Preventive Maintenance of ABB Robot through Optimized Program Codes

Dr. T. Prabhaharan* and Mr. B. Saravanan**
*Mepco Schlenk Engineering College, Sivakasi, India
tpraba@mepcoengg.ac.in
**VSVN Polytechnic College, Virudhunagar, India
vsps_saravanan@hotmail.com

Abstract: The study is made on the amount of Heat generated in servo drive of ABB Robot 1410 to perform the same task of Pick & Place by two main methods of commands & with different program parameters. The Heat generation of more than 120˚ in servo drives can lead to inaccuracy & fault in servo drives [3]. The study analyses the optimal program code that minimizes the Heat Generated.
The ABB Robot is programmed using RAPID Language. This RAPID language has MoveL & MoveJ commands to move the Robot arm to perform the tasks. MoveL command moves the Robot Arm along a straight line while MoveJ command moves the Robot Arm along the joint. The MoveL command with higher Velocity & lesser error Zone induces more Heat than the MoveJ command with lower Velocity & higher error Zone. The temperature recorded is statistically analyzed to get valid inferences. The optimal code that completes the task in a shorter time with less heat generation and prevents the chance for maintenance is suggested in this paper.

Keywords: Preventive maintenance, RAPID Code, T Test for Difference in Mean Temperature between methods, SPSS package.

Introduction

Your Robots are used in large scale manufacturing unit such as Automobile Industry, Food processing Industry etc. These robots are normally programmed using various programming languages [1]. This paper deals with the optimized Program code that minimizes the Heat Generation. The Industrial Robot ABB 1410 was used for this study. It is programmed for Simple pick and place operation using MoveL and MoveJ commands with Velocity values 100mm/min, 500mm/min, 1000mm/min & 2000mm/min. The maximum velocity range of this Robot is 7000mm/min.
But as the distance between the pick & place points are less, the Robot will not attain the high velocity & the trial is stopped with 2000mm/min. The temperature raise in the servo drives were measured for 10 minutes of continuous operation in each type (2 types of program x 4 velocity parameters = 8 trials in total). The temperature is measured using LM35 Temperature sensor at regular intervals of 30 seconds. The temperature measuring device LM35 is interfaced with computer to provide the digital read out. This is done using Audrino Board & Matlab program interface.

Figure1. Temperature Sensor LM35 attched to ABB Servo Drive

Figure2. Temperature Monitored using MATLAB

Audrino Program Code for Temperature monitoring

```
int a;
void setup()
{pinMode(A1,INPUT);
pinMode(7,OUTPUT);
```

```
Serial.begin(9600);}
void loop()
{
    while(1)
    {
    a=analogRead(A1);
    float mv = (a/1024.0) * 5000;
    float cel = mv / 10;
    Serial.println(cel);
    delay(30000);
    }
}
```

Data Acquired and Graphical Plot

The data are acquired in Mat Lab. The temperature sensor readings are recorded once per every 30 seconds and it is continued up to 600 seconds. Initially the temperature of the servo drive rose up and by 10 minutes time the temperature raise is stabilised by the ambient cooling process & the graph showed a horizontal curve. So the study was limited to 10 minutes or 600 seconds. The Temperature values recorded by the Temperature Sensor for programs using MoveL and MoveJ for velocities from 100 to 2000 are given in the table below.

Table 1. Data Acquired using LM35 Temperature Sensor for 10 minutes at 30 seconds intervals

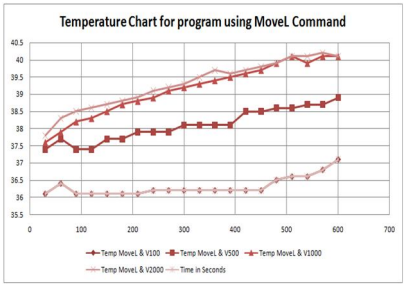
Time in Seconds	Temp MoveL & V100	Temp MoveL & V500	Temp MoveL & V1000	Temp MoveL & V2000	Time in Seconds	Temp MoveJ & V100	Temp MoveJ & V500	Temp MoveJ & V1000	Temp MoveJ & V2000
30	36.1	37.4	37.6	37.8	30	35.4	36.1	36.8	37.4
60	36.4	37.7	37.9	38.3	60	35.5	36.1	36.9	37.4
90	36.1	37.4	38.2	38.5	90	35.5	36.2	37.1	37.5
120	36.1	37.4	38.3	38.6	120	35.6	36.2	37.2	37.5
150	36.1	37.7	38.5	38.7	150	35.6	36.3	37.4	37.5
180	36.1	37.7	38.7	38.8	180	35.6	36.3	37.5	37.6
210	36.1	37.9	38.8	38.9	210	35.7	36.4	37.6	37.7
240	36.2	37.9	38.9	39.1	240	35.7	36.4	37.6	37.7
270	36.2	37.9	39.1	39.2	270	35.7	36.4	37.6	37.8
300	36.2	38.1	39.2	39.3	300	35.8	36.5	37.6	37.9
330	36.2	38.1	39.3	39.5	330	35.9	36.5	37.6	38.1
360	36.2	38.1	39.4	39.7	360	35.9	36.5	37.7	38.2
390	36.2	38.1	39.5	39.6	390	36.1	36.6	37.8	38.2
420	36.2	38.5	39.6	39.7	420	36.1	36.6	37.8	38.2
450	36.2	38.5	39.7	39.8	450	36.2	36.6	37.8	38.2
480	36.5	38.6	39.9	39.9	480	36.2	36.6	37.8	38.2
510	36.6	38.6	40.1	40.1	510	36.3	36.7	37.8	38.3
540	36.6	38.7	39.9	40.1	540	36.3	36.7	37.8	38.4
570	36.8	38.7	40.1	40.2	570	36.4	36.8	37.9	38.5
600	37.1	38.9	40.1	40.1	600	36.4	36.8	37.9	38.5

