CS26020: Experimenting with Sensors

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1 INTRODUCTION

1.1 Purpose of this Document

This document shows and discusses the result of experimenting with the IRSensors and Encoders on the Formula AllCode robots[1] and the in-robot API[2]

1.2 Objectives

- Collect Infrared Sensor data.
- Collect Encoders data
- Visualize the data.
- Analyze and discuss the data.

2 Infrared Sensors

2.1 Programming

To get the Sensor reading from the robot I wrote a function to display the live data on screen with some basic averaging to get rid of noise.

```
void IRSensors(){
 double IRDataSum[8] = {0,0,0,0,0,0,0,0};
 int j;
 for(j =0;j<10;j++){
  int i;
  for(i=0;i<8;i++){
        IRDataSum[i]=IRDataSum[i]+FA_ReadIR(i);
  }
 }
 double IRDataAverage[8];
 int i;
 for(i=0;i<8;i++){
  IRDataAverage[i]=IRDataSum[i]/10.0;
  if (IRDataAverage[i]>600) {
   FA_LEDOn(i);
  } else {
   FA_LEDOff(i);
  }
 }
 FA_LCDClear();
 FA_LCDNumber(IRDataAverage[IR_RIGHT],0,12,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_REAR_RIGHT],0,1,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_REAR] 40,1,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_REAR_LEFT],80,1 ,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_LEFT],80,12,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_FRONT_LEFT],80,20,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_FRONT],40,20,FONT_NORMAL,LCD_OPAQUE);
 FA_LCDNumber(IRDataAverage[IR_FRONT_RIGHT],0,20,FONT_NORMAL,LCD_OPAQUE);
 FA_DelayMillis(100);
```

```
}
```

2.2 Data Acquistion

To acquire the data for the IR sensors I chose a range of suitable scenarios to cover each of the categories:

2.2.1 range of distances

For this I collect a set of data across a wide range of values for 5mm to 125mm for one sensor to give me an idea of the range of useful distances that can be used.

2.2.2 Repeatability & Reliability

For this I collected a set of 20 readings at 20mm, 50mm and used light and dark backgrounds for one sensor to see how repeatable and reliable the data values are.

2.2.3 Similarity

For this I chose to take 20 readings from 4 different sensors at a distance of 20mm to see how they would compare to each other.

2.3 Data Captured

2.3.1 range of distances

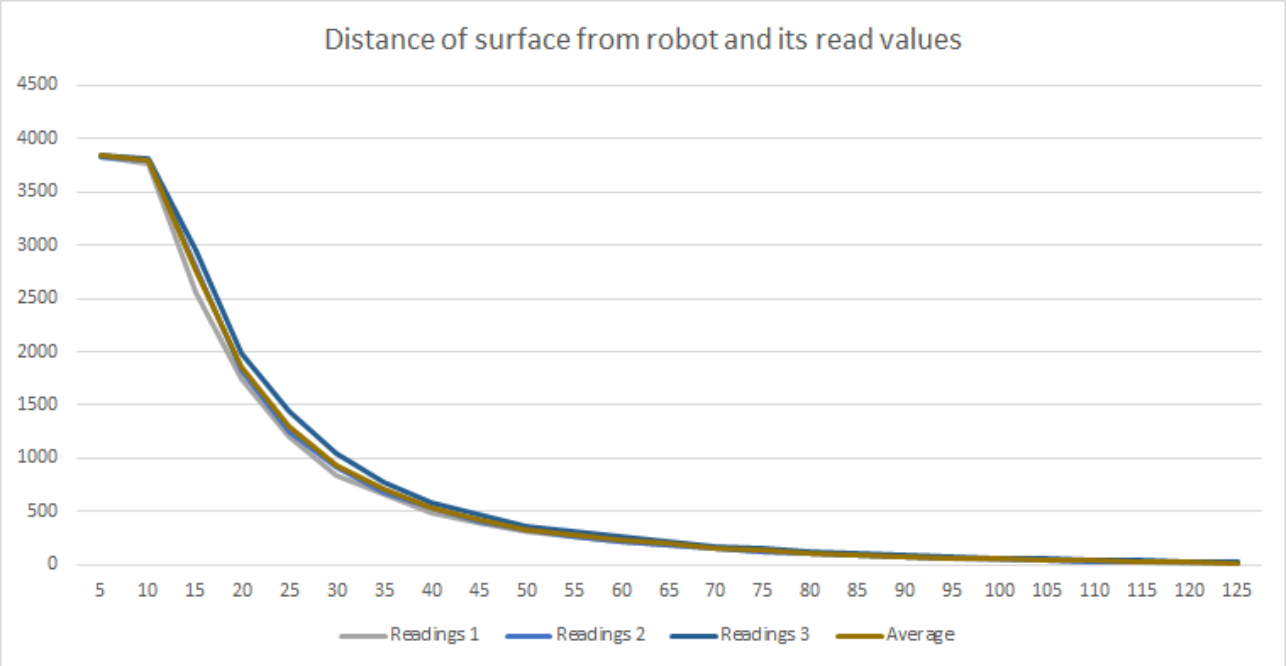
	A	B	C	E	G	I	J
1	MM		Readings 1	Readings 2	Readings 3		Average
2	5		3835	3835	3845		3838.33
3	10		3766	3797	3820		3794.33
4	15		2550	2794	2947		2763.67
5	20		1750	1824	1980		1851.33
6	25		1200	1249	1444		1297.67
7	30		845	917	1053		938.333
8	35		656	677	779		704
9	40		488	530	580		532.667
10	45		394	414	471		426.333
11	50		314	327	367		336
12	55		261	269	315		281.667
13	60		214	221	260		231.667
14	65		180	187	217		194.667
15	70		150	155	174		159.667
16	75		126	129	156		137
17	80		103	108	126		112.333
18	85		89	91	105		95
19	90		72	76	90		79.3333
20	95		60	63	72		65
21	100		51	52	56		53
22	105		42	43	53		46
23	110		34	34	45		37.6667
24	115		30	31	39		33.3333
25	120		18	24	25		22.3333
26	125		16	20	22		19.3333

