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	Low cost GNSS receiver	3
2	Setting Farm land in MATLAB	3
3	Additional research on implementing GNSS station	3
4	Updated List of sensors for Precision Positioning	2
5	LIDAR sensor Part design	2
6	Sensor and Rover assembled design	2
7	ZED F9P Module design	2
8	Report Writing	1
9	low-cost multi-GNSS PPP-RTK solution for precision agriculture	2
	Total hours for the week:	20

Verification Documentation:

Action Item 1: Low cost GNSS receiver – 3 hour(s).

Project Work Summary

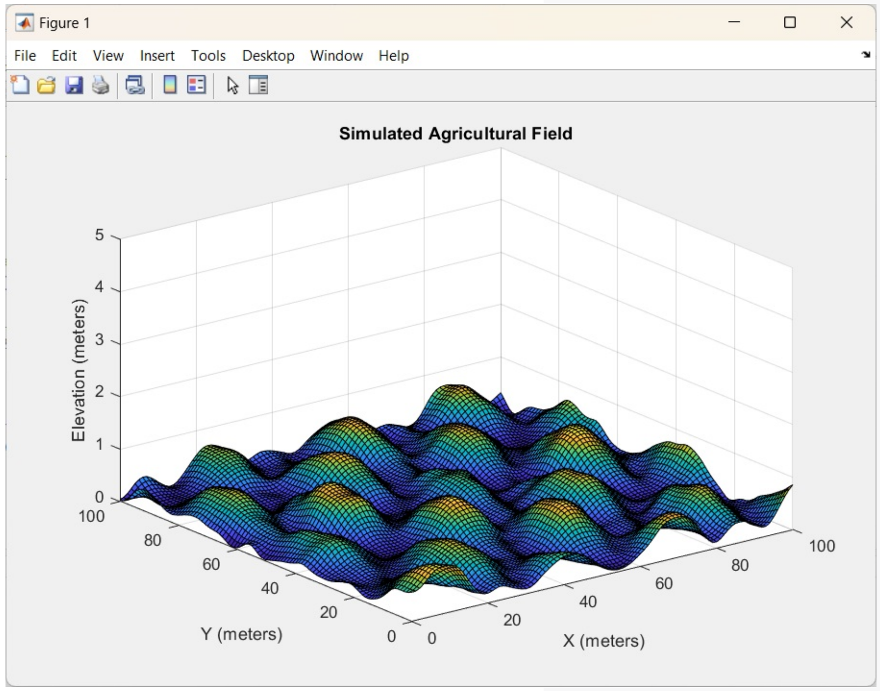
- https://www.researchgate.net/publication/330525981_Low-cost_GNSS_receiver_in_RTK_positioning_under_the_standard_ISO-17123-8_A_feasible_option_in_geomatics
- Low-cost GNSS receiver in RTK positioning under the standard ISO-17123-8: A feasible option in geomatics
- Summary of Report
  - Evaluated performance of low-cost single-frequency u-blox NEO-M8P receiver vs. geodetic dual-frequency Leica GS10 receiver.
  - The authors used ISO 17123-8 standard to assess RTK positioning accuracy.
  - Conducted field tests with two rover points and different RTK solutions (network-based and single-base).
- Relation to Project
  - Extended research on feasibility of using low-cost GNSS receivers for precision agriculture applications.
  - The paper provides quantitative data on positioning accuracy achievable with low-cost systems.
  - The study also demonstrates methodology for rigorously evaluating GNSS receiver performance.
- Motivation for Research
  - Assess if low-cost single-frequency receivers can achieve comparable accuracy to expensive dual-frequency systems.
  - Determine suitability of low-cost GNSS for high-precision applications like agriculture.
  - The paper evaluate performance using standardized testing procedures for reliable comparisons.

Action Item 2: Setting Farm land in MATLAB – 3 hour(s).

Project Work Summary

- Opened MATLAB and began by setting up the simulation environment for creating farm land.
- Created a 100x100 meter grid using the meshgrid function, which

generates 2D arrays X and Y representing the coordinates of your field.
- To create a realistic base terrain, utilized a combination of sine and cosine functions with different frequencies and amplitudes.
- Added random variations using the randn function and applied a Gaussian filter with imgaussfilt to smooth the terrain, creating a more natural-looking surface.



