of products, improves process safety and plant availability, and efficiently utilizes resources and lower emissions. Industrial Process Control addressed in plays an increasingly important role in enhancing the betterment of daily experience as well as the global economy.At present, for companies the purpose of automatic process control has shifted from growing productivity and reducing costs to broader issues. Process control ensures that the plant assets continuously operate predictably within the most profitable range, leading to a greater output of consistent products, reliability, yield and quality using less energy [1] in any modern industry which wants to face the challenges of increasing globalization and competitiveness in the production processes of their business successfully. The main advantages of automatic process control are replacing human operators in tasks that involve hard physical or monotonous work, replacing humans in tasks that are to be done in dangerous environments (i.e., fire, space, volcanoes, nuclear facilities, underwater, etc.), making tasks that are beyond human capabilities, such as, handling too heavy loads, too large objects, too hot or too cold substances or the requirement to make things too fast or too slow, Improvement of Economy: Sometimes and some kind of automation implies improvements in economy of enterprises, society or most of the humankind.[2]

Machines used in industrial automation are also capable of completing mundane tasks that are not desirable to workers. The advantages for a company when it comes to industrial automation. Automation technology, if used wisely and effectively, can yield substantial opportunities for the future. There is an opportunity to relieve humans from repetitive, hazardous, and unpleasant labour in all forms,and there is an opportunity for future automation technologies to provide a growing social and economic environment in which humans can enjoy a higher standard of living and a better way of life. Automated machines can be subdivided into two large categories, open-loop and closed-loop machines, which can then be subdivided into even smaller categories. Open-loop machines are devices that, once started, go through a cycle and then stop. Closed loop machines complete to the cycle described earlier then repeats it until it's stopped.[3]

A Process Control in continuous industrial production processes is a discipline that uses industrial control systems to achieve a production level of consistency, economy and safety which could not be achieved purely by human manual control. It is implemented widely in industries such as automotive, mining, dredging, oil refining, pulp and paper manufacturing, chemical processing and power generating plants. Now a control system in which the individual steps are processed in a predetermined order, progression from one sequence step to the next being dependent on defined conditions being satisfied, is a Sequential Process Control.[4]

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II.LITERATURE REVIEW

1. Jonathan Gana KOLO and Umar Suleiman DAUDA [5]
   This paper involves the design and construction of a programmable control timer, which is designed to count down a pre-set time to zero and trigger ON or OFF the output load. The programmable feature allows it to work with different time inputs and for this prototype the time does not exceed 999 seconds.
2. Md. Shahzamal, Mohammad Abu Sayid Haque,Md. Nasrul Haque Mia,Md. Anzan-Uz-Zaman Sardar,Masud Rana, Mahbubul Hoq, Fahmida Akter, Farhana Hafiz, Mahmudul Hasan, Institute of Electronics, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh.[6]
   Here they have proposed that the timers which can be configured to set time interval is called programmable timer. The programmable timer is usually designed with different functions that would be flexible to customize by the users.
3. Awadallah Sulieman Rahama, Dr. Dalia Mahmoud.[7]
   This paper shows that the system administrator of the Time Operated Electrical Appliance Control system has the ability to add or delete a different appliance and its operations and also the system administrator can add or delete user. The user can give instructions to existing device, get the status of a device and set the operation of a different appliance.
4. Mohammed Mynuddin, Mohammad Alamgir Hossain & Atiqur Rahman Chowdury.[2]
   They have used microcontroller as control technique for this process. The total system has three basic parts these are sensor, controller and actuator. All these sections operate in conjunction. The sensor senses different stages of the process and generates required sensing signals which are input to the microcontroller. Then according to the input signal and the program loaded in the microcontroller, the actuating devices are operated.

