Chapter III

Materials and Methods

To yield with a significant subject of study, the proponents conducted a research as well as consultations from different professionals related in the fields of engineering specifically in mechanical, electronics and computer engineering. Supplements provided by different libraries and Internet are also of great help. By such process, appropriate methods to be use are reliably determined particularly in the part of laboratory and field experiment that will eventually help the proponents realize the appropriate materials to be used. Hence, the practicality, purpose and feasibility of the study are significantly determined.

3.1 Research Design

The assembly of the K-S5 is divided into two major components: software and hardware. The software part is responsible for driving the hardware components as well as the artificial intelligence of the machine itself. The hardware part, on the other hand, is categorized into mechanical and electronic part. The former is mainly focused on the movement of chess pieces while the latter involves the electronic circuit that will run other components.

3.2 Laboratory Experiment

The proponents conducted series of tests to determine how accurate the actuator's motors are with regards to its' steps. Steps are executed in linear horizontal direction for the X and Y axes and linear vertical direction for the Z-axis, in forward or backward direction and up or down direction respectively. The origin is the starting location of every axis. From here, motors will be controlled to move forward until they reach the corresponding number of steps. The distance traveled from the origin up to the last step will then be measured. Then the motor will be controlled to go backward with the same number of steps and record the distance from the last position to the origin. This routine repeats ten times for greater reliability. For every test, the number of steps varies from 152 steps to 1065 steps incremented by 152 steps garnering a total of 7 tests.

The proponents also measured the chess pieces, in terms of height, base diameter and weight, to be used in order to consider certain matters such as the necessary magnetic power to lift them and the size of the chessboard.

To test the reliability and accuracy of the board sensors, the proponents made a testing program that will check the presence of chess pieces on the chess set reading each row the chessboard for 1,000,000 times. Every row of the main board as well as the side boards were checked by first positioning eight chess pieces in a single row in a way the chess pieces were detected by the

board sensors. Then the proponents will run the testing program. The program, after reading the presence of chess pieces on the row, will display the result indicating errors if there's any. Below is a portion of the code in verifying the integrity, stability and accuracy of the board sensors.

```
//testing program

private void buttonRead_Click(object sender, EventArgs e)
      {
         string tmpByte = "";
         tmpByte = GetPortByte();
         txtByte.Text = "reading and verifying...";
         txtByte.Refresh();

         for (int i = 0; i <= 1000; i++)
         {
            for (int j = 0; j <= 1000; j++)
            {
               if (tmpByte != GetPortByte())
               {
                  txtByte.Text = "read error!";
                  return;
               }
            }
         }

         txtByte.Text = tmpByte;

      }
```

3.3 Cost and Benefit Analysis

Cost analysis is essential to determine if the cost of the machine is inexpensive enough to be economically feasible and practical to manufacture. There are many basic methods for making economy studies. The basic methods

to pattern for making economy studies are as follows: the rate of return (ROR), the annual worth (AW) method, the present worth (PW) method, the future worth (FW) method and the payback (payout) period method. Nevertheless, the proponents do not intent to put up for sale or reproduce the K-S5. Estimated total cost of the machine is included though. Whoever wants to reproduce the chess robot will be the one responsible for making the economic analysis but of course with the consent of the proponents.

Tabulated below are the estimated worth of the materials used in assembling the projects prototype. Although some materials may have large difference from the major price since the materials can be obtain from scrap materials.

Table 3.1 Cost Analysis

QUANTITY	**UNIT**	**ARTICLE**	**UNIT PRICE**	**AMOUNT**
			(In Php)	(In Php)
4	pcs.	Old Dot-Matrix Printers	150.00	600.00
3	pcs.	Var. Resistor	7.00	21.00
3	pcs.	PIC16F84A	240.00	720.00
49	pcs.	Resistor ¼ watt	0.25	12.25
9	pcs.	Resistor ½ watt	0.45	4.05
6	pcs.	Resistor 1 watt	1.00	6.00
12	pcs.	MD6B heatsink	21.50	258.00
3	set	12x12 PCB w/ developer	345.00	1,035.00
4	pcs.	Ferric Chloride (pellets)	25.00	100.00
2	pcs.	Laser pointer	35.00	70.00
2	pcs.	Light Dependent Resistor	22.50	45.00
40	m	#22 Stranded Wire	3.50	140.00
7	m	Plastic Host	7.00	49.00
3	pcs.	12V Brushless Fan	100.00	300.00
4	pcs.	M/F 6P Connector	22.50	90.00
4	pcs.	M/F 8P Connector	30.00	120.00
1	pc.	M/F 9P Connector	33.75	33.75

2	pcs.	M/F 3P Connector	11.25	22.50
1	pc.	M/F 4P Connector	15.00	15.00
8	pcs.	1N5404 Diode	3.25	26.00
16	pcs.	1N4004 Diode	1.75	28.00
2	pcs.	1N4001 Diode	1.00	2.00
96	pcs.	UGN3120	37.50	3,600.00
3	pcs.	18-pin IC Socket	7.50	22.50
3	pcs.	11.059Mhz Crystal Oscillator	40.00	120.00
4	pcs.	2N3904	3.75	15.00
13	pcs.	2N3906	3.75	48.75
16	pcs.	Ceramic Capacitors	1.75	28.00
2	pcs.	16V 1000uF Capacitor	5.50	11.00
1	pc.	50V 10uF Capacitor	2.25	2.25
9	pcs.	TIP122	35.00	315.00
4	pcs.	TIP142	62.00	248.00
3	pcs.	DM74LS191N	15.00	51.00
3	pcs.	DM74LS139N	10.75	32.25
3	pcs.	LM339	15.00	45.00
6	pcs.	HD74LS08	7.50	45.00
4	pcs.	HD74LS04	7.50	30.00
1	pc.	DM74LS154N	75.00	75.00
2	pcs.	DM74LS244N	18.75	37.5
1	pc.	DM74LS165N	17.00	17.00
8	pcs.	Tact Switch	7.50	60
4	pcs.	LED	12.50	50.00
Miscellaneous				
Celluloid Plastic Board w/ Sticker				950.00
Celluloid Plastic (Casing)				1,400.00
Angle Bar				588.00
Ply board				745.00
Rollers				84.00
Paint				205
Bolt and Knots				101.75
Steel Works				1,800.00
Wood Works				50.00
ATX Power Supply (2nd Hand)				300.00
			Total	14,775.05