The Design and Implementation of Microcontroller-Based Waste Water Sample Collection Device

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Abstract: *In this study, as waste water sampler was designed and constructed. The sampler operation was controled with a low cost and efficient microcontroller. The sampler was designed so that it could operate under industrial environment the human intervention factor was reduced to minimum so that the human health was protected against chimecally wasted water.*

1. Introduction

Water is one of the most important needs for the human life. Rivers are the main sources of the water. However, in developing countries, the need for detecting these source is needed against the plants that exhaust their garbage.

Detection is implemented by inspecting lots of samples that are collected from these sources at different times. These samples that are collected at different times must be protected without blending. This requires the workers to study carefully and elaborately.

Our device has been designed to automatically collect the required amount of sample in the predefined time intervals. The thing the user should do is to define the beginning and the end of the collection process and the interval duration each sample will be collected in. The system is running according to these values.

In the following section the PIC microcontroller used in the system has been introduced. In the third section the device which has been implemented as prototype and the modules included in this device is being explained. The last section is occupied with the conclusion and the discussions.

2. PIC (Programmable Integrated Circuits)

2.1. What is PIC?

The PICs are the integrated circuits which include RAM, EPROM, EEPROM, PIA all of which are the main components of a microprocessor. As these components are contained in the same integrated circuit, the size of the system based on these microprocessors has been decreased, the cost has been reduced and the most importantly the design of these systems have become easier.

The address bus, the data bus and the control bus that will connect the components such as CPU, RAM, EPROM and PIA will not be considered separately in such systems. Because all of these are placed into the PICs by the company which produced these circuits. Because of the properties discussed above PICs have been the most preferable devices nowadays. (Figure 2.1)The microprocessor which runs the program that is written into the PIC is hardwired according to the RISC architecture. RISC architecture is one of the main architecture types that are used in microprocessor design. The other well known architecture is CISC. In RISC architecture the size of the instruction set of the microprocessor has been reduced and these instructions are designed to run in a single clock cycle.

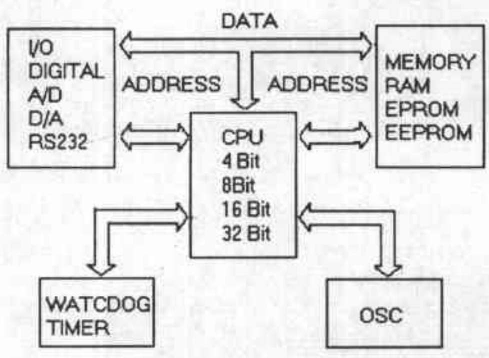

Figure 2.1. A Typical Microcontroller System

2.2. PIC Instruction Structure

Each of the instructions written in our programs occupy 14 bits on PIC. First 6 bits of these 16 bits recognize the instruction and the remaining 8 bits carry the related data. Because the part that carries the instruction is 6 bits (26064), it is clear that there are at most 64 instructions in the PIC. For example, there are 35 instructions in 16C84 PIC. This integrated circuit operates at 10 MHz clock frequency and runs each instruction as fast as 400 ns. It contains 1K EEPROM as program memory, 15 special hardware registers, 36 general purpose registers and 64 byte EEPROM as data memory. Theoretically, these ICs can be programmed 1 million times and keep the programs it stores for more than 40 years without loss of information. As their structures are CMOS, PICs consumes very less energy. The voltage range used in applications lies between 2 and 6 volts. Although their power is less, PICs have the ability to drive a LED directly. Because of the discussed properties of them PICs are used widely nowadays.

3. The Structures and Operation of the System

The system includes there parts named as mainboard, display card and feed card. Mainboard is the part where the microcontrol component is built in and all the controls and adjustments take place. The value and the quality of the entered clock can be inspected by means of display card. Feed card is the part that provides the ±5V DC voltage all the ICs need and the ±30V DC voltage that is needed to feed the step motor and 220V AC voltage for the pump.

The overall block diagram of the system is shown in figure 3.1

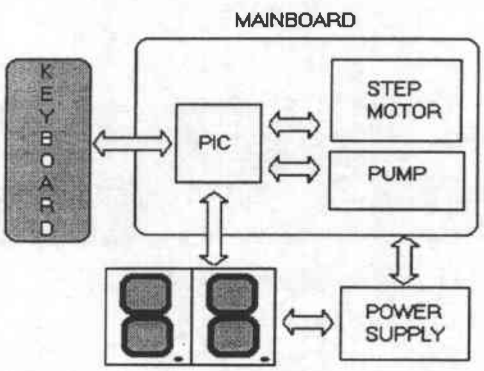

Figure 3.1. The overall block diagram of the system

PIC 16F84 microcontroller is used as the processor. Only the oscillator circuit is occupied on the processor level. This oscillator circuit determines the operation frequency of the PIC. A 4 KHz crystal at XT mode is used in the system (Figure 3.2). All the controls in the system are implemented by the PIC. The PIC is