III.PROPOSED SYSTEM

The system proposes design and development of Microcontroller based programmable timer for supply control. Here a microcontroller based programmable timer with digital display system is developed that can be configured to connect the AC main line to the instruments for a specific time interval. The system proposes development of a Simple Programmable Switching Control. Timer is set and after timer count is over, trigger is given to the output relay. The device uniqueness is in its ability to switch ON an initially OFF load and at the same time switch OFF another initially ON load connected to it after a pre-set time. The system proposed in describes a system using PIC16F877A Microcontroller towards solving problem of electrical power wastage& lesser the usage of labour. The developed system involved the application of a
microcontroller to control the switching times of any electrical load/machine/appliances as desired by the users.

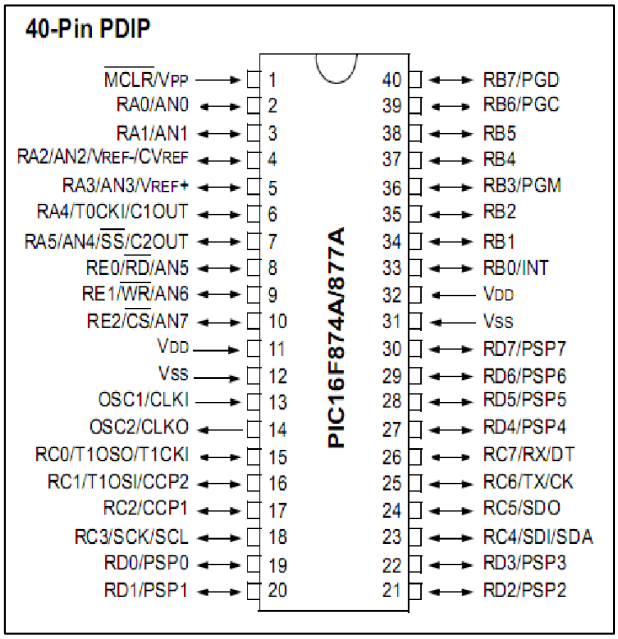

Fig. 1 Pin Diagram – PIC16F877A [10]

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As user pre-set or pre-defined the times for ON and OFF, the instructions are stored in the memory of the microcontroller for corresponding actions. In system a programmable timer for repeated work is created. It mainly consists of a push button, micro controllerunit, drivers and relays and LCD display. The user can set any of the time using push buttons. The settings are stored in the micro controller. The details are displayed in the LCD display. The timer switch controls the load to run for the particular period. Once the particular period is over, the switch automatically makes the load off. Four relays are used to drive output Load.

