Milestone 1

EEE3099S – Engineering Design

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Group 28

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Input Stage

If the robot moves at 0.5 m/s in a straight line and the black tape repeats every 20cm:

$$V = \frac{distance}{time} \Rightarrow time = \frac{distance}{v} \Rightarrow t = \frac{20cm}{50cm/s} = 0.4\ s$$

Therefore $T = 0.4s$, and $f = \frac{1}{0.4s} = 2.5\ Hz$.

This is our input parameter to simulate the robot virtually going over the black lines. We have to then output the reflectivity that the sensor picks up at that point. Which will include noise and is not an ideal model like our input. Thus we have to create a floor model.

Floor Model

The floor model consists of multiple noise disturbances and the reflectivity of the floor and black tape.

Noise:

- Old pieces of tape

Old left over tape can only reduce reflectivity of the floor as new tape will be placed above possible old tape. Thus Noise signal saturates to 0 if > 0. We will assume that old tape will have a LRV between 0.4 and 0.6 (only noise values between this range will be considered, this is to furthermore limit the frequency, account for variance in LRV of tape and provide discontinuous waveforms) . The noise from old tape is neither continuous nor a frequent disturbance.

Variance was chosen at 0.06, with a mean at 0.

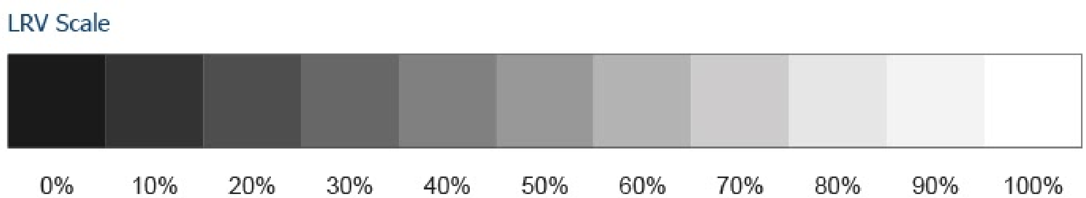
- Dirt

It is assumed that dirt will be spread randomly over the floor with a normal distribution. It is also assumed that the White Lab is cleaned regularly so the floor will not be very dirty.

The dirt will make an estimated reflectivity difference of 0.05. A variance of 0.01 was chosen with a mean of 0 to model the effect of the dirt making the white floor darker and the black tape lighter.

- Floor pattern

According to the LRV index a realistic bright white will have a LVR of nearly 85%. The white lab floor ranges from approximately 80% to 70% due to the lighter and darker patterns.



A normal distribution will be used to model the equal spread of random light and dark patterns of the floor. A variance of 0.05 was chosen with a mean of 0 and a range of +- 0.05 to model the varying light and dark pattern of the floor.

Line Sensor Model

The input to the Line Sensor Model is the floor reflectivity and the output is the reflectivity measured by the sensor.

The line sensor model consists of a 12bit, 100Hz ADC with a reference voltage of 3.3V.

A rate limiter was used to model an ADC slew rate. The rising rate was set to $\frac{3.3}{10} = 0.33\ V/\mu s$ and the falling rate was set to $\frac{3.3}{50} = 0.066\ V/\mu s$.

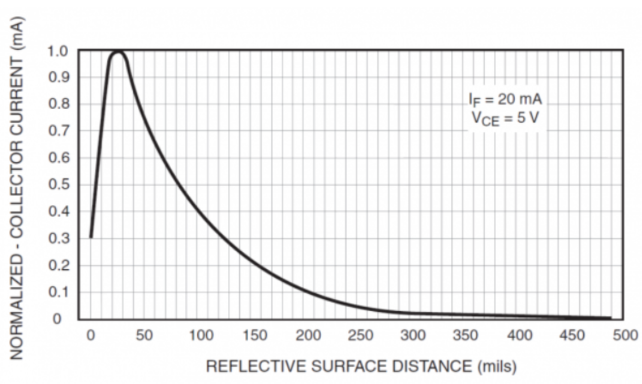
Noise:

- Circuit noise:

The circuit noise of the line sensor model was modeled using band limited white noise with a noise power of $\frac{1}{1000} \times (0.01)^2$.

- Noise from Change in Sensor to floor distance:

According to the Collector current vs Distance graph in the QRD1114’s data sheet, the sensor is sensitive to change in distance from the sensor to the object of interest. As our robot is constantly moving there and uneven floor there ought to be vibrations and



change of this distance. This disturbance is modeled by band limited white noise with a noise power of $\frac{1}{1000} \times (0.02)^2$.

- Sunlight noise:

Noise from the sunlight affecting the light emitted from the sensor was modeled using a normal distribution. This noise only comes into effect between 7am and 7pm when the sun is out. When it is dark outside there is no sunlight noise and the sensor works optimally.

A variance of 0.06 was chosen with a mean of 0.

Sensor Output Signal

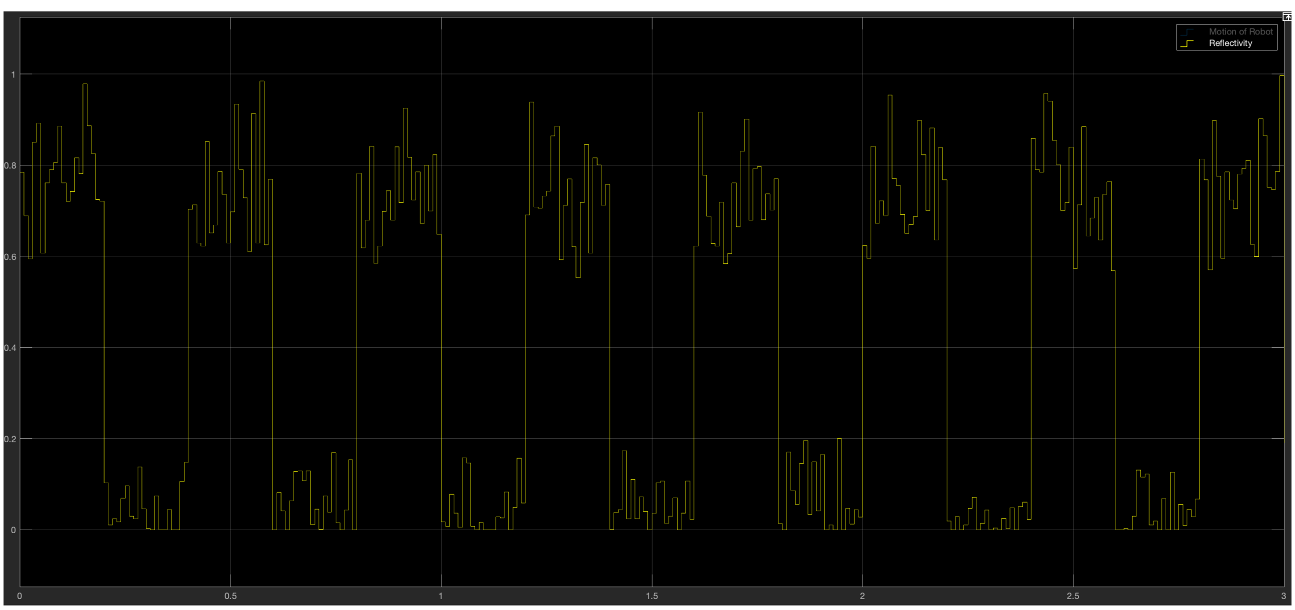


Figure 1: Line sensor output signal