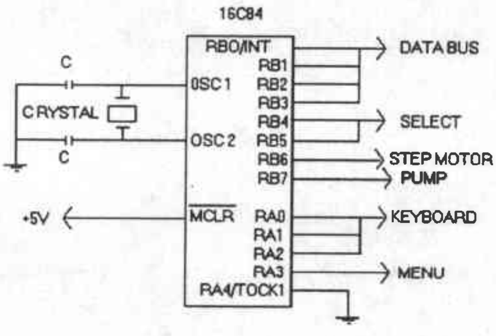

Figure 3.2. PIC 16C84 and Oscillator Circuit

programmed to provide collecting the required amount of the water sample in predefined intervals according to the information that are entered by the keys. Step motor control card is made of two circuits which are called as stator trigger sequence generator and stator driver circuit. Stator trigger sequence generator, as its name implies, generates a trigger in suitable sequences to provide the movement. A bidirectional shift register (74194) has been used for this purpose(Figure 3.3).

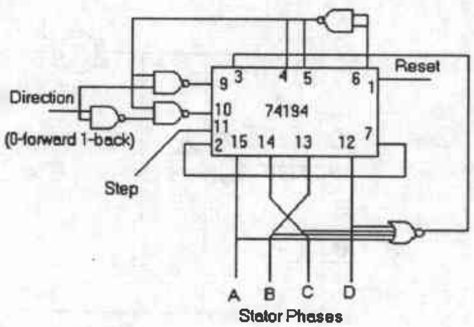

Figure 3.3. Stator Trigger Sequence Generator

When the shift register is initialized the load data inputs (3^{rd}, 4^{th} , 5^{th} and 6^{th} pins) are set to 1001 and mode control inputs are programmed for parallel load. Passing from one sequence to another of the sequence generator is provided by microcontroller component. The ABCD outputs of the sequence generator can not drive the stator bandages of the step motor directly [3,5]. For this aim, a drive circuit has been placed between the sequence generator and the motor (Figure 3.4).

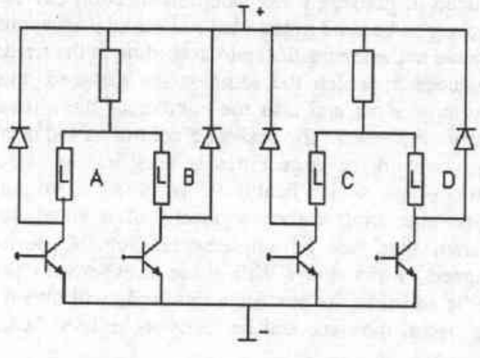

Figure 3.4. Stator Driver Circuit

The pump control card is made of an optotriac that provide physical insulation and a triac that implements current control. The control of the operation of the PIC is made by PIC [4,6]. When the PB7 pin of the PIC is on, the optotriac triggers the gate pin of the triac to make it active. When the gate pin of the triac is active it passes the current and the pump begins to operate (Figure 3.5).

Display choosing and loading level and key control level are also controlled by the PIC and implemented with suitable integrated circuits. Display level is made of a 4 digit clock component by means of which the entered values are inspected and a menu part that determines the quality of the entered value.

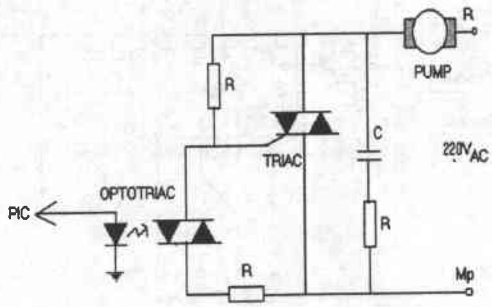

Figure 3.5. Pump Control Circuit

4. Conclusion and Discussions

As this study is about collecting samples from water resources such as barrage and rivers and testing these samples to determine the damages they give to the environment, the first step was collecting information from Selcuk University Environment Engineering Department and Konya Environment Management Organization. The system is designed to automatically implement all the functions that are required to be included in garbage water sample collection devices. However to be used in the plants some additions must be made to the mechanical part according to the needs. The tubes in which the samples are gathered must have large sizes and also the number of these tubes must be increased. The real-time control of the drink water network in large cities is very important for personal and social health. It is possible visually inspect the drink water by means of a simulation program that will be implemented for the device designed in this study. With these arrangements that will be added in the next step, this study will obtain a very useful interface and be ready to be used in the life.

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