CHAPTER 4

RESULT AND DISCUSSION

4.1 Sensor

Distance measurement sensor is a heart of this project. It is important to find and choose the right sensor. In order to make sure that sensor suitable and can operate as required, sensor testing are done.

Based on sensor's datasheet, the detection distances range is from 4 cm to 30 cm are linear. This characteristic has to considered for determine the distance range for the water level of this project.

Several laboratory tests using this sensor were done to get the exact data as an input signal for microcontroller. The sensor have been placed in the position faced on a white sheet of paper straight and measured the output voltage at several incremental distances scales from the sheet of paper measured. Table 4.1 shows the reading of the four conducted test as well as an average of the result.

Table 4.1: Sensor Testing Results

Distance(cm)	Reading Voltage$_{Trial1}$(V)	Reading Voltage$_{Trial2}$(V)	Reading Voltage$_{Trial3}$(V)	Reading Voltage$_{Trial4}$(V)	Voltage $_{Average\ Of\ Trials}$(V)
1	1.59	1.57	1.57	1.59	1.58
2	1.92	1.94	1.96	1.97	1.95
3	2.94	2.92	2.92	2.94	2.93
4	2.69	2.69	2.72	2.71	2.70
5	2.25	2.28	2.28	2.28	2.27
6	1.96	1.95	1.97	1.98	1.97
7	1.72	1.72	1.7	1.72	1.72
8	1.52	1.53	1.54	1.54	1.53
9	1.37	1.39	1.37	1.39	1.38
10	1.24	1.24	1.24	1.25	1.24
11	1.15	1.13	1.14	1.14	1.14
12	1.05	1.05	1.05	1.05	1.05
13	0.96	0.98	0.98	0.98	0.98
14	0.92	0.92	0.92	0.92	0.92
15	0.86	0.86	0.86	0.86	0.86
16	0.8	0.8	0.8	0.8	0.80
17	0.76	0.76	0.76	0.76	0.76
18	0.71	0.72	0.72	0.72	0.72
19	0.67	0.69	0.69	0.69	0.69
20	0.65	0.65	0.65	0.65	0.65
21	0.61	0.61	0.61	0.61	0.61
22	0.57	0.59	0.59	0.59	0.59
23	0.55	0.56	0.55	0.56	0.56
24	0.53	0.53	0.53	0.53	0.53
25	0.51	0.51	0.51	0.51	0.51

The result reading of that sensor had been plot on graph for average voltage versus distance shown in Figure 4.1

