SE423 Final Project Spring 2020, COVID-19 Version

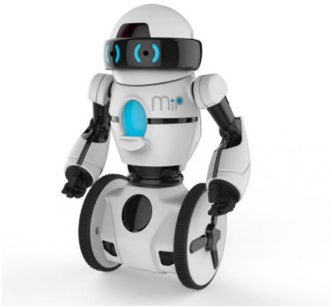
Design your own Self-Balancing Robot, SegBot.

Due Date Monday May 11th at 5pm

Checkpoint #1: Due Friday April 10th at 5pm

Checkpoint #2: Due Friday April 24th at 5pm

Checkpoint #3: Due Monday May 4th at 5pm



For your final project this semester, you will be designing a self-balancing robot that I like to call a Segbot (Segway Robot). You will work on this project with your lab partner sharing ideas and the workload. Before we left for spring break we had created final project groups of four. There is not enough work in this on-line project for four partners so I am returning to your lab groups of two. Of course you are encouraged to share your struggles and solutions with all of us as you work through this project. The final design and description is due Monday May 11. In addition, I have created three checkpoint dates that you are required to send me your status on the project. This is the minimum number of times you need to contact me about your project. I expect you to contact many more times than that with status and questions about your design. A large portion of your grade will be the final design, but you will also be scored on the amount of work you put into this project. The only way I am going to know the work you are putting into the project will be by you sending me status updates.

You will get to decide if you want to make a Segbot that is very low cost or one that uses industrial motors, amplifiers and sensors where cost is not an issue. Make this decision by deciding what parts you want to teach yourself. If you want to go a bit cheaper then hobby robot sites is where you should find your parts. If you want to teach yourself more about industrial automation choose industrial motors and amplifiers. I give a listing of websites (coming soon) at the end of this document, but you can find your parts at other companies also.

I have built a number of Segbots over the years. See the below pictures. I even built one that was controlled by a Gameboy Advanced http://coecsl.ece.illinois.edu/ge423/segboy.pdf. I have a website that gives many details into one of those designs. (You of course cannot use this design exactly.) http://coecsl.ece.illinois.edu/segbot/segbot.html. Also do a web search for "Self Balancing Robot" and you will find many more people that have built their own.

The only part of the Segbot design that you MUST use is one of two controller boards. You can choose between the MSP430G2553 LaunchPad (red board) which you have been programming for all your HW assignments, or you can choose the TMS320F28379D LaunchPad. This is very similar to the processor on the robot cars that we called the motor control chip or TMS320F28335. If you choose this processor, I will give you some starter code to help you get started. Both processors will work to control your Segbot. I am giving you the option of the TMS320F28379D processor in case some of you want to try out other communication protocols like CAN (Controller Area Network) or find that you need more peripherals than the MSP430 has.

Using one of the two LaunchPad's you will design the following: (More details to come in this document and also in lecture)

1. Use EagleCAD to design a circuit board, similar to the green circuit board given to you for homeworks, that connects the Launchpad's header connectors to all the needed sensors, amplifiers, voltage sources and LEDs for example. More below on the requirements for the circuit board.
2. Draw a CAD model of all the parts of your SegBot. The wheels, motors, outline of the circuit boards, sensor locations, battery size and location. This drawing will make sure everything will fit in the space of your design and will also give you an idea of the weight of the system.
3. Pick the motors, gearing and feedback sensor that senses the angle of the motor.
4. Pick the gyro and accelerometer sensor used to stabilize the Segbot.
5. Pick the motor amplifier/H-bridge to drive the motors using PWM as the input to the amplifiers.
6. Pick the battery for the system and a connector to plug the battery into your circuit board.
7. Pick the voltage regulators or DC to DC converters to regulate the battery voltage down to the 5V and 3.3V needed for your system.
8. Derive the equations of motion for a two dimensional Segbot. (In HW and lecture)
9. Develop the controller software to balance your Segbot. (Covered in lecture.)
10. Develop the controller software to allow yours Segbot to move forward and backwards and turn left and right. Covered in lecture.
11. If there is time, add a wireless communication to your circuit board to communicate wirelessly with your PC and write software to make this wireless communication happen.
12. If there is time, add a LIDAR to your Segbot for obstacle avoidance and write software to communicate with the LIDAR.

Companies that I routinely use. BUT you can find parts from other companies.

Motors:

https://www.gobilda.com/

https://www.pololu.com/

https://www.micromo.com/

https://www.haydonkerkpittman.com/

http://www.lynxmotion.com/

https://www.robotshop.com/

https://www.hebirobotics.com/

https://www.banggood.com/search/dc-motors-with-encoder.html?from=nav

http://www.servosystems.com/

https://www.servocity.com/

Motor Amplifiers and H-bridges:

http://www.ti.com/motor-drivers/brushed-dc-bdc-drivers/overview.html

https://www.allegromicro.com/en/products/motor-drivers/brush-dc-motor-drivers

https://www.pololu.com/

https://www.a-m-c.com/

https://www.digikey.com/

https://www.mouser.com/

https://www.newark.com/

Regulators and DC to DC converters

https://www.digikey.com/

https://www.mouser.com/

https://www.newark.com/

https://www.astrodynetdi.com/ecatalog/power-supplies/high-density-dc-dc

http://www.ti.com/

IMUs, Optical Encoders and other Sensors:

https://www.pololu.com/

https://www.usdigital.com/

https://acroname.com/

https://www.robotshop.com/

https://ams.com/angle-position-on-axis

https://www.banggood.com/search/dc-motors-with-encoder.html?from=nav

https://www.allegromicro.com/en/products/sense/linear-and-angular-position

https://www.sparkfun.com/

https://www.adafruit.com/

Wheels

https://www.servocity.com/

https://www.gobilda.com/

https://www.pololu.com/

Hardware:

https://www.servocity.com/

https://www.gobilda.com/

http://www.lynxmotion.com/

https://www.robotshop.com/

https://www.mcmaster.com/

Electronics Distributors:

https://www.digikey.com/

https://www.mouser.com/

https://www.newark.com/

Surplus Companies:

https://www.goldmine-elec-products.com/

https://www.allelectronics.com/

https://www.mpja.com/

Robot Hobbyist Companies:

https://www.pololu.com/

http://www.lynxmotion.com/

https://www.robotshop.com/

https://www.servocity.com/

https://www.sparkfun.com/

https://www.adafruit.com/

Batteries:

https://www.horizonhobby.com/

https://www.batteryspace.com/

https://amazon.com