ECEN 345/ECEN 3450-001

Mobile Robotics I

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Laboratory Assignment #4

Lab 4 - [Report]

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Introduction :
The main objective of this lab was to contrive a Behavior-based control robot that would use light sensing photo-resistors in order to home in on a light source. We had also to create a photoresistor and understand how it was working. The behaviors that are imperative to be created for this lab are CRUISE that will make the robot go straight without any sensing of the light. And LIGHT_FOLLOW when the robot had his voltage increasing it should make one specific wheel moving faster. And modify the behavior for vehicle 2 and 3.

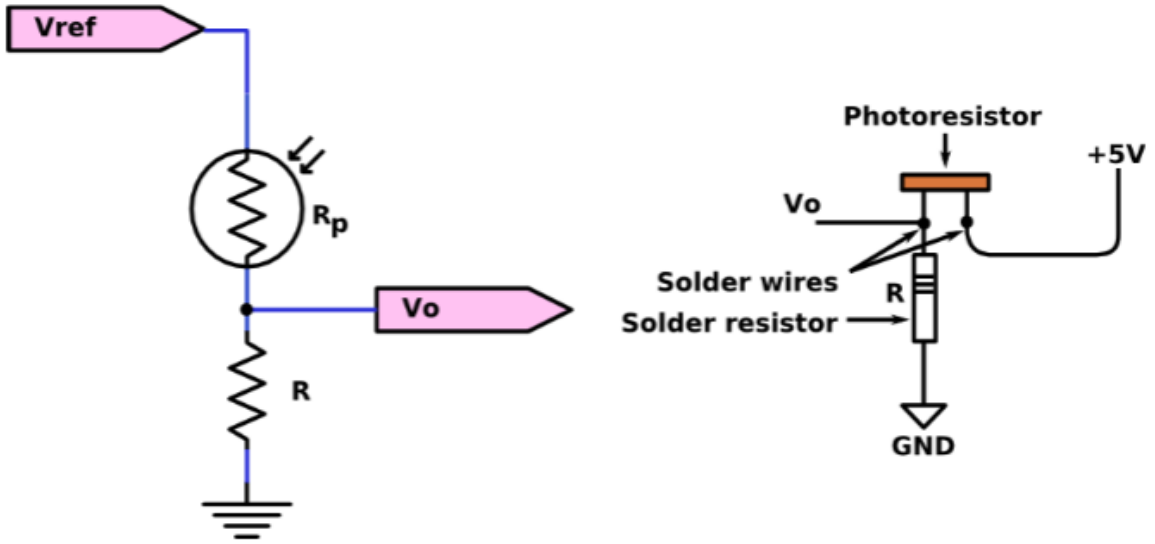
Requirement: - CEENBoT-API – Getting Started guide
- CEENBoT-API: Programming Fundamentals
- Ceenbot + Microchip studio + Ceenbot Utility tools (LAB 1)

Time invested in this project : For the lab I spend around 15h to figure out how the electrical part of the ceenbot works, how and where I should plug the cable etc.. Because i'm not coming from engineering class and the only electrical project i made was on raspberry pi.

Team : I have done this lab alone, so no repartition time for the tasks. But i asked help from Mr. Endrulat and also in the mobile robotics discord group.

Problems encountered : I had trouble understanding how the electrical part is working and I also had some C program organization (Because i'm always switching from different languages and that can create some confusions).

Background:
In the lab we got some information about the realization of the assembly. First of all we had to make some soldering to create the photo resistor. Electric schema below:



But we also provide the different channels to make the necessary connections to obtain the voltage.

