CE2107 Lab2 Assignment Sheet (to be submitted to NTULearn before next lab)

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1. Section 6.2. Give a short 2-3 lines description on concept behind the reflectance reading process. Why does the black surface result in slower voltage decay?

The IR LED fired will bounce off the surface (either black or white) and get detected by the sensor array, which consists of a transistor which affects the current across the Collector and Emitter of the npn BJT based on the amount of IR detected**. Since the BJT is in parallel with a capacitor, the current across BJT will affect the discharge rate of the capacitor. Since black surfaces absorb more energy**, and thus reflect less IR, this causes the effective capacitive reactance of the capacitor to be higher, causing the capacitor to discharge at a slower rate. This causes the capacitor to be read as Logic ‘1’.

1. Section 6.2. Which parameter do you need to tweak in the Reflectance\_Read() if the reflectance sensor reading is not accurate? Hint: check the 8 steps for Reflectance reading.

“uint32\_t time” input can be varied in the main function. This time determines the duration before sampling the voltage across the capacitor at Clock\_Delay1us(time);, A shorter time results in less time for capacitors to discharge after the sensor receives the IR pulse.

1. Section 6.2. Write down the procedure to initialise P7.4 to be an input pin without internal pull-up resistor

P7->SEL1 &= ~(0x10);//clear bit 4 only

P7->SEL0 &= ~(0x10);//clear bit 4 only

P7->REN &= ~(0x10);// clear bit 4 only

P7->DIR &= ~(0x10);// clear bit 4 only

1. Section 6.3. Where are the sources of the offset error between actual distance and the estimated distance return by the function Reflectance\_Position()?

There are substantial amount of gap between the sensors and the limited number of sensors to provide readings contributes to the offset error. For example, the line could be between IR sensor 4 & 5 offset by 0.3 mm. The robot will however be unable to detect the this and perhaps give another value as the sensors are at -0.48mm and 0.48mm**. we just need to add more sensors to cover the gaps.**

1. Section 7.2.  Figure 7. The robot state toggled between LEFT and CENTER state repeatedly when it is detected that the robot is off to the left of the line (input: ‘01’). Under such condition, do you expect the robot to move toward the right in the zig-zag pattern or do you expect it to move in the smooth curve. Assume we shorten the time in each state from 500msec to 5 msec.

When input is 11, the robot will go straight as both Left and Right sensors senses black line. while input of 01, means the robot is tilting to the right and it will go left. Shortening the time from 500msec to 5msec will cause the robot to go between turning left & going straight with 5msec each, looping infinitely. Therefore, the left motor of the robot will stop and start at 5msec intervals while the right motor will continually run. **Which means, the robot will perform a wide curve towards the left as both motors are moving, just that the left motor is rotating slower than the right motor**. For the robot to move in a zig-zag pattern, we have to expect both motors to start and stop alternatively, which is not the case in this scenario.

1. Section 7.3. Fix the bug in the 11-state FSM design.  
   A picture containing table

   Description automatically generated

Ans:

Text

Description automatically generated with medium confidence

1. Section 7.3. What is the purpose of toggling LED within the main routine or ISR?

It is for us to know that the device Is still running, If the LED stops this means our program has stopped running and requires debugging.

1. Section 7.4. What hardware and software modifications are required in order for the robot to move within a lane, i.e. between two black lines, instead of following a line? Detail algorithm not required. Just one bullet point each for hardware and software.

Hardware: Assuming that the 2 lines are of evenly spaced, we need to add at least 4 sensors on either sides of the robot, detecting at least 3 bits 0x1100(line on left), 0x0110(line in middle). Allowing it to detect the left line and right line simultaneously. However, a potential issue may rise when turning as the outward sensor may go off track when turning, because the inner wheel won’t be moving which causes a sharp turn.

Hence we will need to change the software to allow both motors to simultaneously run when turning, with the inner wheel being slower than the outer wheel. This will result in a wider turn, however, this could ensure that the sensor range is always on the line.

Alternatively, we can also create another state such that when either sides of its sensors detects 0x00 (no line),that makes the robot turn on the spot in one direction until it finds a line and continue to line trace, moving left motor forward and right motor backwards.