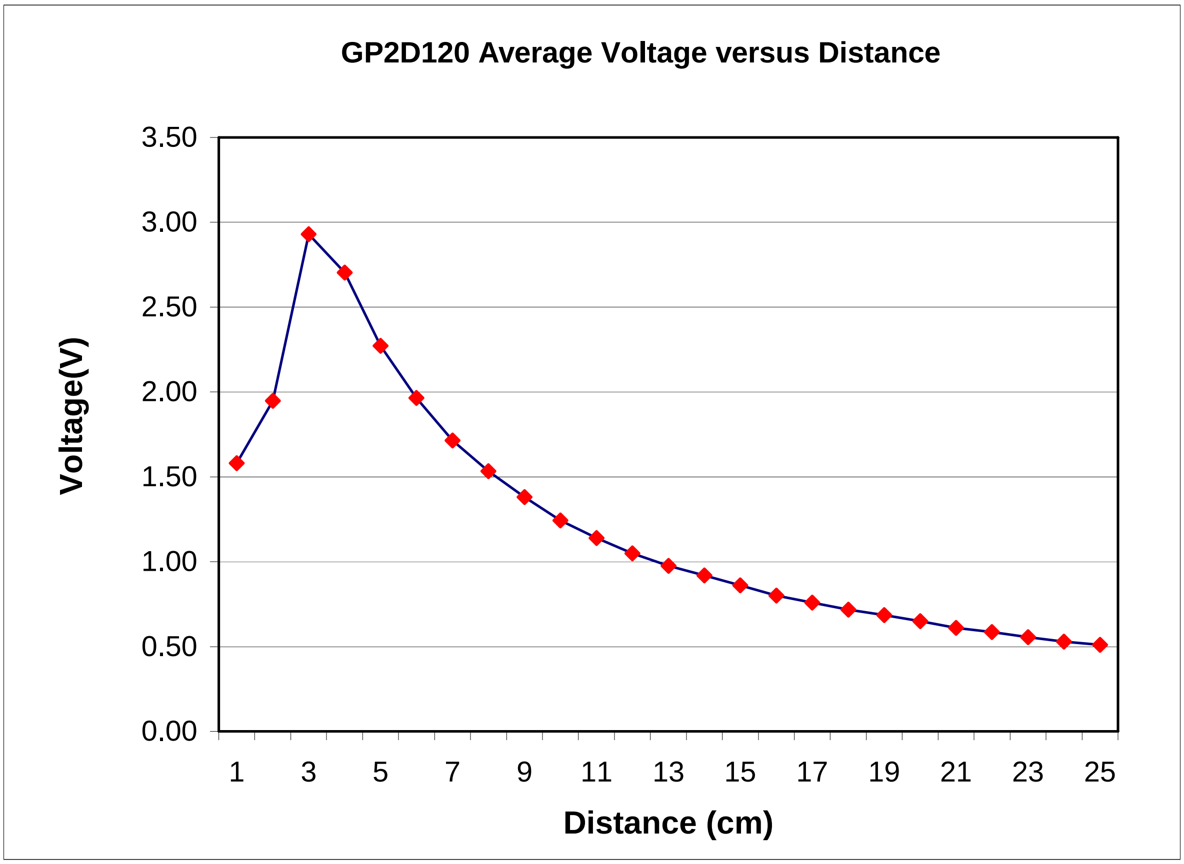

Figure 4.1: GP2D120 Average Voltage versus Distance

Because of some basic trigonometry within the triangle from the emitter to reflection spot to receiver of the sensor, the output voltage of these new detectors is non-linear with respect to the distance being measured. Moreover, as expected from the device specifications, there is a range, namely closer than 4 cm to the object, where the distance cannot be accurately measured.

4.2 Signal Conversion

A sensor has sense the object from multiple ranges of distances and provided a voltage output signals. Table 4.2 shows the output voltage reading of an ADC based on the input signals from a sensor.

Table 4.2: ADC0804 Output Voltage

Input Voltage(V) to ADC at Vin+	Output Voltage (V) D0	Output Voltage (V) D1	Output Voltage (V) D2	Output Voltage (V) D3	Output Voltage (V) D4	Output Voltage (V) D5	Output Voltage (V) D6	Output Voltage (V) D7
3.0	1.50	4.80	4.80	4.80	4.87	0.00	0.00	3.49
2.5	3.28	4.67	0.00	0.00	0.00	0.00	0.00	3.50
2.0	2.52	2.60	2.00	4.90	0.00	3.96	4.09	0.00
1.5	1.50	3.00	0.00	0.00	4.60	0.00	4.09	0.00
1.0	1.50	3.38	4.80	0.00	4.80	3.67	0.00	0.00
0.5	2.50	2.50	0.00	4.85	4.85	0.00	0.00	0.00

Assembly language are formulate as a command to transfer an input signals with the difference voltage values from sensor to an ADC. These values were converted to 8 bits binary data as an ADC output signal which is shown in Table 4.3 where logic 1 stated an output voltage larger than 3.0 V and logic 0 stated output voltage smaller than 3.0V.

Table 4.3: ADC0804 Output in Binary

Input Voltage(V) to ADC at Vin+	Output Voltage in Binary D0	Output Voltage in Binary D1	Output Voltage in Binary D2	Output Voltage in Binary D3	Output Voltage in Binary D4	Output Voltage in Binary D5	Output Voltage in Binary D6	Output Voltage in Binary D7
3.0	0	1	1	1	1	0	0	1
2.5	1	1	0	0	0	0	0	1
2.0	0	0	0	1	0	1	1	0
1.5	0	1	0	0	1	0	1	0

1.0	0	1	1	0	1	1	0	0
0.5	0	0	0	1	1	0	0	0

Microcontroller with source code in Appendix A is used to convert these ADC binary values into hexadecimal values. Table 4.4 shows the output of ADC in hexadecimal values. Figure 4.2 shows the assembly language code how to compare the ADC value with the output range.

Table 4.4: ADC0804 Output in Hexadecimal

Distances (cm)	Input Voltage(V) From sensor to ADC at Vin+	Output Voltage (Hex) from ADC display on TERMULTR			
		Reading 1	Reading 2	Reading 3	Reading 4
25	0.51	1B	1A	19	1A
20	0.65	21	22	23	21
15	0.86	2C	2D	2C	2D
10	1.25	40	41	40	41
5	2.28	77	76	74	75

```
            mov a,p1                ; get data  from ADC
            cjne a,#19h,xsame19     ; compare data  from ADC  with 19H
            jmp cm25
xsame19:    jnc more19
            mov dptr,#XVALID
            call tmltr
            jmp start
more19:     cjne a,#21h,xsame21     ; compare data  from ADC  with 21H
            jmp cm20
```

Figure 4.2: Source Code to Compare Output Range with ADC Value

4.3 User Interface

Based on Table 4.4, the specific values of distance range were identified. There are 5 ranges of distances. These ranges were compared to an input signal from an ADC to determine the level of the water in tank. Also it was used as a controller signal for the pumping motor systems.

Table 4.5: Outputs Range for GUI.