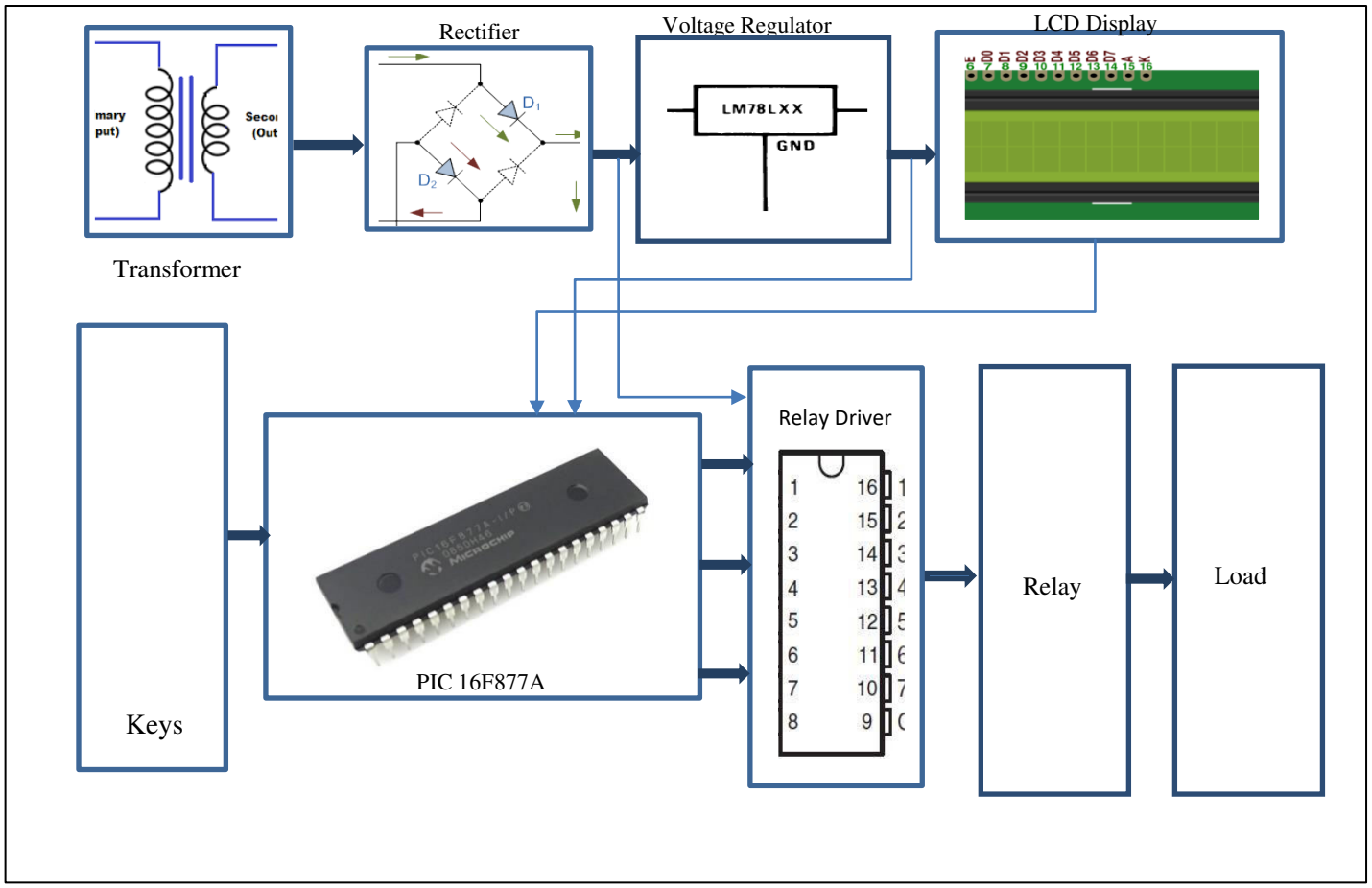

Fig. 2 Block Diagram

AC Plug-in supply is given to circuit from transformer which converts 230V AC to 9/12V AC, further this 9/12V AC is converted and produces a well filtered, variable +5VDC by rectifier& filter circuit and through voltage regulator. Here there are four push switches connected to enter the instructions to the microcontroller. According to program, here there are 2 modes 1. Manual mode, &2. Auto mode. The switch-5 is for set mode which is connected with RD5. When the switch is pressed, the operation of entering time begins, for entering time, switch (1-4) will be used for entering time for each load. The switch-6 is used for manual operation, each load will be operated when switch (1-4) is pressed. The switch-7 is used for auto mode, each load will work according to pre-determined program, which will be stored in microcontroller, starts timer and display's remaining time. After pushing this switch, the program transfer to timer configuration subroutine and start timer operation. Here LCD display feedback section is implemented. The relay board has a relay driver (ULN 2003A). The relays are controlled by the microcontroller and they are able to handle 230 V AC. A 16 × 2 LCD is displaying the status of the circuit and the load status all the time. The ULN2003A is a active high relay driver. 4 relays are controlled by this relay driver. Pin 1-7 are for controlling the relay from which 1-4 are being utilized for load.

