Project 6

See course website for due date.

Overall Project Goal:

The overall plan is to create a car that can follow a black electrical tape line after navigating via a Wi-Fi connection. The creation of the car is broken into nine projects.

The first project is the installation of the Control Board to the FRAM Experimenters Board and the addition of the battery power system for independent operation. A power switch is provided to minimize battery drain.

The second project is the installation of the LCD onto the control board. Demo your working LCD with the Hardware Test code.

The third project is the creation of the car with the forward only part of the H-bridge control for the wheels. Successful verification will be of the car moving in predetermined shapes within a 36" x 36" square area.

The fourth project is adding full control of the H-Bridge allowing the vehicle to travel forward and reverse. Verification will be with timed travel forward followed by timed travel in reverse.

The fifth project is the addition of the emitter / detector circuit that will detect the black line.

The sixth project will be replacing the timed travel forward and reverse from project 4 with remaining inside a black line circle.

The seventh project is the serial communication. There will be homework assignments that will assist in building software routines that can be used in the project.

The eighth project is to communicate with a Wi-Fi device.

And the ninth project is steering via a web interface, auto intercepting and following a black line to the course end.

The Wi-Fi course will be to navigate an area in the quad or EBII Hallway. The top 25 students to complete the course with the fastest time will receive from 1-5 bonus points.

Navigation of each Wi-Fi course segment will be considered successful by driving into the 1 foot square and stopping; if it is the last point, or passing over on the way to the next point.

Project 6 Details:

The sixth project is the use of both Thumb Wheel and the Emitter / Detector circuit to detect and provide the guidance to follow the black line. Verification will be by replacing the timed travel

forward and reverse with detection of a circular black line. Once detected the vehicle must travel around the circle twice.

In Project 5, you added the Thumb Wheel, Detectors and Emitter hardware and code. The Thumb Wheel provides assistance in debugging ADC code, and to provide for a menu selection mechanism. In Project 6, the Emitter and Detectors will be used to both intercept and follow the Black Line. Once intercepted, your vehicle must follow the black line circle traveling around the circle at least twice.

Hardware:

You may need to bend and change the orientation / angle of the detectors to improve.

How are you going to orient your emitter / detectors? Will ambient light affect operation? This aspect is totally up to you on how you will mount your IR LED/detectors to get it to work. You may need straws or shields to help isolate the emitter and detectors; again, you will need to figure this out for your own car. The height, angle, etc. may all play into operation of your vehicle.

The oscilloscopes in EB2 1008 will be of help if you need them.

You are strongly urged to use the soldering irons in the lab along with flux to help avoid cold solder joints. The flux can be cleaned using a toothbrush and rubbing alcohol or nail polish remover. Boards can also be washed with soap and water.

There is an Ultrasonic Cleaner that will be available When Instructor or a TA are in the Lab.

Software:

You may use any part of the previous code that you have developed. No magic numbers allowed. A random sampling of a file will occur by the TA.

Start with the software from Project 5. Use the display to provide feedback to what your software is doing or about to do. Use your function to display the ADC value.

Remember Battery power is required for the motors to run. You can run with both Battery power and USB connected simultaneously.

Make sure you can turn on and off the emitter. Do not leave it on all the time as it will rapidly discharge your batteries. The emitter will barely glow red when on, and is easily detected on many cell phone cameras that do not have an IR filter.

Since your emitter runs off of the USB when it is connected, debug the detectors while using USB power to save on batteries. Use your Black Electrical tape on a blank piece of plain white copy paper. Some students have found it advantageous to create a square made from black tape and make sure their car can move back and forth staying inside the square. Use this to see the change between detection of the line and detection of the white paper. You may find it

convenient to manually move your vehicle and leave your motors disconnected so that accidental drives off the desk do not occur.

You should have a calibration mode to identify the ambient light condition, as the readings will be greatly affected if you are inside, outside, or in front of a device that emits a lot of IR [like sunlight through windows]. Do this by taking readings of the IR conditions from the detectors when the emitter is off. Then turn the emitter on and take readings from the ADC when on white paper and then when on a black line. Use Electrical tape to create the black line. You will need to be able to display all three values. Your code should take into account the ambient light and not just be a fixed threshold.

Think about the emitter as being a small flash light. The closer to the paper, the more focused will be the bounce of light back up toward the detectors. Focus the detectors on the spot that the emitter is illuminating. You will not be able to see the spot, but you should be able to estimate where it is.

You will have your vehicle move forward, intercept the circle and travel around the circle at least twice. Prior to starting in the center of the circle, calibrate your vehicle to the white area, the black line and ambient conditions.

Your vehicle placed inside a black lined circle should:

1 Travel forward until detection of the black line, pause for 1 - 2 second.
2 Make a turn [either direction] to follow the black line.
3 Travel around the circle twice.
7 Should end about in the same location or past the location of intercept.

The display should identify the state of the motion, Intercepting, Waiting, Turning, Circling.

Project Write-up:

There is a project write-up that must be updated with each project. One notebook is to be maintained by each team. The notebook needs to contain all the sections defined in the template. Take advantage of the minimal sections required to get them completed so the various parts and tests can be referenced later. As each project is demonstrated, relevant updates to the various sections are required. There is only one document required per team. Each team member must have a car, and grade points are only shared with the notebook. Work on it together. Ask questions in class. Each team member's car should include red and white and the team number. An easy way to do this is to use red and white paint for the number. These numbers must be readable from 10 feet away and must be visible at all times through the duration of the 8 projects. 10 Points will be deducted for cars not displaying team number and team colors.

The document with Project 6 should include Flow charts for Main, Ports, Timers, ADC and Interrupt files. Software sections should also be included. These can be parts from various team members code. I suggest each team member document the flow chart, description and actual

code for a file of their own code. One member should do their main, another member should do their Interrupts, and another their Timers, etc.

Demonstration Procedure:

Arrange a time through the message board to demonstrate your system to a TA. Make sure you have the TA sign your grade sheet. The TA's will have specifics to look for in each write-up. These will be discussed in class.

Grading Scale for Project 6:

Demo 80%

Item	Description	Points
1	Code inspection of Intercept function	10
2	Black Calibration Mode	10
3	White Calibration Mode	10
4	Vehicle can Travel forward until Black Line Intercept	20
5	Vehicle can stop near / on Black Line	10
6	Vehicle can turn and follow Black Line	20
7	Vehicle can travel around twice	10
8	Display shows relevant information	10
		100

Write-up 20%

Item	Description	Points
1	Project Write-up Notebook	100
		100