Electronics and Robotics Club

http://erc-bpgc.github.io

Winter - 2020 Induction Assignment

1. Study Material:

Please refer to this section for links to reference/study material and the installation guide for the software needed to complete the assignment.

Installation of Dependencies:

1.) ROS (Robot Operating System)

Users with Ubuntu 16.04: Install ROS Kinetic by following steps from the link below:
http://wiki.ros.org/kinetic/Installation/Ubuntu
Users with Ubuntu 18.04: Install ROS Melodic by following the steps from link below:
http://wiki.ros.org/melodic/Installation/Ubuntu

2.) Solidworks:

For installing solidworks, you can download the package for the cracked version by using proxies for torrent sites (kickass torrents is one such torrent site where you will easily find the downloadable files). The license number generators come along with the package. If on campus it'll be easily available on DC.

3.) Fusion360:

If you want the full permanent download for Fusion360, follow the same procedure as for solidworks (torrent proxies or DC++). Alternatively, you can download the free trial version from the official Autodesk web site:
https://www.autodesk.in/products/fusion-360/free-trial

4.) Arduino IDE :

Install Arduino IDE for your operating system from the official website:
https://www.arduino.cc/en/main/software

5.) Autodesk Eagle:

Download the free software for your respective operating systems from the official web site:
https://www.autodesk.in/products/eagle/free-download

Study/Reference Resources

1) ROS:

https://github.com/hardesh/QSTP-Introduction_to_ROS/blob/master/Handout.pdf
Refer to this course and its course handout for installation procedures regarding ROS and resources to learn it.
You can also refer to a book titled 'Programming Robots with ROS' by Morgan Quigley
Link to the book is given below:
https://drive.google.com/file/d/1un6O-7YacQKb92NhgR3s-XS8KextTPOq/view?usp=sharing

2) A4988 motor driver (Motor driver to drive stepper motors)

https://www.robotshop.com/media/files/pdf/datasheet-1182.pdf

3) Resource to learn Cadsoft Eagle:

Jeremy Blum tutorials:
https://www.youtube.com/watch?v=1AXwjZoyNno&list=PL868B73617C6F6FAD

4) LCD display datasheet with pinout:

https://components101.com/16x2-lcd-pinout-datasheet

5) 7-segment LED display datasheet:

https://www.vishay.com/docs/83122/tdsl31.pdf

6) 4 bit synchronous binary counter IC (IC 74LS93) datasheet

https://components101.com/ics/74ls93-4-bit-binary-counter

7) Video explaining the Geneva Mechanism:

https://www.youtube.com/watch?v=Le-PVXUCl0M&t=86s

8) Tutorials for Solidworks:

Lynda's solidworks tutorial videos are the best for learning solidworks and easily available across the internet. Apart from those you can also follow the tutorials in the links provided:

9) Tutorials for Fusion360:

You can learn mechanical designing in Fusion 360 from the following Youtube Web tutorials from CadCam:
https://www.youtube.com/watch?v=vVFYrBCIkPc&list=PLrOFa8sDv6jfKx9poMArMUV2MGbZoXrCT

10) Tutorials for Simulink:

You can follow this playlist for simulink:
https://www.youtube.com/playlist?list=PLyqphRgDVNwThTjFTjEDqlBQf_FOznbNP
We also recommend referring to a book by James Dabney, 'Mastering Simulink'
Link to the book is given below:
https://drive.google.com/open?id=1_bkmucAcCzDMxsd1VFv5F5Y1lfoA7zrW

11) Tutorials for Cadsoft /Autodesk Eagle:

You can learn from Jeremy Blum's Youtube tutorial series from the following link:
https://www.youtube.com/watch?v=1AXwjZoyNno&list=PL868B73617C6F6FAD

12) Tutorials for Arduino :

You can learn about Arduino programming and usage of Arduino IDE from the following Youtube playlist of Jeremy Blum:
https://www.youtube.com/watch?v=fCxzA9_kg6s&list=PLA567CE235D39FA84