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IV.FLOWCHART

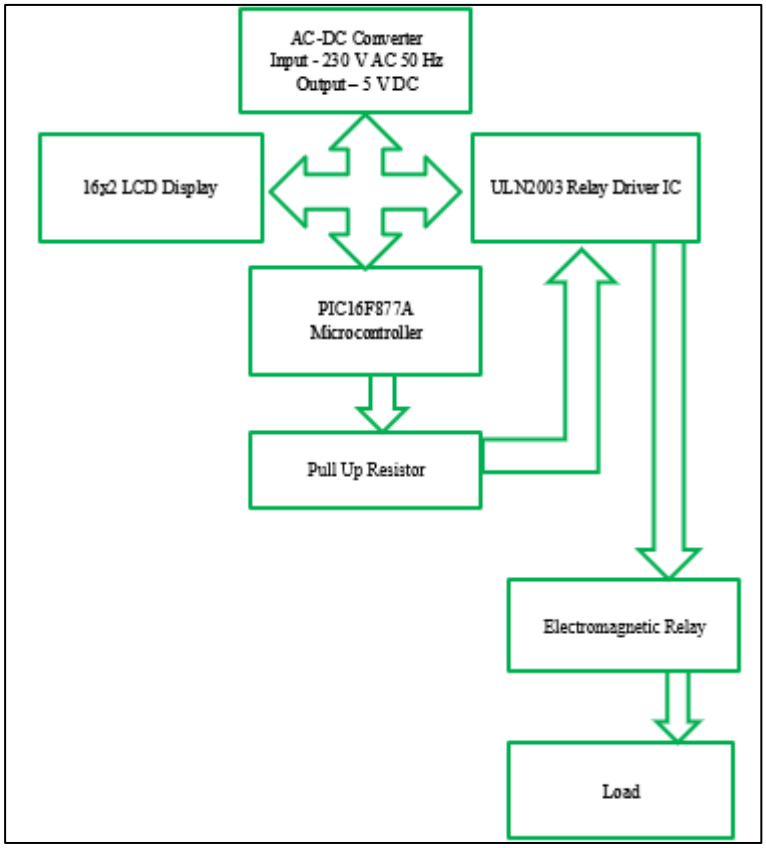

Fig. 3Flowchart

V. METHODOLOGY

A. Hardware

The components used in system are:

1. PIC16F877A: -PIC16F877A is a powerful easy-to-program, CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into a 40- or 44-pin package.It has 256 Bytes EEPROM data memory,self-programming and 2 nos of PWM.
2. Transformer: -The main source of power supply is a transformer and the maximum output power of power supply is dependent on maximum output power of transformer and determine power from its current and voltage rating.
3. Rectifier: -Rectifier is a circuit which is used to convert AC to DC and every electronic circuit requires a DC power supply, for rectification we have used four diodes.
4. Input filter: -After rectification we obtain dc supply from ac but it is not pure dc it may have some ac ripples and to reduce these ripples, we use filters and it comprises of two filters such as low frequency ripple filter and high frequency ripple filter. To reduce low frequency ripples, we use electrolytic capacitor and the voltage rating of capacitor must be double from incoming dc supply. It blocks dc and passes ripples to ground.
5. Regulator (LM7805): -The LM7805 is a voltage regulator that outputs +5 volts.Regulator is a device which provides constant output voltage with varying input voltage. There are two types of regulators:
    - Fixed voltage regulator.
    - Adjustable regulator.
6. Relay Driver–ULN2003: -The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads.

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7. 1N4007: -1N4007 is a PN junction rectifier diode. These types of diodes allow only the flow of electrical current in one direction only.
8. PICkit 3: -PICkit is a family of programmers for PIC microcontrollers made by Microchip Technology. They are used to program and debug microcontrollers, as well as program EEPROM. Some models also feature logic analyzer and serial communications (UART) tool.