2.3.2 Repeatability & Reliability

2.3.3 Similarity

2.4 Data Visualised

2.4.1 range of distances



2.4.2 Repeatability & Reliability

2.4.3 Similarity

2.5 Discussion

2.5.1 range of distances

From the data we can determine the range of useful distances are from 10mm to around 120mm where the difference between the sensor values for different distances is not significant.

We can also determine a function for the relationship between the sensor reading and actual distance in mm. By logging the sensor reading we end up with a reasonably straight line to fit the y = mx + c model which allows us to calculate a gradient and a y intercept.

	A	I	J	K	L	N	O	R	T	U	V
1	MM		Average	LOG of Average	LOG of LOG		log(Average)*m +c	difference from actual value		log(log(Average))*m+c	difference from actual value
2	5		3838.333	3.584142688	0.554385291		0.710669271	4.289330729		9.12043249	-4.12043249
3	10		3794.333	3.579135481	0.553778138		0.973338604	9.026661396		9.289924745	0.710075255
4	15		2763.667	3.44148566	0.536745964		8.19420855	6.805791 45		14.04461115	0.955388855
5	20		1851.333	3.267484621	0.514213552		17.32200016	2.67799984		20.3347392	-0.334739198
6	25		1297.667	3.113163149	0.493201881		25.41743589	-0.417435891		26.20033854	-1.200338535
7	30		938.3333	2.972357144	0.473100991		32.80387375	-2.803873746		31.81168502	-1.811685021
8	35		704	2.847572659	0.454474814		39.3498506	-4.349850597		37.01135183	-2.011351831
9	40		532.6667	2.72645552	0.435598417		45.70344484	-5.703444838		42.28087008	-2.280870083
10	45		426.3333	2.62974929	0.419914346		50.77648533	-5.776485325		46.65922118	-1.659221176
11	50		336	2.526339277	0.402491674		56.20119454	-6.201194538		51.52291881	-1.522918 81
12	55		281.6667	2.449735454	0.389119188		60.21969773	-5.219697734		55.2559702	-0.255970199
13	60		231.6667	2.36486355	0.373806087		64.67193007	-4.671930075		59.53076156	0.469238439
14	65		194.6667	2.289291592	0.359701113		68.63630339	-3.636303393		63.46829354	1.531706455
15	70		159.6667	2.203214259	0.343056734		73.15177046	-3.151770459		68.11472371	1.885276287
16	75		137	2.136720567	0.32974773		76.63991375	-1.639913752		71.83005316	3.169946844
17	80		112.3333	2.050508646	0.311861605		81.16244103	-1.162441033		76.82312797	3.176872034
18	85		95	1.977723605	0.296165597		84.98061756	0.019382442		81.20481146	3.795188854
19	90		79.33333	1.899455702	0.27862917		89.08641548	0.913584517		86.10026486	3.899735137
20	95		65	1.812913357	0.258377049		93.62627627	1.373723732		91.75382889	3.246171115
21	100		53	1.72427587	0.236606751		98.27604452	1.72395548		97.83120586	2.168794 14
22	105		46	1.662757832	0.220829002		101.5031737	3.496826313		102.235708	2.764291985
23	110		37.66667	1.575957189	0.197544416		106.0565843	3.943415705		108.7358124	1.264187638
24	115		33.33333	1.522878745	0.182665325		108.840987	6.159012969		112.8894459	2.110554084
25	120		22.33333	1.348953548	0.129996995		117.9648001	2.035199922		127.59229	-7.592290008
26	125		19.33333	1.286306739	0.109344545		121.2511426	3.748857383		133.3576095	-8.357609457