Action Item 3: Additional research on implementing GNSS station – 3 hour(s).

Project Work Summary

- https://www.mdpi.com/2075-1702/12/9/612
- Low-Cost Real-Time Localization for Agricultural Robots in Unstructured Farm Environments
- Summary of Report
  - The paper also evaluated GNSS RTK systems for precision agriculture applications.
  - The study develops a low-cost IoT-based GNSS RTK solution for precision agriculture.
  - The authors achieved centimeter-level positioning accuracy using u-blox ZED-F9P receivers.
  - Implemented PPP-RTK corrections via cellular network for improved performance.
- Relation to Project
  - Validates the feasibility of using low-cost GNSS receivers for high-precision agriculture.
  - Provides a practical implementation example of an IoT-connected RTK system.
  - Demonstrates achievable accuracy levels for agricultural applications.
- Motivation for Research
  - Based on the last week research, the sensors needed were defined.
  - Now upon further research there is a potential way to even further reduce the overall price.
  - Potential to increase adoption of precision agriculture techniques among farmers.
- Changes to consider for your project based on the paper:
  - Use of u-blox ZED-F9P receivers instead of previously considered options.
  - Incorporation of cellular connectivity for receiving PPP-RTK corrections.
  - Addition of a more powerful single-board computer (e.g. Raspberry Pi) for data processing.

Action Item 4: Updated List of sensors for Precision Positioning – 2 hour(s).

Project Work Summary

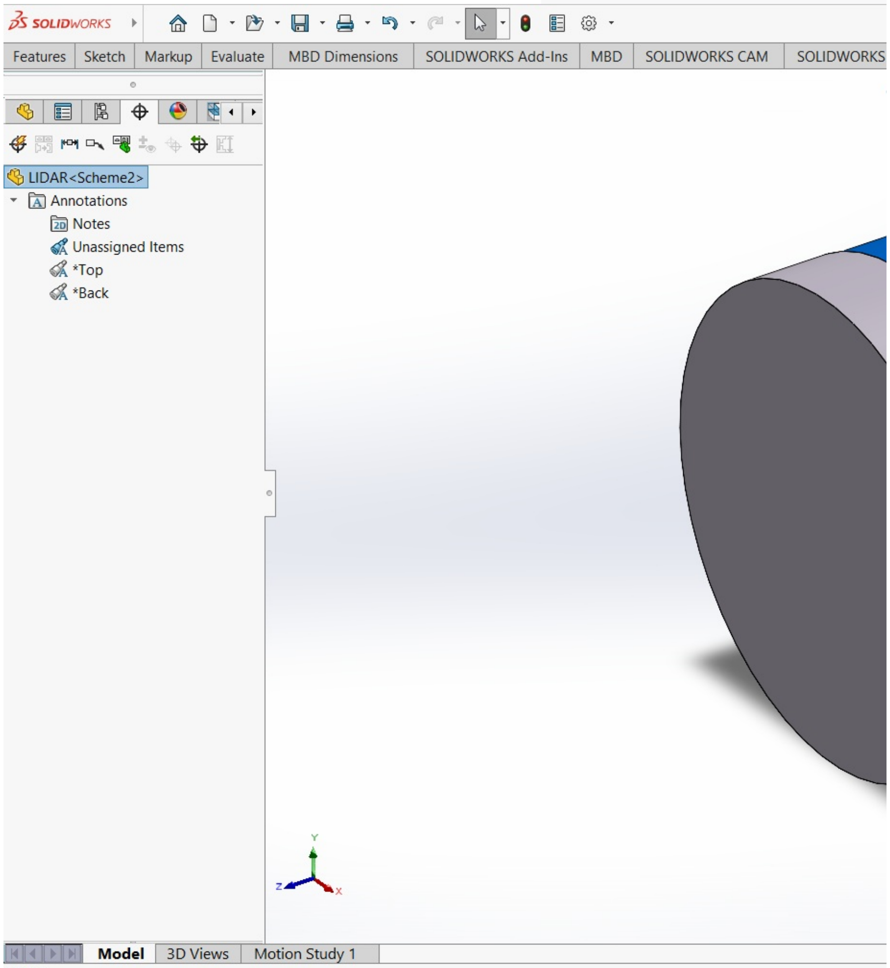
- Upon further research, the simple usage of GNSS receiver is not sufficient for achieving cm level accuracy and needs for some changes in the list of sensors.
- Further research suggest better and cheaper GNSS receiver and also suggest incorporating LIDAR for better performance.
- Modified currently suggested sensors and added new sensor related

to LIDAR based sensing and came up with a better performing combination of sensors and cheaper alternative.

