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LOW COST PLC ALTERNATIVE SOLUTION WITH SCADA INTERFACE USING MICROCONTROLLER

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Abstract - *Now a days, the available PLCs in the market are based on microprocessor. But these PLCs are very much costly. Because of their high cost, it is not possible to use these PLCs in small scale industries, where less number of tasks are going to automated. Therefore they dose not prefer the automation in their small scale industries. Our paper aim at finding the low cost PLC alternative solution using microcontroller. This system can be implemented for many industrial applications. Here we are showing one of those i.e. Automatic bottle filling system which is based on earlier PLCs. The system is controlled by programming microcontroller. SCADA is used to monitor the process. It is also a user interactive system. The entire system is more flexible and effective.*

Key Words: PLC, SCADA, Sensors, automation.

1. INTRODUCTION

In industries, PLCs are widely used for automation and controller purpose. The available PLCs are powerful but they are having high cost. As the technology are developed, microprocessor replaced by microcontrollers, in most of the areas. Inspiring from these revolutions, presenting here an idea of microcontroller based PLC alternative solution for automation.

The automation is used to reduce the need for human work and it saves the time. Many industries prefer automation to avoid the labour unavailability problem. The labours require corresponding industrial training. So that most of the valuable time is wasted as well as labour charges also. Therefore industries started automation.

We are proposing the ultimate idea for bottle filling process where bottle detection and liquid level in tank can done by using industrial sensors. In this system, the industrial proximity sensor is used to detect the bottle which is travelling on conveyer belt, under the filling valve. Another one more sensor is used to detect the level of liquid in the tank. This system uses the liquid filling pump to fill the bottle in less time. To fill the equal amount of liquid in each bottle, timer is used. The pump remains on for the preset value of timer and switches off once time is out. As soon as filling process is over, the conveyor belt starts moving again.

This system uses custom made open source microcontroller based PLC alternative, instead of using costly PLCs. It uses the Arduino microcontroller plat form with ATMEGA 328 core. The basic version of this is built around a 28 pin microcontroller. But in advance version, it can be built around 100 pin microcontroller. The whole system is monitored using SCADA. The SCADA is used to display the current status of remote equipments, can monitor as well as control and change the parameters as per the requirement.

1.1 Objective

To develop an automatic bottle filling system with low cost PLC alternative solution using sensors. This system reduces the cost of machine and increases the flexibility.

1.2 Methodology

The bottles are placed on conveyor belt. The IR sensor is used to detect the presence of bottle. After sensing the bottle conveyor belt stop and the corresponding pump switch ON and the bottle filling operation takes place. When there is no bottle present front of the sensor, the output of sensor becomes zero and pump remains in off position. The filling process is based on timing. The pump remains ON for the particular time period of the timer and the filling of bottle is done in that particular time. The alarm gets sounded when the level of the liquid in the tank goes below the reference level.

2. FLOWCHART

Fig. 1 shows flowchart for communication between PC i.e. SCADA and microcontroller. By using this we can interact with system by changing the parameters or checking the current status. Fig. 2 shows flowchart for actual bottle filling process.