B. Software

Software is a set of programmed instructions stored in the memory of stored-program digital computers for execution by the processor. Software requires the concept of a general-purpose processor - what is now described as a Turing machine - as well as computer memory in which reusable sets of routines and mathematical functions comprising programs can be stored, started, and stopped individually, and only appears recently in human history. Computer programmers had to provide long strings of binary code to tell the computer what data to store. Code and data had to be loaded onto computers using various tedious mechanisms, including flicking switches or punching holes at predefined positions in cards and loading these punched cards into a computer. With such methods, if a mistake was made, the whole program might have to be loaded again from the beginning.[11]

Different types of PIC MicrocontrollersCompilers: -

1. MPLAB XC8 C Compiler.
2. MPLAB XC16 C Compiler.
3. MPLAB XC32 C Compiler.
4. Mikro C PRO Compiler.
5. PIC CSS Compiler.

Different types of C compilers are available but there is not so much difference between all the compilers. If we talk about the back end generated machine code, then these are almost same but if we talk about their syntax in c language then these are quite different between each other. The switching of any user from one compiler to another compiler is not quite difficult. you just have to understand difference between libraries and syntax of these compilers.[12]

In this Project we have used Mikro C PRO Compiler for coding the PIC16F877A Microcontroller. the compiler is intended for writing programs for PIC microcontrollers in C language. It is provided with all data on internal architecture of these microcontrollers, operation of particular circuits, instruction set, names of registers, their accurate addresses, pinouts etc. When you start up the compiler, the next thing to do is to select a chip from the list and operating frequency and of course - to write a program in C language. The installation of MikroC PRO for PIC is similar to the installation of any Windows program.[12]

INTEGRATED DEVELOPMENT ENVIRONMENT FOR MIKROC PRO FOR PIC: -

PROJECT MANAGER- A program written in MikroC compiler is not a separate document, but part of a project which includes Hex code, assembly code, header and other files. Some of them are created during the operation of compiler, while some are imported from other programs.

CODE EXPLORER- The Code Explorer window enables you to easily locate functions and procedures within long programs. For example, if you look for a function used in the program, just double click its name in this window, and the cursor will be automatically positioned at appropriate point in the program.

PROJECT SETTINGS- This Option provides the user to parameterize and configure the device used in the Project. Selecting a Specific part number of Microcontroller, Setting up of Oscillator Frequency. . For the purpose of debugging, a software simulator can be used. In order to enable the compiler to operate successfully, it is necessary to provide it with basic information on the microcontroller in use as well as with the information on what is expected from it after the process of compilation.

CODE EDITOR- A Code Editor is a central part of the compiler window used for writing a program. A large number of options used for setting its function and layout can be found in the Tools/Options menu [F12].

SOFTWARE SIMULATOR-Prior to starting up the simulator, select the appropriate mode in the Project Settings Window (Build type - release) and click the Run /Start Debugger option.The compiler will be automatically set in simulation mode. As such, it monitors the state of all register bits. It also enables you to execute the program step by

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step while monitoring the operation of the microcontroller on the screen (i.e. simulation of operation). A few icons, used only for the operation of this simulator, will be added to the toolbar when setting the compiler in this mode.[13]

