InternPro Weekly Progress Update

Name	Email	Project Name	NDA/ Non-NDA	InternPro Start Date	OPT
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Progress

Include an itemized list of the tasks you completed this week.

#	Action Item/ Explanation	Total Time This Week (hours)
1	Research Paper on Designing and implementing GNSS RTK	3
2	Sourcing GNSS RTK Equipment Components online	3
3	Feasibility study of building a GNSS station and rover postioning	3
4	SolidWorks Installation and Setting Up	3
5	MATLAB GNSS RTK Simulation	1
6	Report Writing	1
7	Rover Design	2
8	GNSS receiver SolidWorks Design	2
9	Assembling the entire setup	2
	Total hours for the week:	20

Verification Documentation:

Action Item 1: Research Paper on Designing and implementing GNSS RTK – 3 hour(s).

Project Work Summary

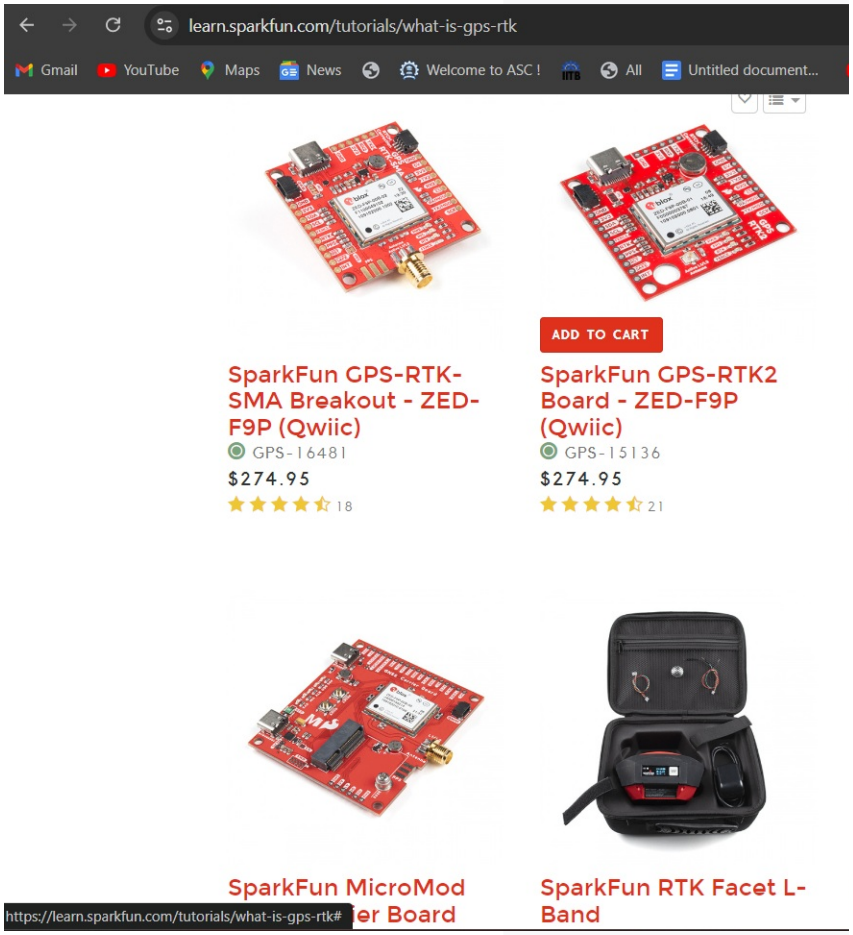
- https://www.mdpi.com/1424-8220/24/2/646
- Designing and Testing an IoT Low-Cost PPP-RTK Augmented GNSS Location Device
- Summary of Report
  - The paper describes the design, implementation and testing of a low-cost IoT GNSS device that uses PPP-RTK corrections to achieve high-accuracy positioning.
  - The device uses a u-blox ZED-F9P GNSS receiver, a mini PC running the u-center software, and custom software to parse and transmit location data.
  - In kinematic vehicle tests, the device achieved horizontal accuracy of 7.7 cm and vertical accuracy of 5.2 cm for fixed ambiguity solutions, which were available 79.5% of the time.
- Relation to Project
  - Provides a working implementation of an IoT-connected GNSS device that could be adapted for precision agriculture applications.
  - Demonstrates the feasibility of achieving centimeter-level accuracy with low-cost GNSS hardware and commercial PPP-RTK corrections.
  - Validates the performance of PPP-RTK techniques in dynamic urban environments, which is relevant for autonomous vehicle navigation.
- Motivation for Research
  - Enable high-accuracy positioning for mass-market applications by leveraging low-cost multi-constellation GNSS receivers and PPP-RTK corrections.
  - Overcome limitations of existing RTK and PPP techniques for large-scale deployment, such as communication bandwidth constraints and long convergence times.
  - Develop an integrated IoT device that can provide real-time centimeter-level positioning data for applications like precision agriculture and autonomous vehicles.