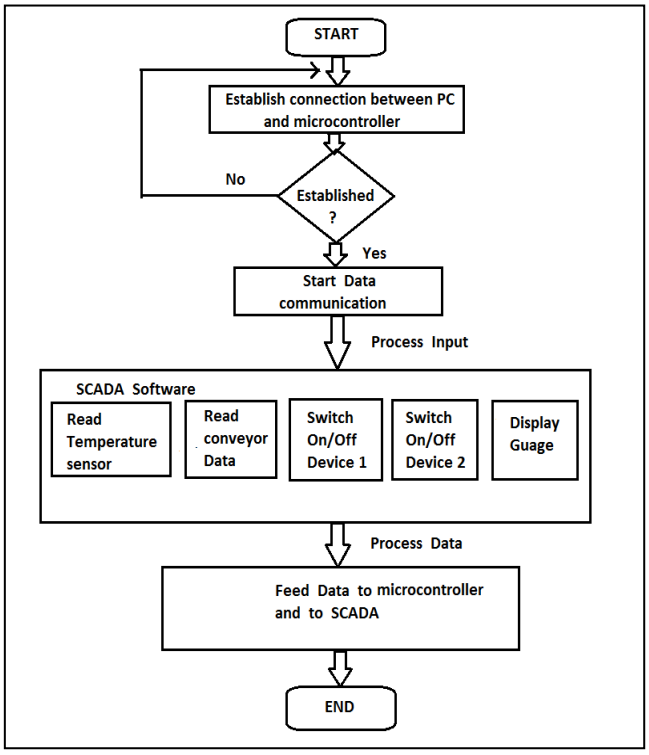

Fig -1: PC & Microcontroller Communication

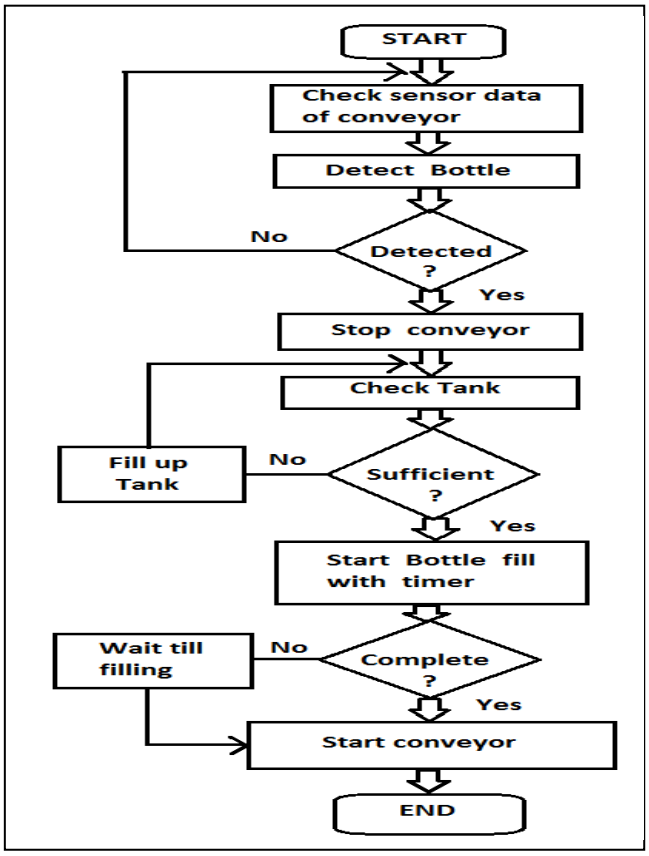

Fig -2: Bottle Filling Process

3. BLOCK DIAGRAM

In this idea of project, Arduino microcontroller platform with ATMEGA 328 core is used. It can be easily interfaced with any SCADA software for controlling the automated system or we can make our own SCADA software.

The basic block diagram is as shown in FIG.1 and the application block diagram is as shown in FIG.2. The explanation is given as follows:

