Contact Details:

Ossian Beaton

H00467392

ob4000@hw.ac.uk

1. Introduction

The Line Follower unit is built up of three TCRT5000 IR (infrared) sensors, which are arranged in a line and placed at the front of the robot. The purpose of this unit is to sense a black line under the robot, and based on which sensor detects it, make adjustments to the direction so as to follow the line. If the line is detected by the left sensor, the robot will turn left. If the line is detected by the right sensor, it will turn right. As the quality of the components given differ from the exact specifications given in the datasheet, the aim of this characterisation report is to determine the effectiveness of the components in a real world setting.

Through the tests, the sensor was found to be effective at detecting the reflective line. However, the sensor's effectiveness would increase if it could be lowered further to the peak operating distance listed in the data sheet. [1]

2. Theory and Technical Background

The TCRT5000 IR sensor is a reflective sensor, which contain an infrared emitter and a phototransistor in a leaded package which blocks visible light[1], both of which are facing in the same direction. The infrared emitter is a light emitting diode which emits infrared light. Infrared light is a type of radiation which is not visible to the human eye, as it's wavelength is higher than that of any colour of visible light in the electromagnetic spectrum.

The phototransistor is almost identical to a normal transistor, except from the base which is present in normal transistors being absent, with light instead being shone upon the base generating a current proportional to the intensity of the light shone upon it. [2]

As the visible portion of the electromagnetic spectrum is blocked, that means that it only reacts to infrared light. The infrared light emitted from the emitter reflects off of the surface so that it shines upon the phototransistor, which increases the current within it which changes the voltage that is read in by the Arduino's analogue pins.

3. Method

Experiment 1: The IR sensors were tested by holding them over different materials with different levels of reflectiveness, and measurements were taken. The materials tested were the brown board, the black reflective line, the white table as well as turning the robot upside down so the IR sensors faced the sky. All tests took place within the same room under the same lighting conditions so that the amount by which the values are affected by background noise was consistent.

Experiment 2: The IR sensors when screwed in completely sits at a height of 6mm off of the ground, and can be lowered to a height of 4mm by unscrewing it partially. The sensors were tested on the white table again. Measurements were taken at heights of 6mm, as well as 4mm.

4. Results

Experiment 1:

Brown Board

Repeats	Left	Middle	Right
1	334	338	338
2	331	335	335
3	345	349	349
4	348	352	352
5	343	347	347

```
Sensor 0: 334
Sensor 1: 338
Sensor 2: 338
Sensor 0: 331
Sensor 1: 335
Sensor 2: 335
Sensor 0: 345
Sensor 1: 349
Sensor 2: 349
Sensor 0: 348
Sensor 1: 352
Sensor 2: 352
Sensor 0: 343
Sensor 1: 347
Sensor 2: 347
```

Figure 1 : Results From The Brown Board

Black Reflective Line

Repeats	Left	Middle	Right
1	951	975	974
2	946	969	968
3	933	956	955
4	928	951	951
5	933	957	956

```
Sensor 0: 951
Sensor 1: 975
Sensor 2: 974
Sensor 0: 946
Sensor 1: 969
Sensor 2: 968
Sensor 0: 933
Sensor 1: 956
Sensor 2: 955
Sensor 0: 928
Sensor 1: 951
Sensor 2: 951
Sensor 0: 933
Sensor 1: 957
Sensor 2: 956
```

Figure 2 : Results From The Black Reflective Line

White Table

Repeats	Left	Middle	Right
1	330	333	333
2	333	335	335
3	370	372	372
4	357	359	359
5	289	292	291

```
Sensor 0: 330
Sensor 1: 333
Sensor 2: 333
Sensor 0: 333
Sensor 1: 335
Sensor 2: 335
Sensor 0: 370
Sensor 1: 372
Sensor 2: 372
Sensor 0: 357
Sensor 1: 359
Sensor 2: 359
Sensor 0: 289
Sensor 1: 292
Sensor 2: 291
```

Figure 3 : Results From The White Table

Sky

Repeats	Left	Middle	Right
1	936	936	941
2	958	959	964
3	883	885	889
4	942	945	946
5	923	924	927

```
Sensor 0: 936
Sensor 1: 936
Sensor 2: 941
Sensor 0: 958
Sensor 1: 959
Sensor 2: 964
Sensor 0: 883
Sensor 1: 885
Sensor 2: 889
Sensor 0: 942
Sensor 1: 945
Sensor 2: 946
Sensor 0: 923
Sensor 1: 924
Sensor 2: 927
```

Figure 4 : Results From The Sky

Experiment 2:

6mm

Repeats	Left	Middle	Right
1	322	325	325
2	341	343	343
3	299	301	301
4	305	308	307
5	328	300	300

```
Sensor 0: 322
Sensor 1: 325
Sensor 2: 325
Sensor 0: 341
Sensor 1: 343
Sensor 2: 343
Sensor 0: 299
Sensor 1: 301
Sensor 2: 301
Sensor 0: 305
Sensor 1: 308
Sensor 2: 307
Sensor 0: 328
Sensor 1: 300
Sensor 2: 300
```

Figure 5 : Results At 6mm

4mm

Repeats	Left	Middle	Right
1	352	355	354
2	377	379	379
3	362	365	364
4	371	374	372
5	386	388	388

```
Sensor 0: 352
Sensor 1: 355
Sensor 2: 354
Sensor 0: 377
Sensor 1: 379
Sensor 2: 379
Sensor 0: 362
Sensor 1: 365
Sensor 2: 364
Sensor 0: 371
Sensor 1: 374
Sensor 2: 372
Sensor 0: 386
Sensor 1: 388
Sensor 2: 388
```

Figure 6 : Results From 4mm

5. Conclusions (100)

Overall, the IR sensors were found to be effective at detecting different materials based on their reflectiveness. The left IR sensor consistently reads in a lower value than the other two IR sensors, however, due to how far apart the values for the brown board and the values for the black line are, the difference is never enough to interfere with the line following process. There is a lot of variance in the values that the IR sensor's read in. In addition, by testing the different heights, it was observed that the values read in increased the closer that the sensors were to the ground, with the highest values at a height of 4mm, which is the lowest it can be dropped using the included screws. As such, it can be concluded that by lowering the sensors even further to the peak operating heigh listed in the data sheet, 2.5mm[1], more accurate values can be obtained.

6. References

1. TCRT 5000 Data Sheet
2. https://electronicscoach.com/phototransistor.html