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PLC Based System Using Microcontroller for Industrial Application Based on Android Technology.

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***Abstract*—A Programmable Logic Controller (PLC) is a special computer which is used to automate industrial drives, machines and control the way they operate as per the programming. A modern PLC constitutes a microprocessor, sensors, actuators connected to input-output ports. However the space and power requirement of PLC is higher compared to a small microcontroller system functioning as PLC. Also in today's world, low cost wireless control of devices remotely has gained importance. This paper presents a concept of using an 89S52 microcontroller which acts as a small PLC for controlling industrial devices wirelessly through Bluetooth using Android application as an interface between the system and the user.**

***Index Terms*—PLC, single microcontroller chip, Blue Control Android Application, Bluetooth Module.**

I. INTRODUCTION

The advent of PLC was a major breakthrough in control system engineering. Be it any hardware industry, PLCs eliminated the use of control devices such as relays, cam timers, drums sequencers. Hence the industrial processes became faster and more reliable. But PLCs are suitable mostly for large scale industrial applications where space is not a major concern and the manufacturing processes are more complex. Our project aims to design a microcontroller system which works similar to a PLC for small and medium scale industrial applications. Also, this project can also be used for home automation application to switch the devices wirelessly. The Android platform has been used since Android has been in huge demand in the market and also because it is open source. Android is a software stack for mobile devices that includes an operating system, middleware and key applications and is used extensively for touchscreen mobile applications such as smartphones and tablets[1]. The Android applications are developed in Java and are run on virtual machine called 'Dalvik' created by Google. The Android SDK provides a set of tools for developing applications on the Android platform. The purpose of Android in our system is to send control signals from a smartphone to the system via Bluetooth.

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II. LITERATURE SURVEY

The proposed system of industrial automation can be thought of an extension of home automation concept and mainly emphasizes on the real time operation of different loads for different production processes. This is because every process is carried out by a machine which acts as a load being controlled. In addition to it, the system should be such that it reduces labor, saves energy, and improves accuracy, precision of the process thereby improving its quality.

In 1988 Waheed, M.A. ; Sethuraman, S.K. ; Deans, N.D. proposed the concept of using a single-chip microcontroller to control the devices in real time[3]. This idea is the backbone our project work. Also the wireless control of devices using Bluetooth was first proposed in 2001 by Lilakiatsakun, W. ; Seneviratne, A. wherein their work was limited to wireless home networking solutions[4]. Further in 2008, Wijetunge, S.P. Wijetunge, U.S. ; Peiris, G.R.V. ; Aluthgedara, C.S. ; Samarasinghe, A.T.L.K.[5] proposed a concept of sensing and controlling through Bluetooth which could control up to five devices situated at

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remote locations. An Application Programming Interface (API) was introduced as a software component to provide a development platform (for e.g. SDK) for a specific Bluetooth enabled application. Then Android platform came into picture when Annan Zhu ; Peijie Lin ; Shuying Cheng introduced their work on control of home devices using ARM microcontroller and GSM network[6]. But since we were developing a low cost, prototype model, we chose AT89S52 microcontroller instead of ARM. The ARM microcontroller could also be used in case when the complexity and memory requirements of the system increase. Our work combines the above mentioned proposals to develop a project which not only switches ON/OFF devices but does this with some extra features. This is because industrial applications need such a type of design. We have added two extra modes of operation to facilitate the common or separate allocation of time for each process. Also since it is just a prototype, we have used open loop control instead of closed loop. The closed loop system can be used for any one or all of the set of loads hence a separate monitoring system could be implemented for each load.

III. METHODOLOGY

A. Programming of Modes

The most important aspect of our project is the programming of microcontroller for operation of loads in different modes. The modes are programmed so depending on user's requirement. In our prototype project model, we have selected three modes which are as follows:

1) Auto mode: In this mode, all the loads are programmed to operate for a fixed time interval (say 15 seconds).When the command is issued to the microcontroller; it turns ON Load 1 for 15 seconds, then Load 2 for 15 seconds and so on.

2) Set mode: In Set mode, the user has the liberty to set different timings for each different load .For eg.Load 1 is to operate for 15 seconds, Load 2 for 10 seconds, Load 3 for 25 seconds and so on. Therefore the user can decide how much time he has to give for each process in an industry.

3) Manual mode: In this mode, the loads are controlled manually. Hence user can switch ON/OFF a load whenever he desires to do so.

