**ESET 219 Project**

**Objective** – The project is creating a line following robot. The logic circuits will need to be designed to control the speed and direction of the robot to allow it to navigate a black tape path. The schematic design is loaded to the FPGA board which is attached to a prebuilt robot platform and necessary hardware.

**Sensor Description** – There are three infrared (IR) sensors on the front of the robot. These sensors emit IR light and detect the amount of light reflected from the surface. The reflected light generates an analog voltage proportional to reflected light. An analog comparator conditions the analog voltage to a digital voltage by comparing the analog voltage to a reference voltage (set by potentiometer).

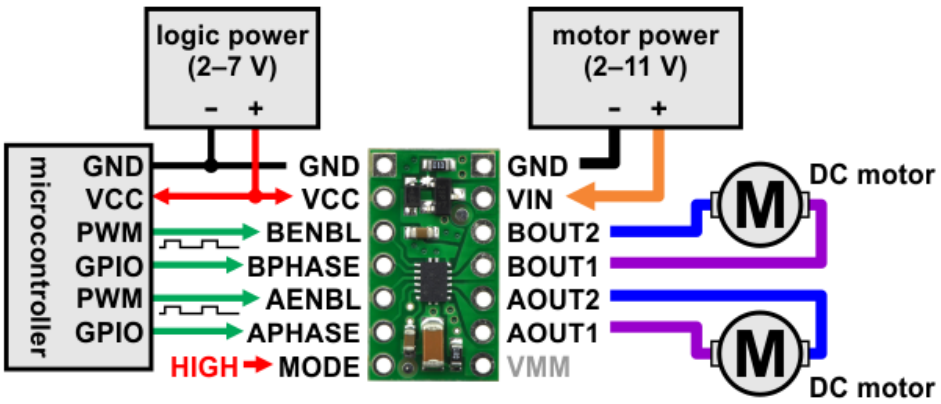
If the reference voltage is greater than the analog voltage, a digital HIGH will be seen on the output. If the reference voltage is lower than analog voltage, a digital LOW will be seen on the output. The potentiometer can adjust the sensitivity of the IR sensor. The table below summarizes the sensor output to position on tape.

| Sensor Output | Sensor Position On Tape |
|---|---|
| LOW | On Tape |
| HIGH | Off Tape |

**Motor Direction & Speed Operation**

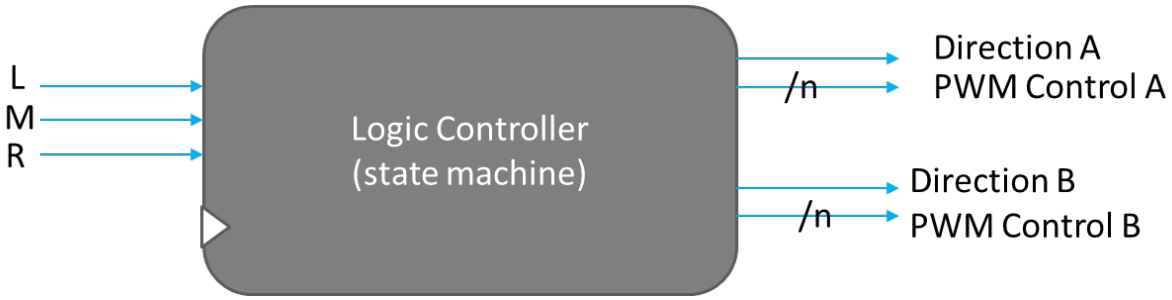
Each motor is controlled by a H-bridge circuit. The H – bridge connects the motor to the digital outputs of the FPGA board. The table below describes the operation of the H – bridge. The ENABLE pin controls the speed with a PWM, while the PHASE pin controls direction of the motor.

| Simplified drive/brake operation with MODE=1 (PHASE/ENABLE) | | | | |
|---|---|---|---|---|
| **xPHASE** | **xENABLE** | **xOUT1** | **xOUT2** | **operating mode** |
| 0 | PWM | PWM | L | forward/brake at speed *PWM %* |
| 1 | PWM | L | PWM | reverse/brake at speed *PWM %* |
| X | 0 | L | L | brake low (outputs shorted to ground) |



**Logic Controller Operation**

The state machine controls the duty cycle of each motor PWM and motor direction according to the sensor input. A block diagram of the logic controller is given below.




Depending on the input of the sensors, the logic controller must set the direction and PWM control value accordingly to adjust the robot position so that it is over the tape.

There are various ways to turn such as

- Slowing speed down of one motor while keeping both turning the same direction.
- Reversing direction of one motor while keeping one the opposite direction.
- Stopping a motor while keeping one turning.

**Notes on Project**

- The project is a group project with each group being 2 students. Groups of 3 will only be allowed with permission from the TA. You are free to choose your own groups and let the TA know of your group formation. All team members must belong to the same lab section. No group formations will be allowed after 11/18). Failure to find a group will result in doing the project solo.
- A physical robot will not be given to any group until a draft of a complete state diagram and schematic (PWM, state machine logic, etc.) is shown and explained to the TA. The robots are only available for use during lab time. No robot will be loaned out.
- The grade for the project is based on how much of the tape track the robot navigates. You can test the robot as often as you want but can only have two demo attempts. The best demo attempt will be used as project grade.
- No report is required for the project. You should understand the project, as questions related to it may be on the final exam.