The graph of all the above readings are plotted with Time on x axis & the temperature recorded on y axis. It is observed that the Temperature raise in the servo drives with MoveL commands is marginally greater than the respective Temperature raise using MoveJ commands.

Results and Discussions

The statistical tool “t test for difference between sample means“ was employed for the analysis as the sample size is small. The Mean value of temperature recorded using MoveL program was compared with MoveJ program.

The t value calculated using SPSS package shown in Table1 was compared with the t value at 95% confidence and 19 DOF. The t value is 2.093 whereas the calculated values in table 3 are 11.906 for V100, 49.472 for V500, 24.245 for V1000 and 14.318 for V2000. All the calculated values by SPSS package (Table 3 values) are greater than the t value of 2.093.



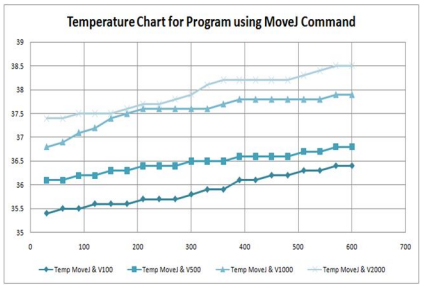


Figure 3. Temperature Chart for Program using MoveL & MoveJ commands

Table 2. Paired Sample Means

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Temp MoveL & V100	36.310000	20	.2751078	.0615159
	Temp MoveJ & V100	35.895000	20	.3284333	.0734399
Pair 2	Temp MoveL & V500	38.085000	20	.4729248	.1057492
	Temp MoveJ & V500	36.465000	20	.2158825	.0482728
Pair 3	Temp MoveL & V1000	39.140000	20	.7590853	.1697366
	Temp MoveJ & V1000	37.560000	20	.3234580	.0723297
Pair 4	Temp MoveL & V2000	39.295000	20	.5878458	.1538070
	Temp MoveJ & V2000	37.940000	20	.3803045	.0850387

Table 3. Paired Sample Difference between means & t value

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Temp MoveL & V100 - Temp MoveJ & V100	.4150000	.2183089	.0488149	.3128292	.5171708	8.502	19	.000
Pair 2	Temp MoveL & V500 - Temp MoveJ & V500	1.6300000	.2754900	.0616014	1.5010887	1.7589333	26.460	19	.000
Pair 3	Temp MoveL & V1000 - Temp MoveJ & V1000	1.5800000	.4808831	.1030074	1.3644030	1.7955970	15.339	19	.000
Pair 4	Temp MoveL & V2000 - Temp MoveJ & V2000	1.3550000	.3332081	.0745072	1.1990547	1.5109453	18.186	19	.000

This clearly indicates that their exist a remarkable difference in temperature between the two methods of programming. The paired mean values calculated for all methods in Table 2 indicates that Temperature raise for program using MoveL is greater than the corresponding Temperature raise for program using MoveJ.

Conclusion

It is evident that, the temperature of the servo drives increases with the following parameters.

a. Increase in number of MoveL commands in the program code.
b. Increase in the velocity of motion. High V Value.
c. Decrease in the Error Zone. Low Z Value.
d. Increase in Pay Load & Reach of the Robot.
e. Higher Ambient Temperature of the work environment.

Lowering of Pay Load / Reach is not possible in an Organization, which is the basic function for Robots are employed. Changing the Environment Temperature is normally costly. Reducing the error zone is not possible all the time, as few operations require precision. More velocity reduction leads to drop of productivity. Change of program code using MoveJ commands are economical and also provide better performance with less heat generation.

Refering Table 2, it is evident that the difference in temperature between MoveL command & the respective MoveJ command is 1 or 2 degrees higher. This difference can go higher, if the payload capacity & reach of the Robot is increased. This leads to maintenance problems. Hence MoveJ commands can be replaced by MoveL commands where ever motion geometry permits, as it can enhance the Servo Drive performance.

References

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