From the data we can see that the distance from the actual value is less for the log of log and from this we can determine that the relationship.

$$\text{Obstacle distance in mm} = \log(\log(\text{sensor value}))\text{*-M+C}$$

For this set of data the gradient is -279 and the intercept is 163 which used a white obstacle. The experiment was re done with a black obstacle and gradient came out at -198 and intercept at 110. As these are both the extreme cases of objects reflection and light absorption, an average was take to determine the distance more reliably at a gradient of -238 and intercept of 136.

2.5.2 Repeatability & Reliability

2.5.3 Similarity

3 Encoders

3.1 Programming

```
void encodersDataGathering(int power){
 FA_SetMotors(power,power);
 FA_DelayMillis(500 + power*10);
 int i;
 for(i = 0;i<5;i++){
  FA_ResetEncoders();
  FA_DelayMillis(1000);
  FA_LCDNumber(FA_ReadEncoder(1), 25*i,
     1, FONT_NORMAL, LCD_OPAQUE);
  FA_LCDNumber(FA_ReadEncoder(0), 25*i,
     12, FONT_NORMAL, LCD_OPAQUE);
 }
 FA_SetMotors(0,0);
}
```

```
int main(){
 FA_RobotInit();
 FA_LCDBacklight(50);
 int power = 0;

 while(1){
  if(FA_ReadSwitch(0)){
   FA_LCDClear();
   encodersDataGathering(power);
  }
  if(FA_ReadSwitch(1)){
   FA_LCDNumber(power, 0,
    24, FONT_NORMAL, LCD_OPAQUE);
   power = power + 10;
   FA_DelayMillis(200);
  }
 }
}
```