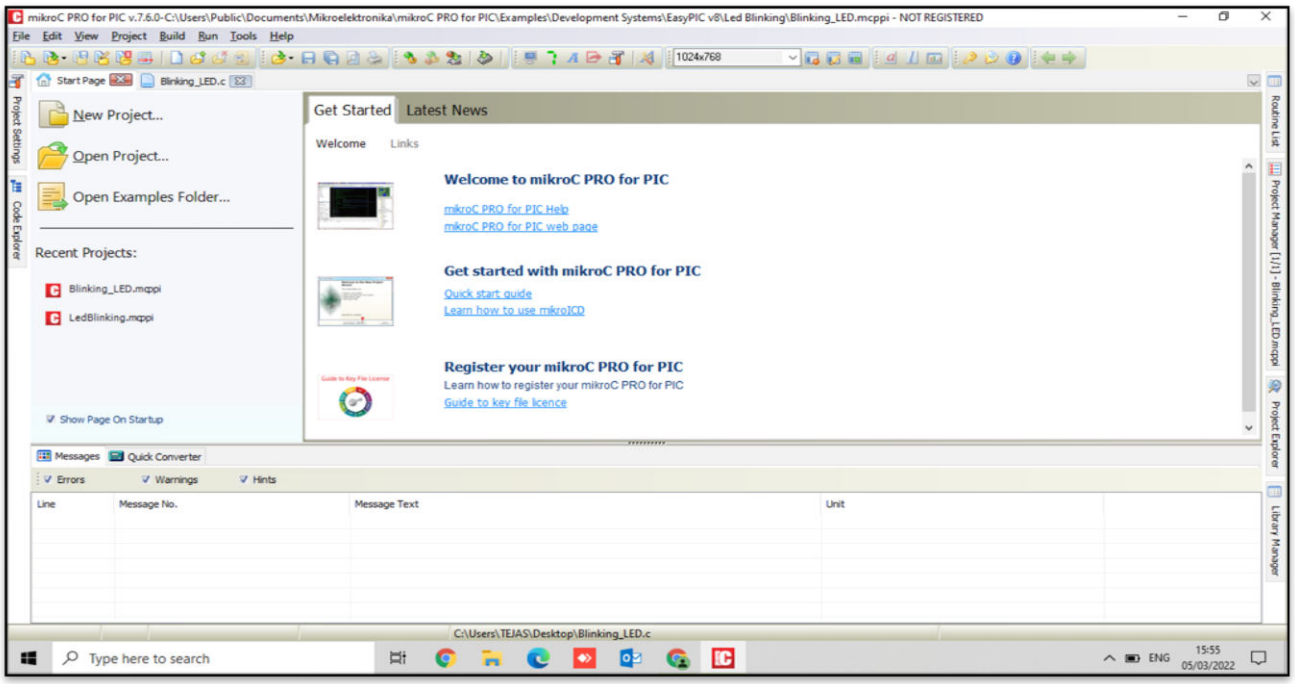

Fig. 4 mikroC PRO for PIC

VI.CONCLUSION

Controllers play an important role in every sector of work in any process. To carry out a process effectively, it is important to analyse the input and output parameters of a process. Controllers minimizes or eliminates the error in the process thus saving time and maximising the efficiency. Depending upon the complexity of the Process the controllers are selected on the basis of various technical and economic considerations. A PLC can be used to control a process but, the no of modules and cost involved limits the use of PLC for some applications. The use of Microcontrollers provides the user with various control features required for a Process by interfacing the components to Microcontrollers.