B. Block Diagram

The Fig.1 depicts the block diagram of PLC based microcontroller system. The proposed system makes use of four bulbs as a set of loads. The loads are controlled wirelessly using Bluetooth through a smartphone having Android Operating system. A Bluetooth module is placed between the mobile phone and the microcontroller so that it receives command from the phone and issues it to the microcontroller. When a load is to be driven, a command is sent via mobile phone to the Bluetooth Module. The Bluetooth Module decodes the command and sends the required signal to the microcontroller AT89S52.The microcontroller will consider it as an interrupt on one of its pins. Therefore it will scan the program and accordingly send output command to the relay driver and the corresponding relay contact is closed to switch the load ON.

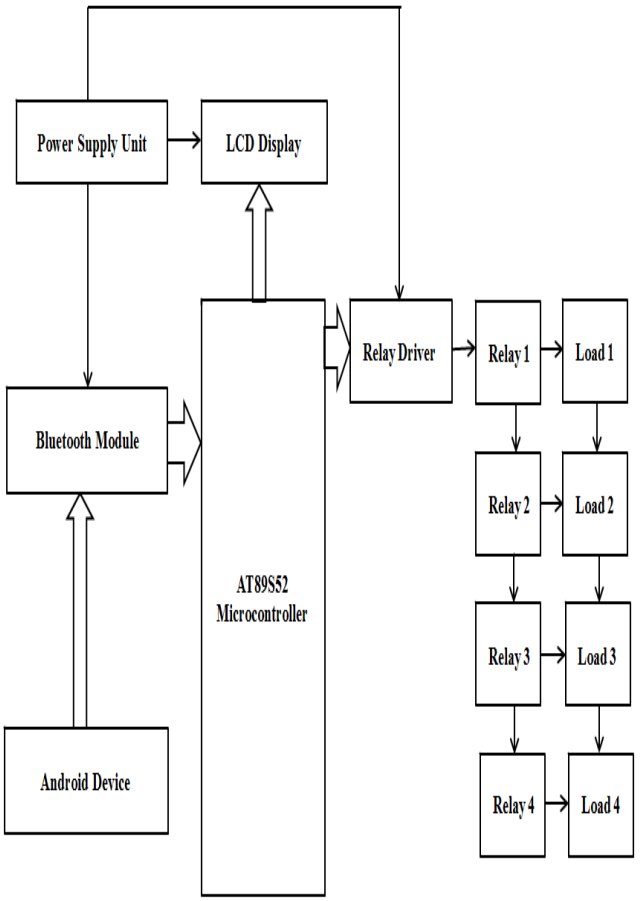

Figure 1.PLC Based Microcontroller System

Once the load is ON, it will remain so until the timeout occurs in Auto mode or Set mode. In Manual mode, a load continues to remain in particular state (ON/OFF) as long as it is not switched to another state by the user.

C. Implementation of the Proposed System

In this section, the details of the project circuitry and its working have been provided. There are various components which we have used to implement this system. The figures below are the snapshots of our project. Each section of the project has been separately explained.

Fig. 2 shows Bluetooth Module HC-05[7] which has been configured in slave mode. It establishes communication between the mobile phone and the microcontroller. It receives and decodes the commands sent by the phone and serially transmits the data to the microcontroller at a baud rate of 9600 bps. It uses two pins which are UART Txd pin (Pin 1) and UART Rxd pin (Pin 2) which are connected to Pin 11(Txd) and Pin 10(Rxd) of microcontroller respectively. This module operates in ISM band at a frequency of 2.4GHz.

Fig. 3 shows the LCD interfaced to the microcontroller [8]. The LCD is used for displaying the modes of operation to the user. The LCD used is a 16x2 LCD having green backlight Using LCD, we can also view the amount of time to be given to each of the loads before turning the system ON. The countdown for each load is also displayed on LCD which enables us to see the ON time remaining for a particular load.

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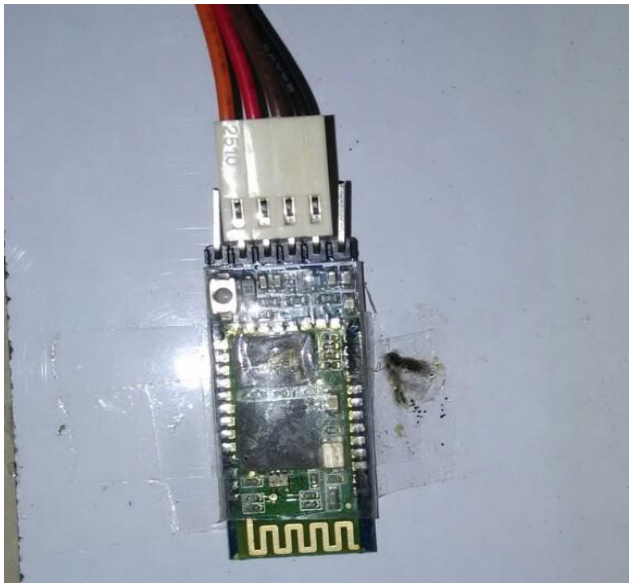

Fig .2 HC-05 Bluetooth Module.

