CE1901 LABORATORY PROJECT

SUMMARY

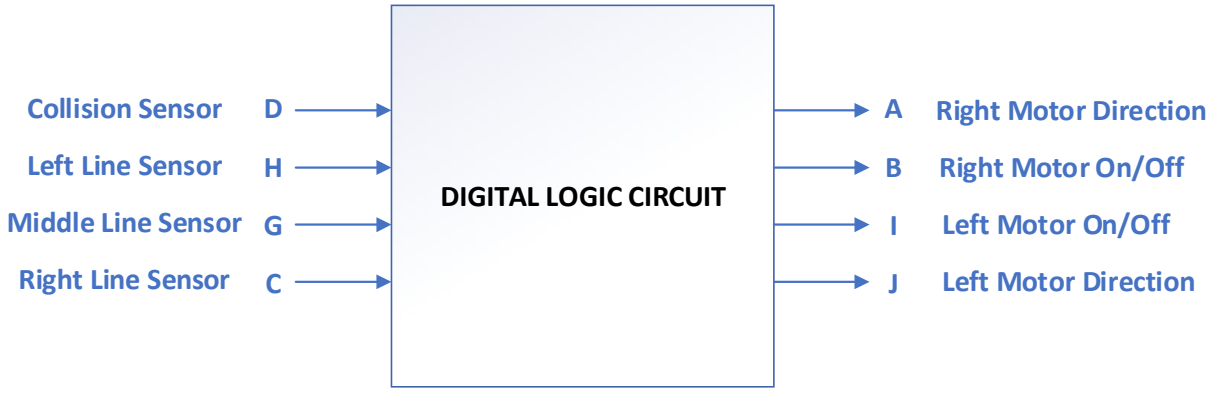
These laboratory exercises continue to focus you on design of logic equations as well as the implementation of those equations as wired SSI/MSI integrated circuit chips. This week, you design different mobile robot behaviors for the same mobile robot from the last laboratory.

PRELIMINARY READING

Review the preliminary reading from the last laboratory and these reference tables and figures.

Table 1: Robot Electrical Signals

NAME	TYPE	MEANING	IF 0	IF 1
A	Control	Right motor direction	reverse	forward
B	Control	Right motor on/off	off	on
C	Sensor	Right line sensor	over black	over white
D	Sensor	Collision sensor	no collision	collision
E	Power: GND	Battery negative (0V)		
F	Power: VCC	Battery positive (+5V)		
G	Sensor	Center line sensor	over black	over white
H	Sensor	Left line sensor	over black	over white
I	Control	Left motor on/off	off	on
J	Control	Left motor direction	reverse	forward



Block Diagram of Design Problem

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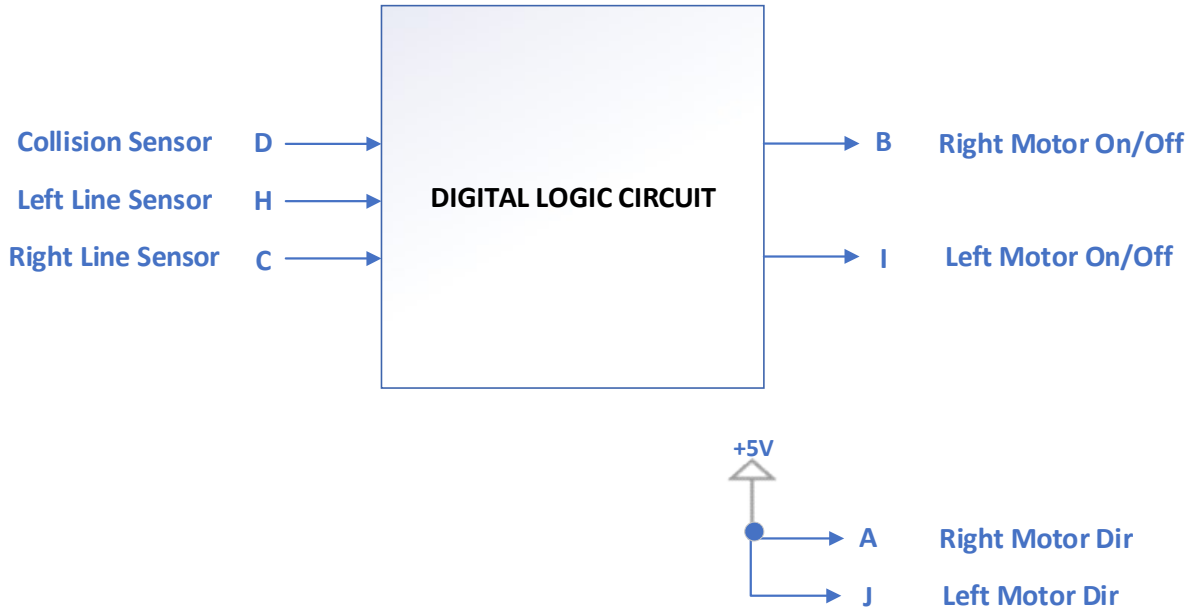

