ARBOC:

Areas of implementation:

- Underwater surveillance
- Ship propeller/lower deck inspection.
- Detecting oil spills in Semi-submersible/Off shore oil drilling platforms.

Platforms to develop novel solutions:

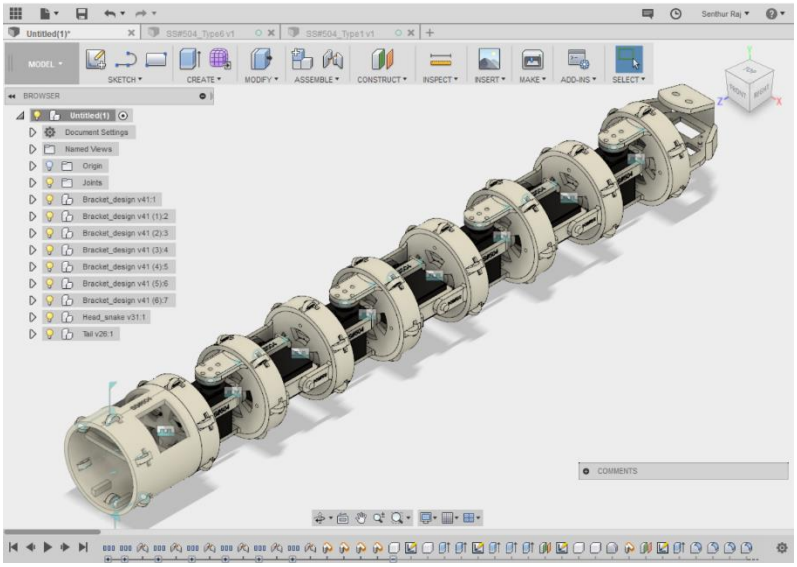
- Implementing Reinforcement learning for gait generation of the snake robot and to study the optimal gait for goal-based locomotion.
- Underwater path planning.
- Optimal control algorithms with feedback from IMUs for snake robots.

Challenges:

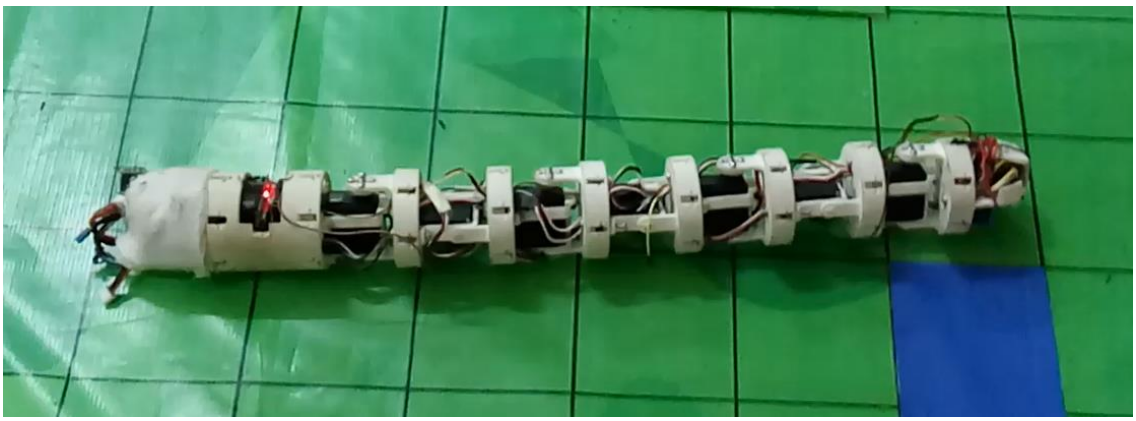
- To find an innovative way to wirelessly communicate underwater. If the developed communication system is not robust and unreliable, tethers can be used as most underwater surveillance vehicles are tethered.
- Gait generation and mathematical modelling.
- Fabrication.

Progress till date:

- Designed/Developed a 3D CAD model of the snake-robot using Autodesk's Fusion 360.



- Simulation of a minimalistic design of the bot has been done with V-rep.
- 3D printed all the individual parts and assembled it together.



- Snake's serpentine motion has been studied and mathematically modeled.



- Rolling and Helical gaits have also been modeled and implemented.


- Bluetooth communication with the bot has been established.