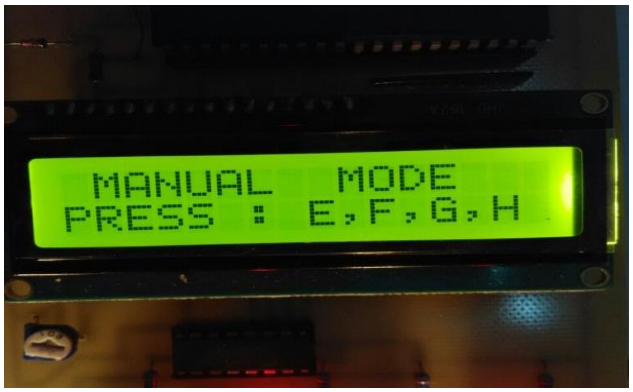

Fig .3 LCD indication of different modes.

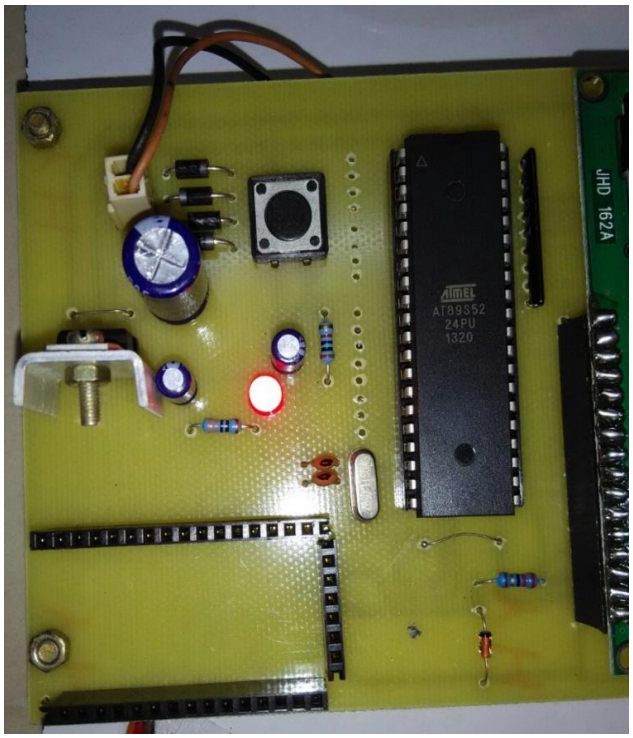

Fig .4 Controller kit with power supply.

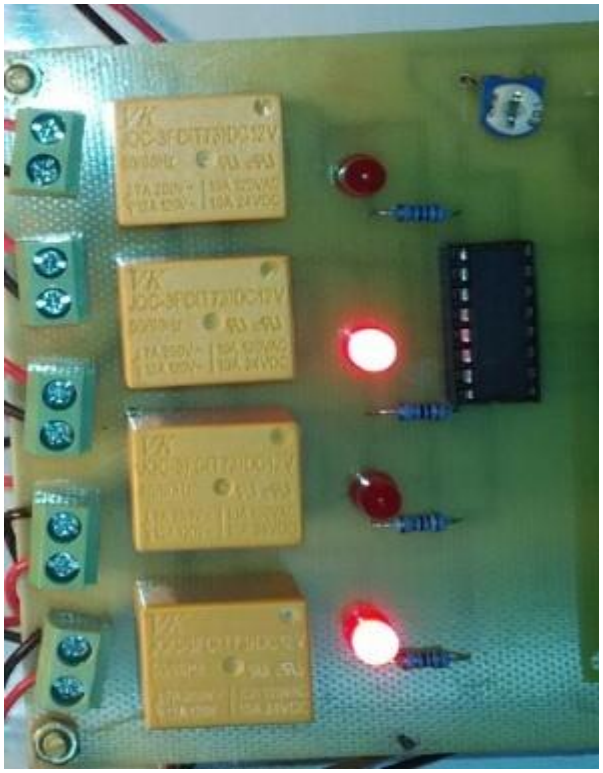

Fig .5 Relay driver IC and loads.

Fig. 4 shows the circuit of microcontroller along with power supply. We have chosen AT89S52 microcontroller for our system with a crystal frequency of 11.0592MHz.The microcontroller is programmed to control the operation of the loads according to the commands received from the smartphone via Bluetooth module. It also indicates the mode of operation and the remaining ON time of a specific load on LCD. Port 2 is interfaced with the LCD module. Port 3 is interfaced with the Bluetooth module and Port 0 is interfaced with relay driver and load circuit.