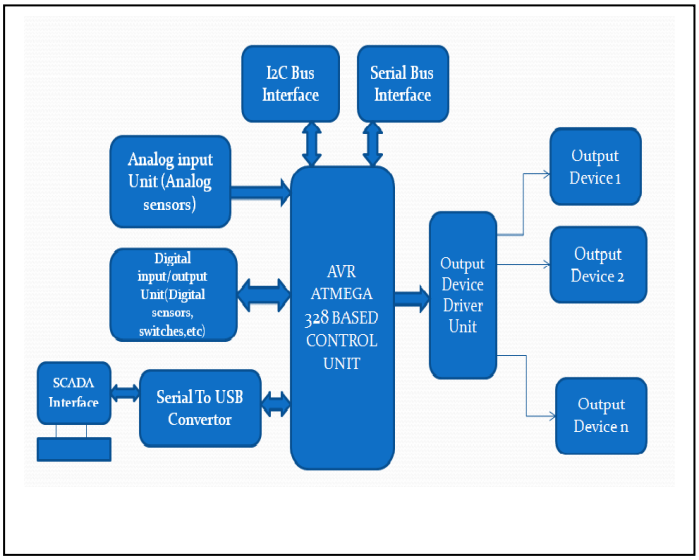

Fig -3: Basic Block Diagram

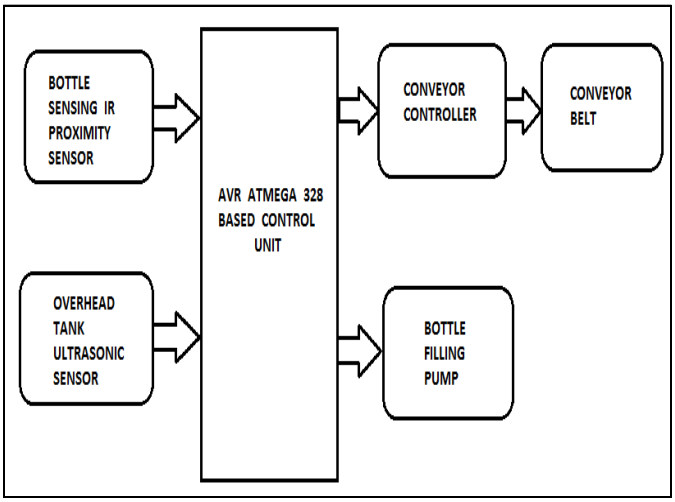

Fig -4: Application Block Diagram

3.1 SCADA Interface

SCADA (Supervisory Control and Data Acquisition) is computer based system. It is used for controlling and monitoring various industrial processes. It is user interactive software, because by using GUI (Graphical User Interface) we can control the specific and customized tasks. In this way

user can directly interact with this software. By using GUI we can control com port connections, such as pressing the buttons and control the equipment, etc.

In this system, by using SCADA we can monitor the current status of the system like filling the bottle or the level of liquid in tank.

3.2 Serial To USB Converter

It is used for making the communication between USB based computers and serial devices. We use here; FTDI (Future Tech Devices International) serial to USB converter is used. FT232RL IC is used. It is bidirectional converter. This converter is used to load the data which is coming from the SCADA system into the microcontroller. This converter converts human interpretation language into its ASCII value which is understandable by the microcontroller.

FT232RL is 28 pin IC. It has internal clock generator so that no external crystal is required. It works on FIFO i.e. First In First Out technique.

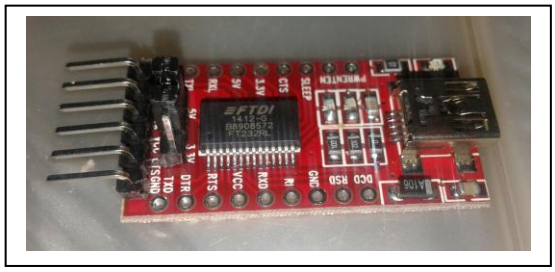

Fig -5: FT232RL

To interface the SCADA i.e. computer to the microcontroller we use FT232RL IC which converts the USB data into serial data.

3.3 Microcontroller

This system uses Arduino microcontroller platform with ATMEGA 328 core. The ATMEGA 328 is a single chip microcontroller which is created by ATmel and it belongs to MEGA AVR series.

It is 28 pin IC and it is of 8 bit. It is based on RISC (Reduced Instruction Set Computer) architecture. It has 26 I/O pins, 32 working registers, 32Kb of flash memory, 2Kb RAM and 1Kb EEPROM.