Distances (cm)	Output Range (Hexadecimal)	The Output Display on GUI
> 25	X < 19	LO (LOW)
25	19 ≤ X < 21	25
20	21 ≤ X < 2C	20
15	2C ≤ X < 40	15
10	40 ≤ X < 76	10
5	76 ≤ X < 78	5
< 5	X ≥ 78	HI (HIGH)

The hexadecimal output ranges in Table 4.5 was used to develop a graphic user interface (GUI). VB programming was applied as software tool to produce an interface source code for GUI. Figure 4.2 is a display window for Water Monitoring System. The source code of VB programming can be referring on Appendix C.

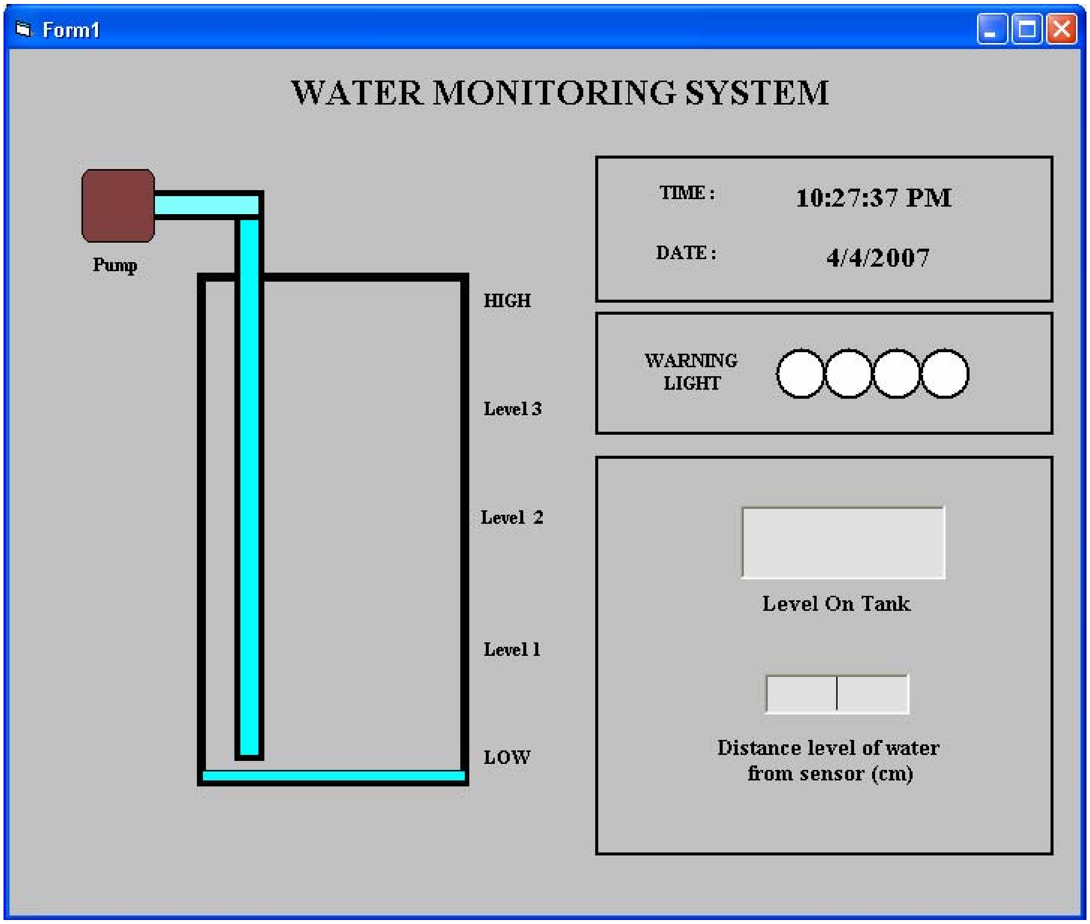

Figure 4.3: Water Monitoring System Display Window

On the display window, it shows the level of water inside the tank, the value of water distance from sensor in cm and also the warning light as an alarm which will blinking to alert user when the tank was full.

Hardware Design

Basically, the construction of hardware design of this project can be present as 3 main modules. Plate 4.1 shows an ADC circuit, Plate 4.2 shows a pump driven circuit, Plate 4.3 shows the position of sensor and Plate 4.4 shows the combination of all circuit with microcontroller inside the black box.