Action Item 2: Sourcing GNSS RTK Equipment Components online – 3

hour(s).

Project Work Summary

- Relevant Links
  - https://learn.sparkfun.com/tutorials/what-is-gps-rtk
  - https://learn.sparkfun.com/tutorials/how-to-build-a-diy-gnss-reference-station/all
  - https://pointonenav.com/news/gnss-receivers/
  - https://youtu.be/ieearzWTCZw
  - https://www.youtube.com/watch?v=Oc1LBFDj2MA&t=904s&pp=ygUIZ25zcyBydGs%3D
- Summary of Findings
  - GNSS Antenna and Receiver: The setup requires a high-quality GNSS antenna (such as a u-blox L1/L2 antenna) and a compatible GNSS receiver (like the ZED-F9P).
  - Computing Platform: An ESP32-based system, which offers lower power consumption and simpler setup.
  - Data Transmission: The setup requires a means of transmitting correction data. An internet connection for NTRIP server functionality, using either WiFi or Ethernet.

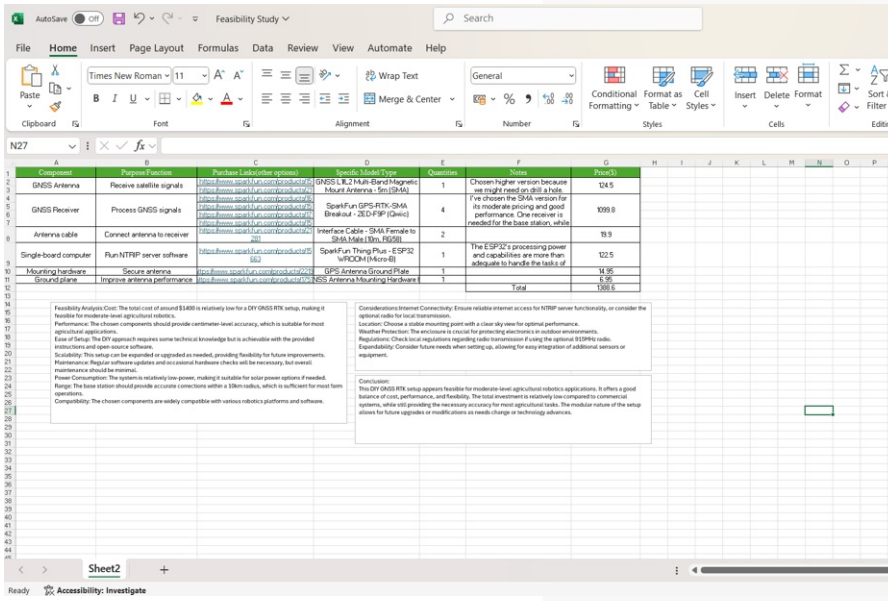


Action Item 3: Feasibility study of building a GNSS station and rover postioning – 3 hour(s).

Project Work Summary

- Component Selection and Cost Analysis:
  - The study identified essential components for a GNSS RTK system, including a
    - high-precision GNSS antenna
    - multiple GNSS receivers (one for the base station and three for rovers)
    - a single-board computer for data processing
    - necessary accessories
- Scalability and Coverage:
  - The design incorporates four GNSS receivers - one for the base station and three for rovers.
  - This configuration is tailored for a moderate-sized farm, assuming that three robots would provide sufficient coverage for the area.
- Performance and Compatibility:
  - The selected components, particularly the SparkFun GPS-RTK-SMA Breakout (ZED-F9P) receivers, offer a balance between performance and cost-effectiveness.