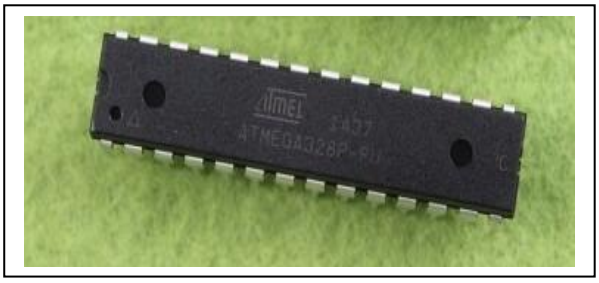

Fig -6: ATMEGA 328

The maximum operating frequency of ATMEGA 328 is 20 MHz. It has external and internal interrupts. Each pin of microcontroller provides 5 Volts, 40mA current. It has 16 digital and 8 analog channels. If we want more than 16 digital channels then we can convert the analog channels to digital channels by using in build ADC (Analog to Digital Converter) by writing the proper code.

3.4 Sensors

Different types of sensors are used in industries. A sensor detects the changes in physical or electrical or other quantities and produces an electrical or optical signal. The output is a response to the change in specific quantity.

We can use here analog sensors (For example: accelerometers, pressure sensors, light sensors, temperature sensors, sound sensors and so on) as well as digital sensors (For example : digital accelerometer, digital temperature sensors, switches, etc.).

Fig -7: IR Proximity Sensor

In this system two sensors are used one is IR (Infrared) sensor which is used to detect bottle on conveyor belt and it sends the signal to microcontroller and it will immediately stops the conveyor belt.

Another one sensor i.e. ultrasonic sensor is used to detect the liquid level in tank. It will measure the distance between from top of the tank to the liquid level in the tank.

3.5 Output Device Driver Unit

If all the output devices which are connected to microcontroller wants the service at a time then microcontroller does not able to provide sufficient current and voltage to drive each device. So here we can use output device driver unit such as relay, etc.

3.6 Output Devices

The output devices are connected to relays. Relays acts as switch. We can connect AC as well as

DC output devices, such as AC or DC motors, cooling system, heater, etc.

3.7 Serial Bus Interface

By using serial bus interface, we can connect externally wireless RF module, Wi-Fi module, Ethernet and Bluetooth microcontroller.

3.8 I2C Bus Interface

Inter-integrated bus is used to connect external memory such as EEPROM, etc. But this bus is optional.

4. PROCESS DISCRIPTION

We are showing the automatically bottle filling system which is previously based on big PLCs. In this system, ATMEGA 328 core with Arduino microcontroller platform plays a vital role. Two sensors are used, one is IR sensor and another is ultrasonic sensor. IR sensor is used to detect the bottle on the conveyor belt. As bottle is detected, sensor sends the signal to microcontroller. At that time, the conveyor motor immediately stops according to program stored in microcontroller. At the same time solenoid valve is opened and liquid fills in the bottle. How much time will be required to fill one bottle is decided by the preset value of the timer. When timer gets reset, solenoid valve closed. Then the microcontroller sends the signal to conveyor motor and conveyor belt starts to rotate and process repeats.

Fig -8: Process Description

In tank, a specific liquid level is defined which is known as "threshold level". To measure the distance between top of the tank to that threshold level, the ultrasonic sensor is used. When liquid level goes below the threshold level then the distance between top of the tank to liquid level will increases. At that time, the ultrasonic sensor sends the signal to microcontroller and microcontroller stops the whole system and alarm sounded.

Fig -9: PCB

SCADA is used for checking the current status of the system and also the parameters can be changed as per the requirement of user who is sitting at single position instead of moving over the whole industry. Emergency stop button is added to immediately stop the whole system in any critical condition. As per the requirement of user, user can use 8 pin microcontroller, 28 pin microcontroller, 100 pin microcontroller and so on. Therefore this system is very flexible.

5. CONCLUSION

The main goal was to develop, low cost, flexible, efficient and time saving PLC alternative system. This system was successfully tested and implemented. This can be used in small scale industries for automation purpose. We can change the microcontroller according to the no. of applications to be automated.

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