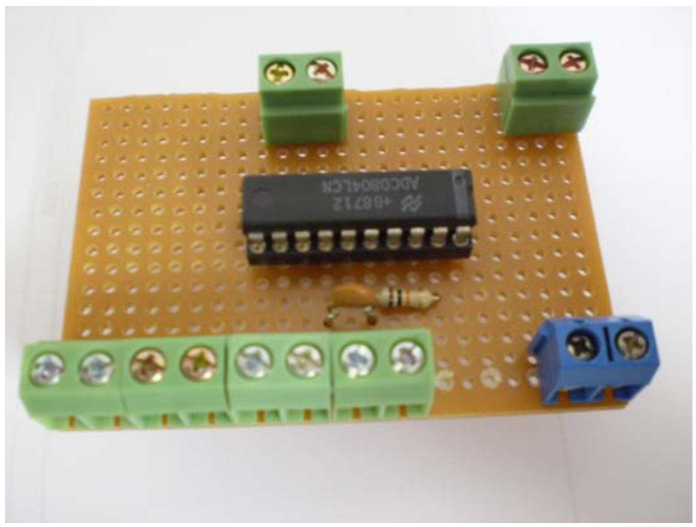

Plate 4.1: ADC Circuit

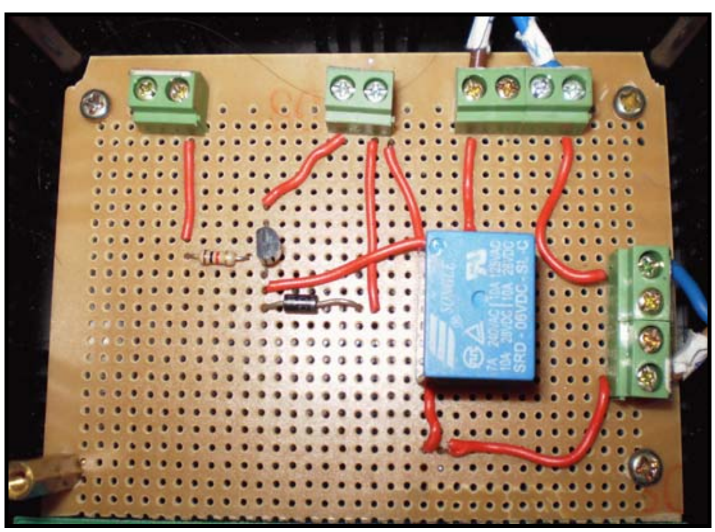

Plate 4.2: Pump Circuit with Transistor Driven Relay.

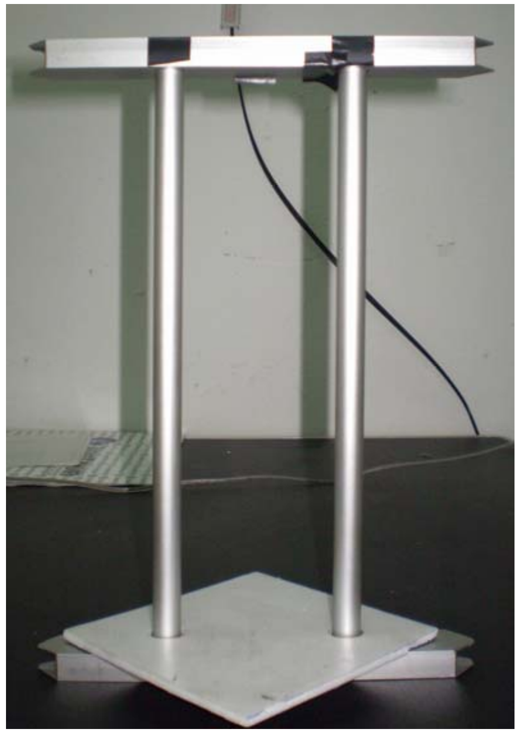

Plate 4.3: Sensor Position

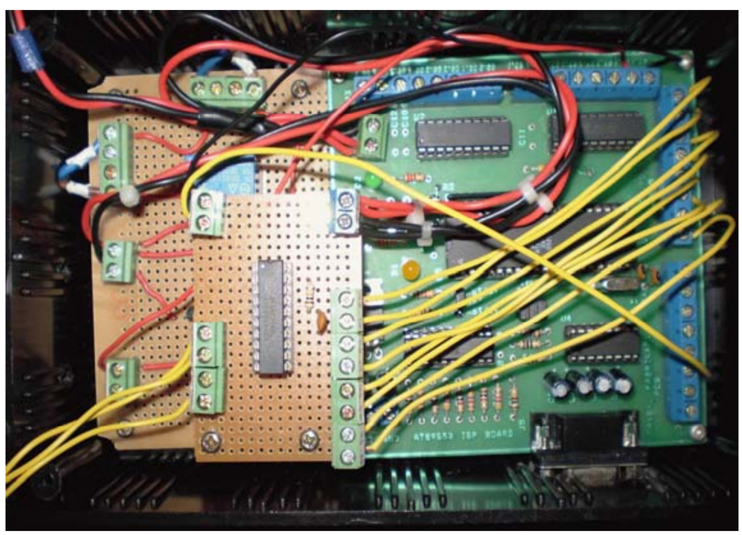

Plate 4.4: Combination all Circuit