3.2 Data Acquistion

3.2.1 Range of power

3.2.2 Repeatability

3.2.3 Similarity

3.3 Data Captured

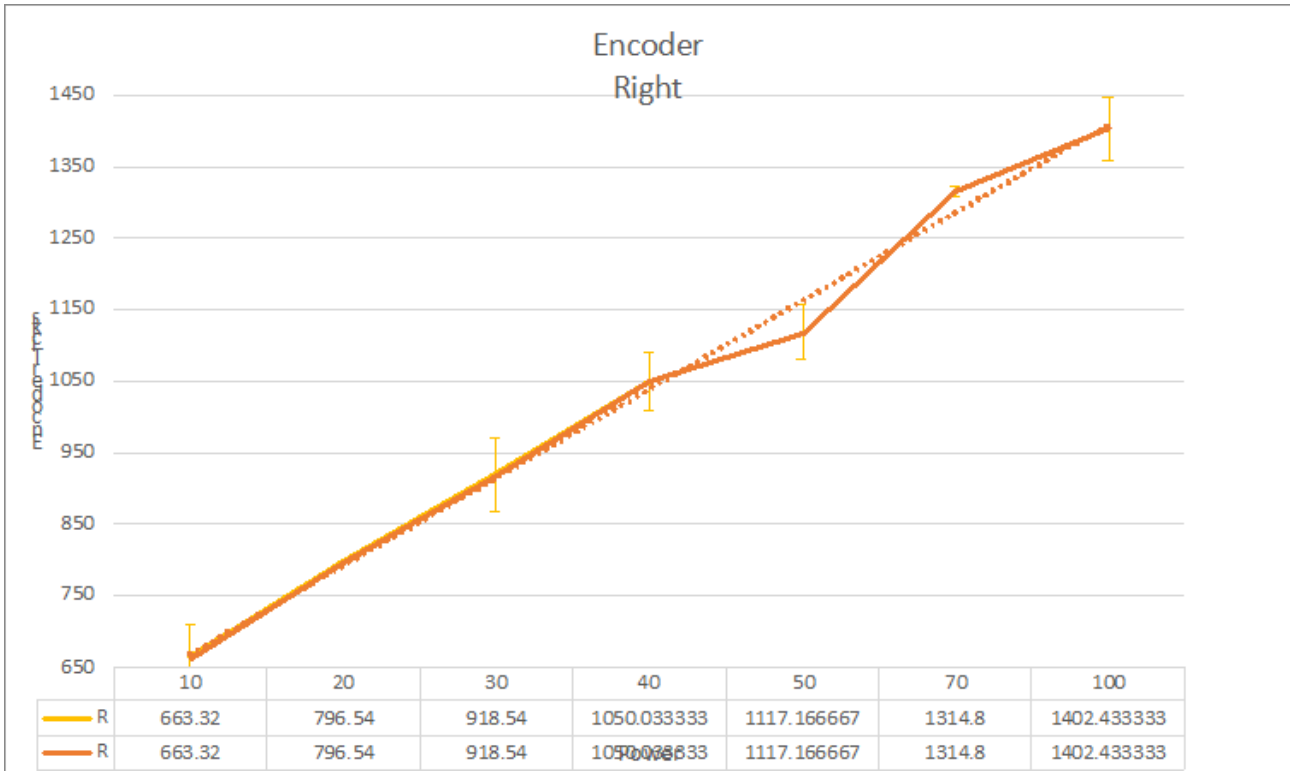
3.3.1 Range of power

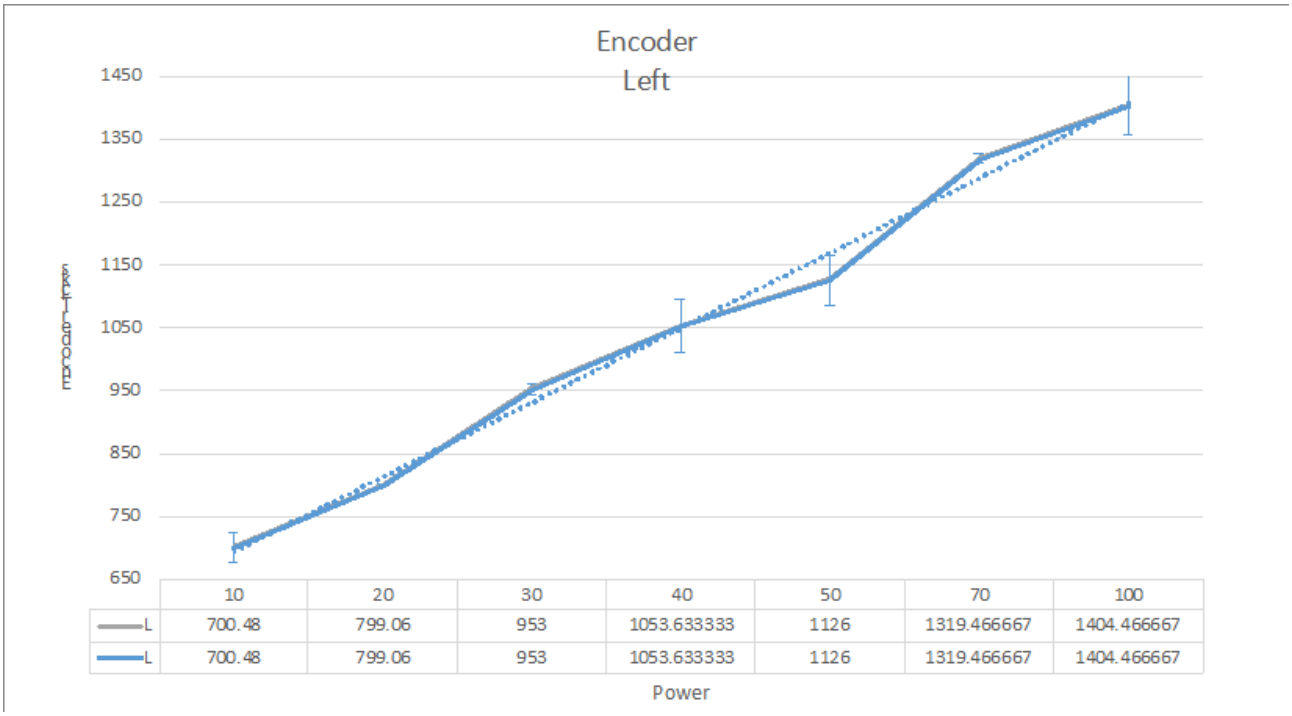
3.3.2 Repeatability

3.3.3 Similarity

3.4 Data Visualised

3.4.1 Range of power





3.4.2 Repeatability

3.4.3 Similarity

3.5 Discussion

3.5.1 Range of power

3.5.2 Repeatability

3.5.3 Similarity

References

[1] *Formula AllCode Robot* `https://www.matrixtsl.com/allcode/formula/`

[2] *in-robot API* allcode_api.h & allcode_api.o Pete Todd & Laurence Tyler 1.1