2. Assignment:

2.1 Computer Science

a) **ROS and Computer Vision:**

In this part, you will have to study OpenCV which is a library of programming functions mainly aimed at real-time computer vision and ROS (Robot Operating System) which is an open-source, meta-operating system used in robots. You are required to print three Aruco tags of different IDs. Then, using OpenCV and your laptop camera (or an external camera), find the real-time orientation and position of the three tags. Write a ROS node that publishes the information on each tag in three different namespaces of a single topic. The topic should use a custom message type which will include the ID, position, orientation and timestamp of the tag.
Aruco tags can be generated from the following website:
http://chev.me/arucogen/

b) **Research Paper Analysis:**

Read the following 2 research papers on path planning:

- Steven M. LaValle - Rapidly Exploring Random Trees: A new Tool for Path Planning.
  http://msl.cs.illinois.edu/~lavalle/papers/Lav98c.pdf
- Bug Flood: A bug inspired algorithm for efficient path planning in an obstacle rich environment.
  https://arc.aiaa.org/doi/abs/10.2514/6.2016-0254

Compare both the path planning algorithms in terms of speed, approximate preferred number of obstacles, requirement of a map, type of map, etc.

2.2 Electronics

a) **PCB Design:**

Learn Eagle, which is a software enabling the designing of PCBs using schematic diagrams, and design a circuit in eagle for running a stepper motor using Arduino and an A4988 motor driver. Also interface an LCD display in your circuit which display the angle (module 360) on that display. A4988 datasheet, LCD display datasheet and resources to learn Eagle are given in the references below.

b) **Mini Project**

You are required to design the circuit for a mod 16 counter using an Arduino, a counter IC (IC 74LS93) and 7-segment LED displays. Program your arduino such that it takes the binary input from the counter IC and displays the corresponding number on the 7-segment LED displays. Refer to the “Study Resources” section for all the necessary datasheets.

c) **Communication**

Make a transmitter-receiver pair using 2 Arduinos and 2 nRF24L01 modules (one for each). Use a keypad at the transmitter end to transmit digits and display them at the receiver on an LCD screen. Simulate this circuit on www.tinkercad.com where all the components you need would be available.

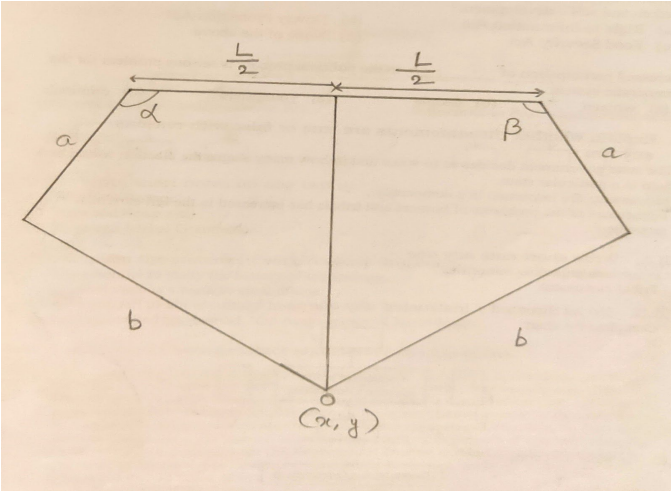
2.3 Mechanical

a) **Mechanical Design**

- Simulate the following things using simulink:
    - Arm manipulator in 2-D plane
    - 4-link leg of a Quadruped

- Design the following using solidworks:
    - A tyre/wheel assembly for a rover assuming the rough terrain it would traverse and prepare a report justifying your design
    - A 4 wheel differential drive (no steering required) Pick N Place bot

b) **Inverse Kinematics**



The given figure shows the linkages in a quadruped (4 legged bot). Find the values of the joint angles alpha and beta so as to take the point O at a certain point in space having coordinates (x,y). The answer should be in terms of L,a,b,x and y. (**Do not assume any ideal cases or values of any angles apart from those labelled in the diagram)**

c) Gears and their implementation

Design a model of a gear set employing the Geneva Mechanism with 8 dwells on the driven wheel of dimensions of your choice in solidworks (using solidworks toolbox or otherwise) or in Fusion360. Prepare a brief report of the process of designing the model including but not limited to specifications such dimensions used, variation of the mechanism(if any used), etc. The link to a video explaining the mechanism has been given in resources.