A Block Diagram with Reduced Signal Set

KEY POINTS

Remember these key points about the robot signals:

- motor forward = logic 1 = +5V
- motor reverse = logic 0 = 0V
- motor on = logic 1 = +5V
- motor off = logic 0 = +5V
- collision = logic 1 = +5V
- no collision = logic 0 = 0V
- line sensor over white = logic 1 = +5V
- line sensor over black = logic 0 = 0V

- Not ery input and output is needed to solve problems.

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PRE-LABORATORY WORK

1. **Complete** a truth table for each output in Figure 5. The task is to keep the robot centered over a black line of electrical tape placed on a white surface in a random path. You will place the robot onto the track with the center sensor aligned over the black line. Horizontal tape forms road blocks on the track at periodic intervals. The first step in design is to determine appropriate behaviors for each input pattern. **Use** Figure 6 to help think about how the logic outputs for the left and right line sensors change as the robot rolls along the track.

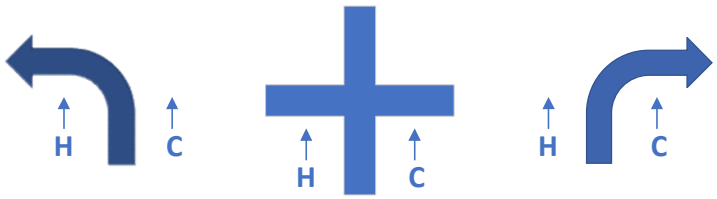

Figure 6: **Robot Motion and Sensor Position Along the Track**

INPUTS			DESIRED BEHAVIOR	OUTPUTS	
				Left Motor On/Off	Right Motor On/Off
D	H	C		J	A
0	0	0	Road Block! Stop!		
0	0	1	Turn Left		
0	1	0	Turn Right		
0	1	1	Forward		
1	0	0	Collision! Stop!		
1	0	1	Collision! Stop!		
1	1	0	Collision! Stop!		
1	1	1	Collision! Stop!		

2. **Review** the 74151 data sheet. Pay close attention to the IEEE Std. 91-1984 schematic symbol as well as the truth table. Note that the 74151 names its selection bits C, B, and A rather than S2, S1, and S0. Note that bit C is the most significant bit in the data sheet truth table. Finally note that the 74151 also has an **active-low** enable control bit called G. You must enable the 74151 for it to become active.
3. **Implement** your solution as a Quartus schematic blueprint using two 74151 multiplexers; one for each on/off signal. **Don't forget to enable each MUX!**
    a. **Type** 74151 into the part selection box.
    b. **Type** "GND" and "VCC" into the part selection box.
    c. **Remember** that if you get an "inst names already exists" error when compiling, ensure that every component in the schematic has a unique "inst" name. You may have to double click a component and change its inst numbers to inst99 or inst98 for example to ensure they all have unique inst names.
    d. **Add** pin numbers next to the chip for each 74151 pin. **Hint:** use the text tool found in the schematic editor icon bar. **Consult** the data sheet available on your course site for pin information.
    e. **Complete** waveform simulation.

DELIVERABLES DUE DURING THE LABORATORY PERIOD

Each student must complete these deliverables. This is not a team exercise.

1. **Demonstrate** the pre-lab work to your instructor.
2. **Check out** a Digi-bot, batteries, wire kit, and two 74LS151 chips from EECS Tech Support.
3. **Build** and **demonstrate** a working Digi-Bot.
    a. **Focus** on using the shortest wires possible. **Consider** red = power, black/white/gray = ground, yellow = inputs, green = outputs.
    b. **Use** the power and ground busses on the robot body but remember that they only run one half the length of the board.
    c. **Remember** that you can use short red and black/white/gray wires to connect multiplexer data inputs to power and ground rails.
4. **Complete** a laboratory submission packet.
5. **Submit** your laboratory packet using the method required by your instructor.