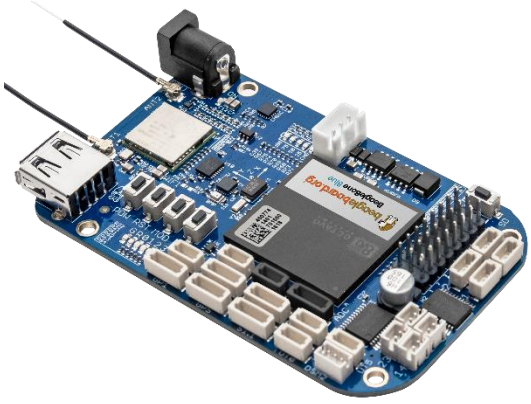
Things to be done:

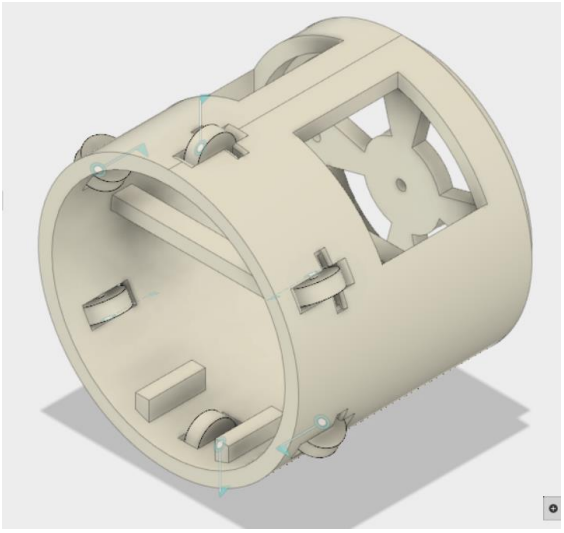
- Feedback control with IMUs [Each module holding one].
- Fabrication of the bot, almost 80% of the bot is already waterproof by design. The head and tail modules need to water proofed.
- Eliminate the Bluetooth communication and come up with some other way of underwater communication or prepare the tail of the bot ready to be tethered.
- Eliminate the use of micro controller which makes it nearly impossible to implement reinforcement learning and autonomous path planning.

Components to be used:

Beaglebone Blue	https://www.mouser.in/ProductDetail/BeagleBoard/BBBLUE?qs=MoCBKJu1Jj2UWBPau58zsg%3d%3d

- Battery: 2-cell LiPo support with balancing, 9-18V charger input.
- Features 9-axis IMU and barometer sensors.
- Wi-Fi 802.11 b/g/n, Bluetooth 4.1 and BLE enabled.
- 8x 6V servo outputs [Eliminates the need for MCU]
- Better than Beaglebone black as it has the robotic cape integrated within it. In case of using Beaglebone black, robotics cape needs to be bought separately which would again be nearly impossible to accommodate.
- Can be easily accommodated in the tail of the bot. [RPI3 was bulkier and needed a MCU which was nearly impossible to accommodate.]





IMU [MPU-6050]	6	https://www.amazon.in/GY-521-Mpu6050-Accelerometer-Arduino-REES52/dp/B008BOPN40/ref=sr_1_fkmr0_1?ie=UTF8&qid=1520608664&sr=8-1-fkmr0&keywords=mpu+6050+imu
MG995 Metal Gear Servo	3	https://www.amazon.in/TowerPro-MG995-Metal-Servo-REES52-COM/dp/B0156059W2
USB Camera	1	Haven't found anything that is waterproof, reliable and USB powered. Looked into Endoscope cameras online not sure if they're worth the money, will look for retailers and buy later in the month of march.
Ultrasound Range Finder	4	https://www.amazon.in/REES52-Ultrasonic-Distance-Measuring-Transducer/dp/B00MYYE6XM/ref=sr_1_8?s=industrial&ie=UTF8&qid=1520661741&sr=1-8&keywords=ir+sensor

Milestones and Deadlines:

PHASE I:

- **End of March:**
  - The prebuilt mathematical model of the snake-bot should be reworked to be able to navigate underwater.
  - Making the bot ready for fabrication, i.e.) filing all the rough/messed up edges, modifying the head and tail modules to accommodate all the components.
  - Integrating all the hardware with Beaglebone blue and getting it set for application of reinforcement learning to generate gaits.
- **End of June:**
  - A skeletal framework of the RL agent.
  - Underwater path planning and goal-based locomotion[i.e.) say suppose the bot is in a glass tank and you place your hand on the glass, the bot should track the hand[goal] and try to reach it]
  - Getting into Communication, looking for existing ways to wirelessly communicate underwater and critically estimating those with parameters like how hard it is to implement/robustness/reliability.
  - Beginning to field test with a fish tank.