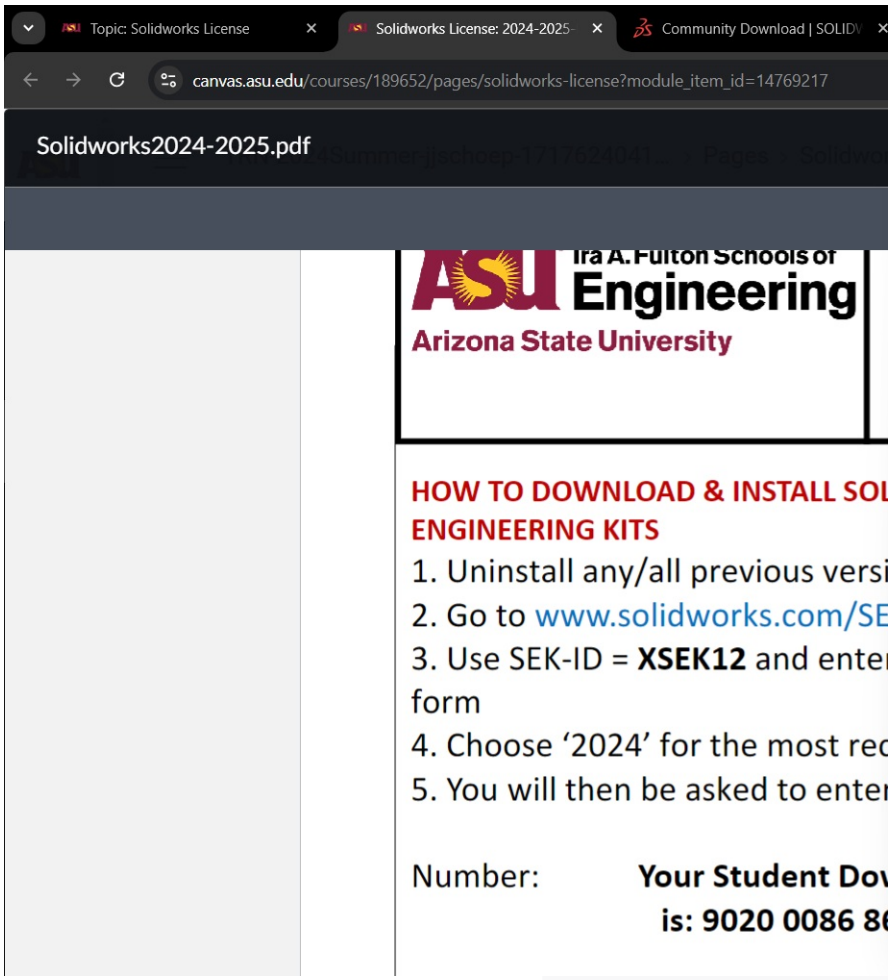
    - The use of L1/L2 multi-band antennas and compatible hardware ensures high-precision positioning.
    - Additionally, the ESP32-based single-board computer provides adequate processing power for running the NTRIP server software
- Created an excel sheet to collect all the researched data and compiled them together to form the feasibility study for establishing the GNSS base station.



Action Item 4: SolidWorks Installation and Setting Up – 3 hour(s).

Project Work Summary

- Now that we have completed the feasibility study based on the hardware and component requirements, we also need to verify if the rover's design can accommodate the GNSS receiver.
- To evaluate if the rover design can accommodate a GNSS receiver, I needed to use SolidWorks for 3D modeling and analysis.
- I reviewed the installation manual for SolidWorks, based on the Student Edition Key (SEK) serial number provided through the EPICS program's licensed version.
- I successfully installed SolidWorks on my PC and activated the licensed version using the provided Student Edition Key (SEK).



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Action Item 5: MATLAB GNSS RTK Simulation – 1 hour(s).

Project Work Summary

- Before getting into hardware of buying the GNSS RTK and other agricultural robot, we could simulate and understand some of the difficulties faced in implement a real world application.
- MATLAB does contain 'gpsSensor' and 'gnssSensor' objects for simulating the GPS and GNSS receivers, but how realistically it could incorporate the inaccuracies in the measurements is still needs to researched.
- Further research is needed in finding if there is a way to simulate the GNSS RTK in MATLAB or perhaps any other coding language like Python or ROS 2.

Action Item 6: Report Writing – 1 hour(s).