Action Item 5: LIDAR sensor Part design – 2 hour(s).

Project Work Summary

- The dimensions for the LIDAR RS-Helios was found to be 107mm diameter cylinder with a height of 80.7 mm.
- Opened the SolidWorks and sketched a 107mm 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.

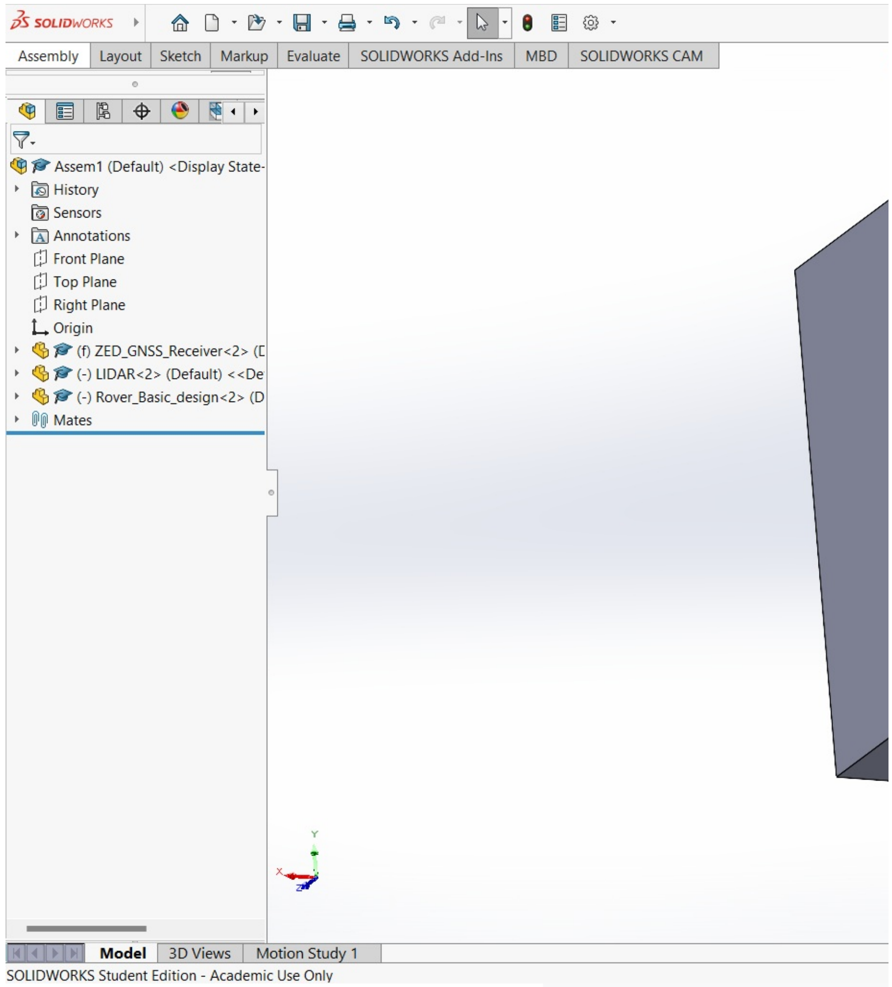


- LIDAR
-

Action Item 6: Sensor and Rover assembled design – 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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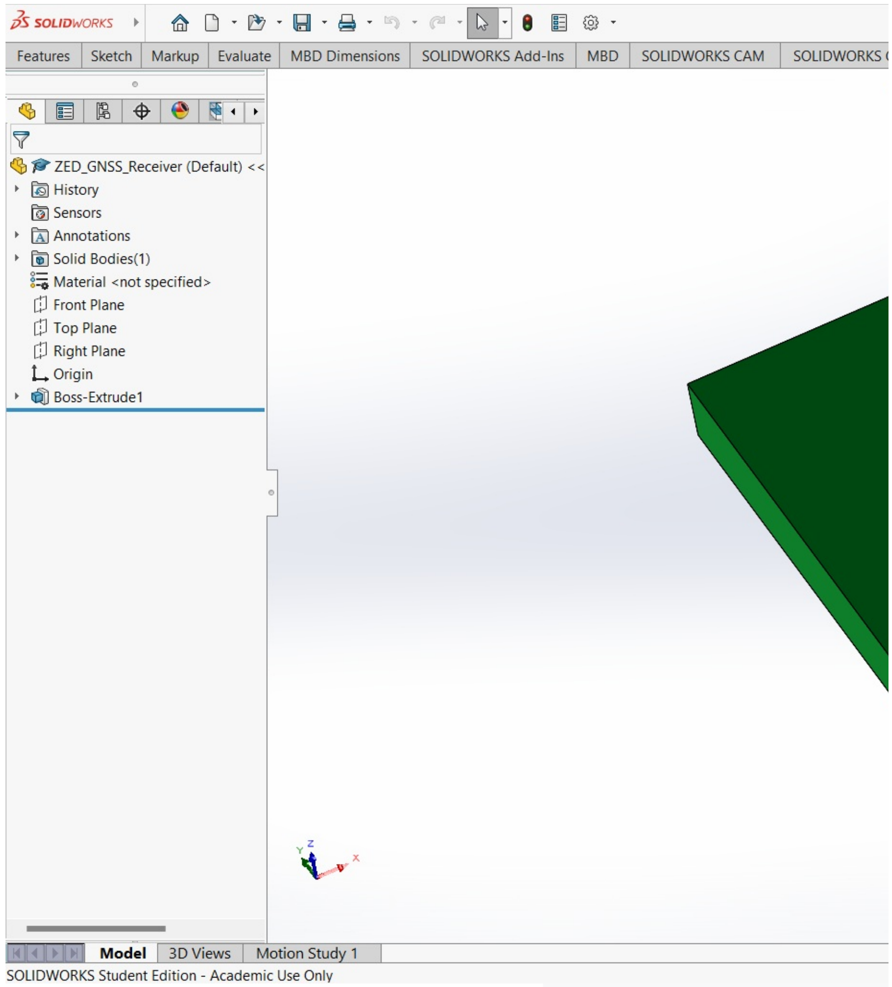
Action Item 7: ZED F9P Module design – 2 hour(s).

Project Work Summary

- The dimensions for the ZED F9P Module was found to be cuboid with dimensions 17.0mm x 22.0mm x 2.4mm.
- Opened the SolidWorks and sketched a 17.0mm x 22.0mm rectangle and the base plane and extruded the sketch 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.



Action Item 8: Report Writing – 1 hour(s).

Project Work Summary

- Bullet Point #1 (Ask your project partner what level of detail they request in this report)
- Bullet Point #2
- Bullet Point #3

Action Item 9: low-cost multi-GNSS PPP-RTK solution for precision agriculture – 2 hour(s).

Project Work Summary

- https://ieeexplore.ieee.org/document/9964640
- A low-cost multi-GNSS PPP-RTK solution for precision agriculture: a preliminary test
- Summary of Report
  - The author tested performance of low-cost u-blox ZED-F9P receiver with PPP-RTK corrections.
  - The paper compared results using geodetic antenna vs low-cost antenna.
  - The study achieved a sub-decimeter accuracy with geodetic antenna, decimeter-level with low-cost antenna.
- Relation to Project
  - The paper directly evaluates low-cost PPP-RTK system for agriculture applications.
  - Provides benchmark performance metrics for similar low-cost setups.
  - Provides sensors that are relevant for precision positioning for agricultural applications.
  - Demonstrates feasibility of using consumer-grade equipment for precision positioning.
- Motivation for Research
  - Wanted to further research to find if there are any cheaper alternative for high precision positioning of rovers.
  - Enable affordable high-accuracy positioning for precision agriculture.
  - Evaluate performance tradeoffs of low-cost components.
  - Assess viability of PPP-RTK technique with consumer hardware.

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