ADC Channel	Pin on J3 Header Connector (on '324 Controller Board)
ADC Channel 3	1
ADC Channel 4	2
ADC Channel 5	3
ADC Channel 6	4
ADC Channel 7	5
VCC (5V)	**19**
GND (0V)	**20**

The photosensor is pretty understandable, when the light is high on the sensor the resistance decreases and the voltage is higher. With the code given below we know how to convert the voltage received in the ADC channel into concrete voltage.

```
#include "capi324v221.h"

void CBOT_main( void )
{

    ADC_SAMPLE sample;  // Storage for ADC code.
    float      voltage; // Storage for 'voltage' representation of ADC code.

    // Open the ADC subsystem module.
    ADC_open();

    // Set the voltage reference (we want 5V reference).
    ADC_set_VREF( ADC_VREF_AVCC );

    // Set the channel we will sample from.
    ADC_set_channel( ADC_CHAN3 );

    // Okay, now SAMPLE it!
    sample = ADC_sample();

     // Convert it to meaningful value.
     voltage = ( ( sample * 5.0f ) / 1024 );

     // Now do whatever it is you need to do with this information..., etc.

} // end CBOT_main()
```

Procedure:

So we'll make two functions, one called cruise which will perform a constant forward motion as long as the conditions of Light follow are not called, and light_follow who receive the output voltage and act in consequence.

Source Code Discussion:

For the source code discussion we need to split the analysis in two parts, machine 2a and 3a.

In machine 2 we use an infinite while where the robot cruises and then use the light_follow. For the cruise function it's a simple moving forward with stnb but for the light follow I use two variables which indicate the left and the right voltage. And with a if we are checking if the voltage of the right sensor or the left sensor is over 3v (Because the voltage range is about $0.238V \leq Vo \leq 3.846V$). If it's the case we are accelerating the movement of the wheel (i.e : left if the left voltage is higher) with the fonction STEPPER_set_accel2(2,2) for both wheel, and STEPPER_set_accel(STEPPER_LEFT or STEPPER_RIGHT,2). To realize machine 2b we need to switch the wire of the ADC voltage to make the robot accelerate in the opposite direction of the light instead.

In machine 3 we basically have the same operation nevertheless instead of the acceleration function we use the STEPPER_move_stnb(STEPPER_BOTH,...) with a decrease of the wheel speed where the concerned wheel has the censor whose voltage is superior to 3v. And like the machine 2 we just need to switch the wire of the ADC voltage to make the robot fear the light with a constant speed instead.

Results:

Part 1:

1) When I measured the voltage of the photosensor I had 1.30V for the left photosensor and 0.6V for the right sensor. So we can see that the voltage of the different sensors are different.
2) ADC CHANNEL : 1-2
   Voltage in : 19
   Ground : 20
3) I put the two photo sensors just above the IR sensor because it's just in front of the machine to make the machine have a vision of the obstacle in front of it.
4) Here is the voltage for différent cases :

	left	right
ambient light on the lab table	2.24	1.09
ambient light on the lab floor	2.20	1.02
cover the sensor	0.21	0.33

next to a bright artificial light source	4.78	4.03
in sunlight	2.5	1.32

5) Here is the functionality of the machines :
   machine 2a : Accelerate in the direction of the light
   machine 2b : Run away of the light direction
   machine 3a : Go in the light direction with a constant speed
   machine 3b : Go in the out of the direction with a constant speed

6) For machine 2 the robot is aggressive and accelerates to the goal without being stopped.
   For machine 3 the robot has a “normal” speed to the goal.

Conclusion :
We can say the lab is almost working well nevertheless the machine 3 had a weird behavior and was working sometimes. Also I have encountered a problem where the robot reboots after a while. I imagine that it is a too important number of actions which surely leads to an overload of the CPU and the reboot of the machine. Nevertheless the lab allowed us to understand and realize the machines of braitenberg.