Report Writing

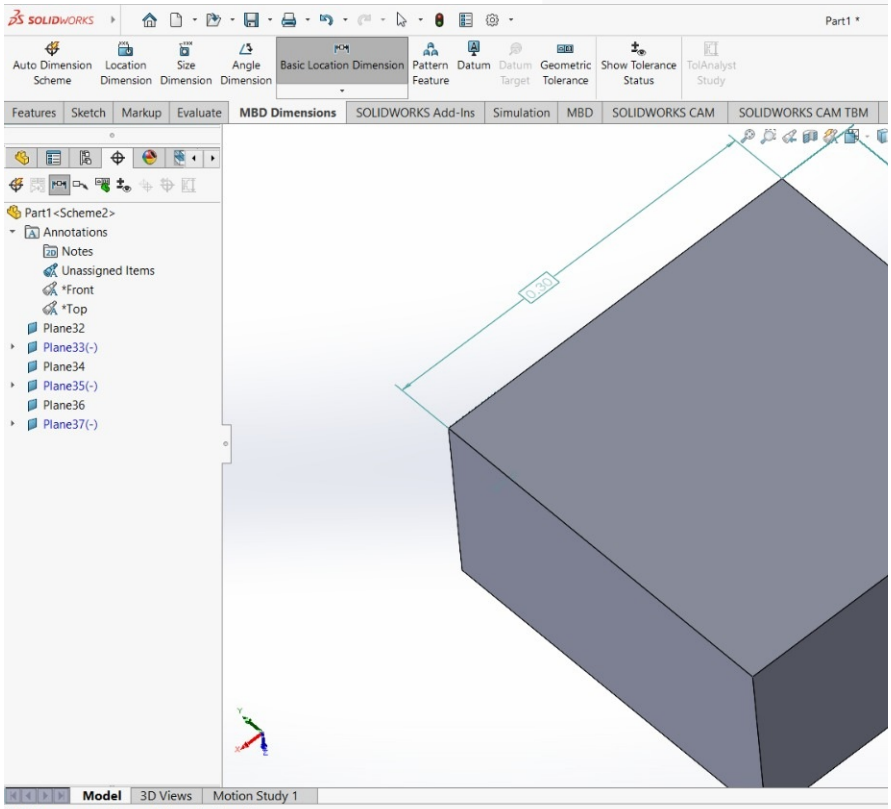
- Compiled all the contents for the entire week and documented it in the word document.
- Organized screenshot, relevant links and documented contents to write for the weekly progress.
- Described all the action items in detail and wrote it as per the requirements.

Action Item 7: Rover Design – 2 hour(s).

Project Work Summary

- We need to first design the rover so that we could attach the GNSS receiver to understand if it could accommodate the receiver within the body.
- We do not need a highly defined structure of the rover for the understanding purpose, hence a basic cuboid with 30x30x15 cm preliminary design for the rover is chosen.
- Opened the SolidWorks and chose the front plane. Then chose the sketch option the create a 30x30 square plane. Extruded the shape

to form the cuboid robot.



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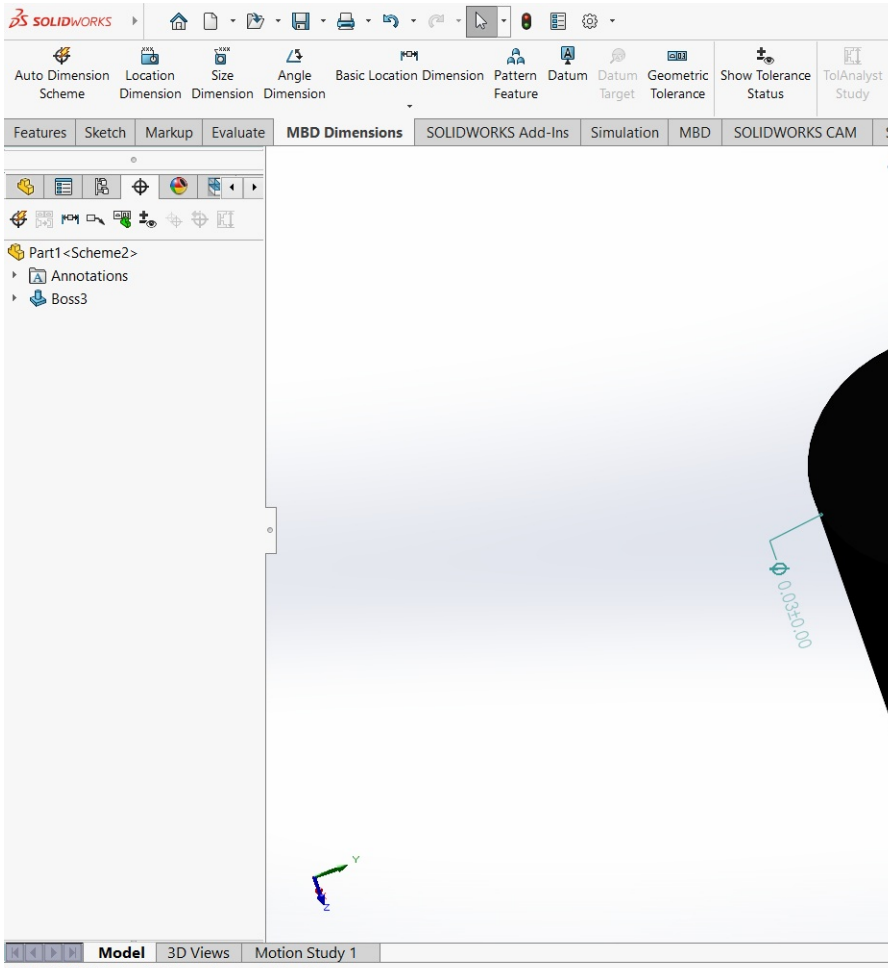
Action Item 8: GNSS receiver SolidWorks Design – 2 hour(s).