Fig. 5 shows the relay driver and load circuitry. The circuit consists of a relay driver IC ULN2003 [9], four SPDT electromagnetic relays for each of the four bulbs acing as loads. Also LEDs have been provided to indicate the status of each load (ON/OFF).

IV. SOFTWARE DESCRIPTION

A. 'C' Programming

In this project, we have used Keil C Compiler for developing microcontroller program in C language. Fig. 6 below shows the flowchart of our project in brief. When the system is turned ON, the microcontroller enables its serial port and displays the keys to be pressed for different modes of operation on the LCD and waits for the command from mobile phone before executing any action.

When Key-'A' is pressed, the AUTO mode of operation is selected wherein, all the loads are remain in operation for a fixed time instant one by one. After a load has finished its due time interval, the next load gets switched ON and so on. When Key-'B' is pressed, Set mode of operation is selected. In this case, each of the loads can be programmed for different time intervals and sequential switching takes place.

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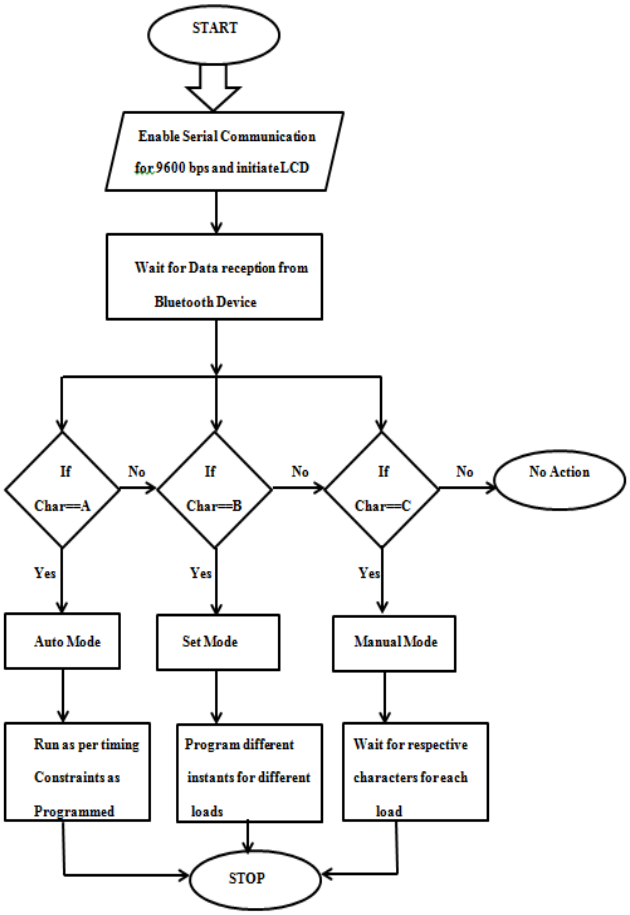

Fig. 6 Basic Flowchart for this system

When Key 'C' is pressed, manual mode of operation is selected where the user can manually switch ON and OFF one or more than one of the loads. They will continue to remain ON until the user switches them OFF.

B. Android Application interface

We have used Blue Control Android application which is available freely on Google Playstore. It is an interface between the user and the system. In industrial applications, this will act as control panel for the user. It contains different keys for issuing the commands to the system. The up and down arrows are for incrementing and decrementing the time count respectively.

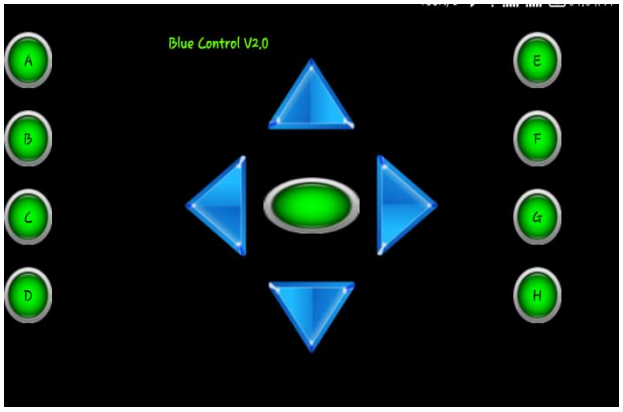

Fig. 7 Blue Control Application acting as Controlling Panel

V. CONCLUSION

The proposed system reduces the space and power consumption and ensures efficient use of the available resources. Also numbers of operators required for monitoring the system are less. Only one operator is required to issue the commands and monitor the proper working of the system. We can use any of the different modes available which best suits the industrial process application. Also since it is not possible in some cases to control or manually override/reset any machine owing to high temperature, we can control the system wirelessly over a suitable distance from the system.

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