Code :

```
/*      Auth: Nelson Lefebvre
*       Course: ECEN3450-Mobile Robotics I
 */
#include "capi324v221.h"

float voltageleft,voltageright;

void cruise(){
        STEPPER_move_stnb( STEPPER_BOTH,
        STEPPER_FWD, 10, 200, 10, STEPPER_BRK_OFF, // Left
        STEPPER_FWD, 10, 200, 10, STEPPER_BRK_OFF ); // Right
}

void LightFollow(){
        // Open the ADC subsystem module.
```

```
	ADC_open();
	// Set the voltage reference (we want 5V reference).
	ADC_set_VREF( ADC_VREF_AVCC );
	// Set the channel we will sample from.
	ADC_set_channel( ADC_CHAN3 );
	// Okay, now SAMPLE it!
	ADC_SAMPLE left = ADC_sample();
	ADC_set_channel( ADC_CHAN4 );
	// Okay, now SAMPLE it!
	ADC_SAMPLE right = ADC_sample();
	// Convert it to meaningful value.
	voltageleft = ( ( left * 5.0f ) / 1024 );
	voltageright = ( ( right * 5.0f ) / 1024 );
	LCD_printf("Vehicle 2a\nLeft: %f\nRight: %f", voltageleft, voltageright);

	if ((voltageleft > 3.5)&&(voltageright > 3.5))
	{
		STEPPER_set_accel2(2,2);
	}

	if ((voltageleft > 3.5)&&(voltageright < 3.5))
	{
		STEPPER_set_accel(STEPPER_LEFT,2);
	}
	if ((voltageleft < 3.5)&&(voltageright > 3.5))
	{
		STEPPER_set_accel(STEPPER_RIGHT,2);
	}
}

void CBOT_main( void )
{
	ADC_SAMPLE sample;

	while(1){
		// Now do whatever it is you need to do with this information..., etc.
		LCD_open();
		STEPPER_open();
		cruise();
		LightFollow();
		LCD_clear();
	}
}
```

```
/*      Auth: Nelson Lefebvre
*       Course: ECEN3450-Mobile Robotics I
 */
#include "capi324v221.h"

float voltageleft,voltageright;

void cruise(){
        STEPPER_move_stnb( STEPPER_BOTH,
        STEPPER_FWD, 100, 200, 50, STEPPER_BRK_OFF, // Left
        STEPPER_FWD, 100, 200, 50, STEPPER_BRK_OFF ); // Right
}

void LightFollow(){
        // Open the ADC subsystem module.
        ADC_open();
        // Set the voltage reference (we want 5V reference).
        ADC_set_VREF( ADC_VREF_AVCC );
        // Set the channel we will sample from.
        ADC_set_channel( ADC_CHAN3 );
        // Okay, now SAMPLE it!
        ADC_SAMPLE left = ADC_sample();
        ADC_set_channel( ADC_CHAN4 );
        // Okay, now SAMPLE it!
        ADC_SAMPLE right = ADC_sample();
        // Convert it to meaningful value.
        voltageleft = ( ( left * 5.0f ) / 1024 );
        voltageright = ( ( right * 5.0f ) / 1024 );
        LCD_printf("Vehicle 3\nLeft: %f\nRight: %f", voltageleft, voltageright);
        if ((voltageleft > 3)&&(voltageright < 3))
        {
                STEPPER_move_stnb( STEPPER_BOTH,
                STEPPER_FWD, 100, 200, 25, STEPPER_BRK_OFF, // Left
                STEPPER_FWD, 100, 200, 50, STEPPER_BRK_OFF ); // Right
        }
        if ((voltageleft < 3)&&(voltageright > 3))
        {
                STEPPER_move_stnb( STEPPER_BOTH,
                STEPPER_FWD, 100, 200, 50, STEPPER_BRK_OFF, // Left
                STEPPER_FWD, 100, 200, 25, STEPPER_BRK_OFF ); // Right
        }
}
```

```
void CBOT_main( void )
{
	ADC_SAMPLE sample;

	while(1){
		// Now do whatever it is you need to do with this information..., etc.
		LCD_open();
		STEPPER_open();
		cruise();
		LightFollow();
		LCD_clear();
	}
}
```