Project Work Summary

- Research some online sources for the available GNSS receivers for the rover to get a reasonable estimate of the GNSS receiver's dimensions.
- The dimensions for the receiver was found to be 3cm diameter cylinder with a height of 5 cm.
- Opened the SolidWorks and sketched a 3 cm diameter circle and the base plane and extruded the circle to form the rough diagram of the sensor.
- Effectively I created the rough diagram to successfully compare the dimensions of the rover and receiver through SolidWorks.



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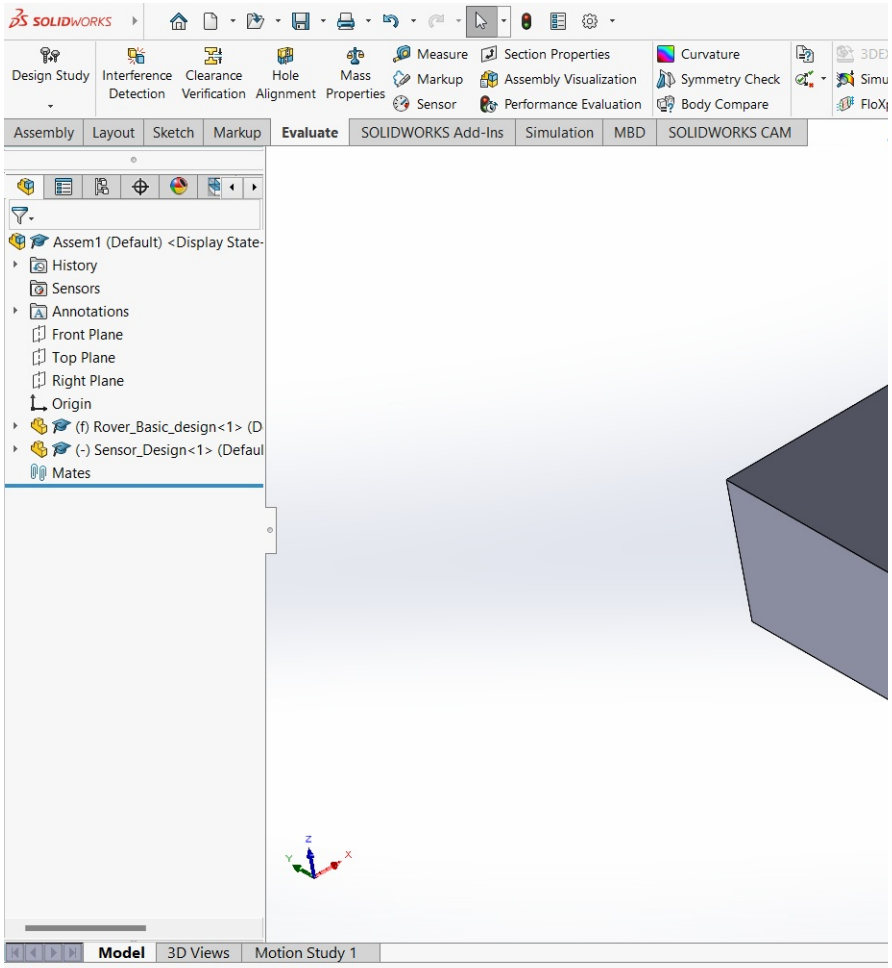
Action Item 9: Assembling the entire setup – 2 hour(s).

Project Work Summary

- Now that I have created both the shapes of the rover and sensor in the SolidWork, I then have to assemble them together to find if the receiver goes well with the rover.
- So I opened the assemble feature of the SolidWorks and added both the structures together to the SolidWorks and used the Mate option to mate them together.
- Effectively I have attached the sensor to the design of the rover and it almost seems perfect from the preliminary design but further work is needed to better estimate the effectiveness.



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