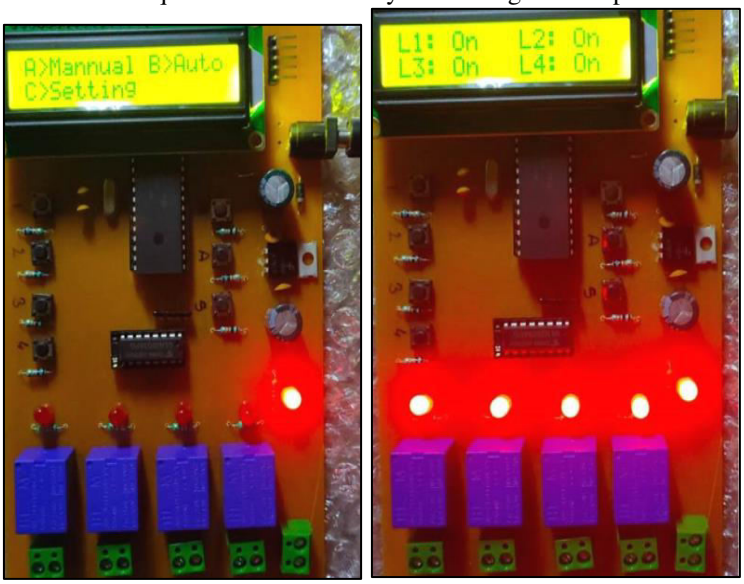

Fig. 5 Working Model

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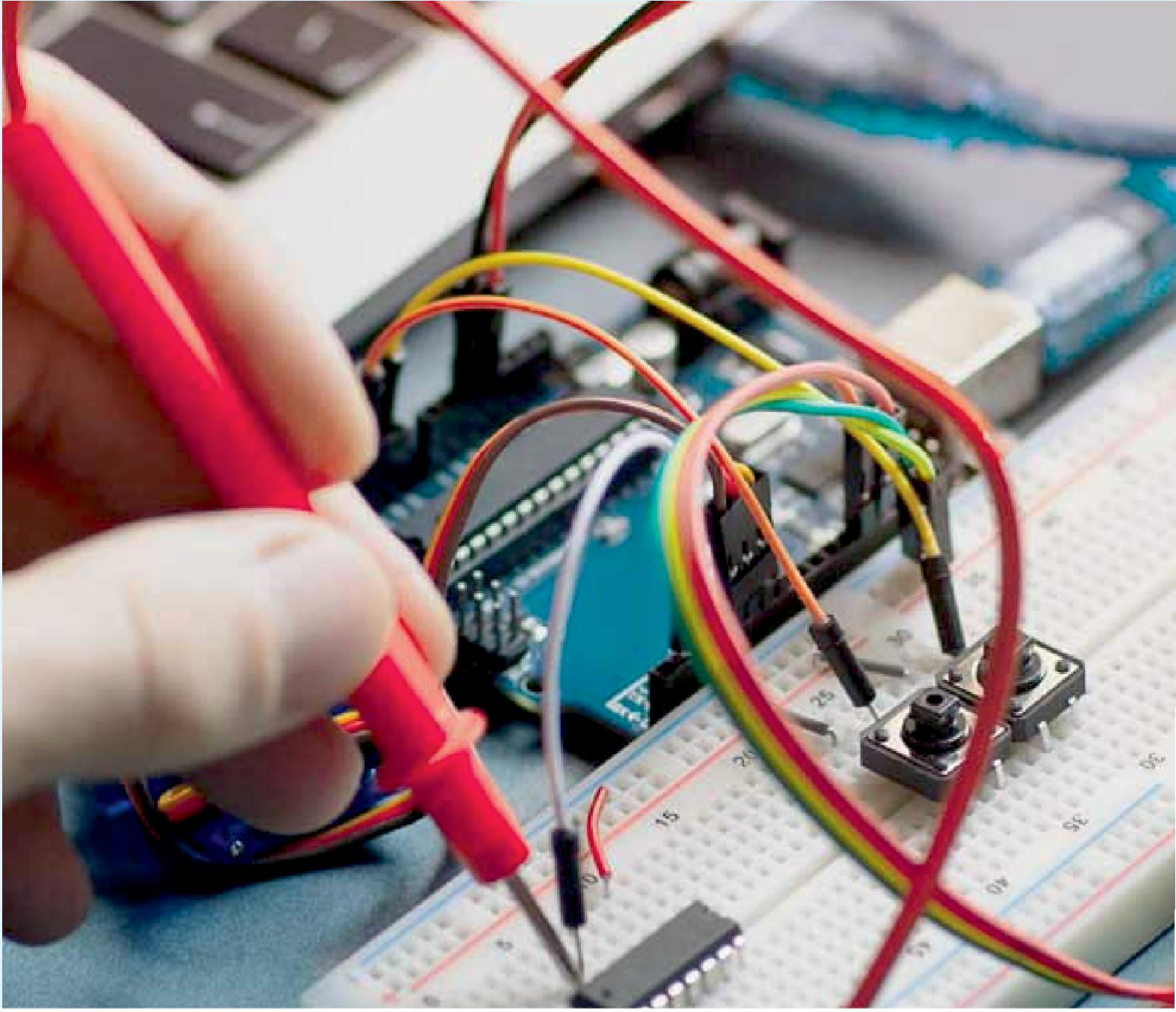

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