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	Simulation of Agricultural Robotic Rover	3
2	A review of robot perception, robot design, motion planning and control	3
3	Unreal Engine 5 for Agricultural Applications	2
4	Simulation Approach in V-REP, ROS and MATLAB	3
5	Research on simulating GNSS online with MATLAB	3
6	Report Writing	1
7	More refined simulation environment of the farmland	2
8	Rover imported to the Farmland MATLAB environment	3
	Total hours for the week:	20

Verification Documentation:

Action Item 1: Simulation of Agricultural Robotic Rover – 3 hour(s).

Project Work Summary

- https://www.mdpi.com/2079-9292/11/5/790
- Computational Simulation of an Agricultural Robotic Rover for Weed Control and Fallen Fruit Collection—Algorithms for Image Detection and Recognition and Systems Control, Regulation, and Command
- Summary of Report
  - The paper presents a simulation of an agricultural robotic rover designed for weed control and fallen fruit collection tasks.
  - The authors developed control algorithms for image recognition and system control of the robotic rover.
  - Simulations were conducted using robotic simulation software to test the algorithms in various scenarios.
- Relation to Project
  - Moving forward with the simulation we are looking for research papers on simulating agriculture processes online using rovers.
  - The paper provides a framework for simulating specific agricultural tasks (weed control and fruit collection) that could be adapted for other applications.
  - Demonstrates the use of image recognition algorithms in agricultural robotics simulation, which may be relevant for precision positioning tasks.
- Motivation for Research
  - To validate robotic algorithms and designs before physical implementation, reducing development costs and time.
  - To test various scenarios and hypotheses without risking damage to physical hardware.
  - To increase the speed and efficiency of agricultural robotics development through simulation-based testing.

Action Item 2: A review of robot perception, robot design, motion planning and control – 3 hour(s).

Project Work Summary

- https://onlinelibrary.wiley.com/doi/10.1002/rob.22230
- Towards autonomous selective harvesting: A review of robot perception, robot design, motion planning and control
- Summary of Report
  - Provides an overview of selective harvesting robots (SHRs) and their components.
  - Discusses challenges in developing SHR technologies, especially in robot design, motion planning, and control systems.
  - Highlights potential benefits of integrating AI and soft robotics and Identifies open research questions and need for further development.
  - Reviews state-of-the-art in perception, grasping, cutting, motion planning and control for SHRs.
  - Analyzes challenges in developing SHR technologies for real-world agricultural environments.
  - Discusses potential of AI and soft robotics to improve SHR capabilities.
- Relation to Project
  - Provides background on key components needed for simulating agricultural robots.
  - Identifies areas where simulation could accelerate development, like testing AI algorithms
  - Highlights challenges that should be considered when developing simulation environments.
- Motivation for Research
  - The paper helps to understand current state-of-the-art related to the agricultural processes simulation.
  - The paper identifies key challenges that simulations should aim to replicate.
  - The paper determines areas where simulation could have biggest impact on advancing SHR development.

Action Item 3: Unreal Engine 5 for Agricultural Applications – 2 hour(s).

Project Work Summary

- https://arxiv.org/abs/2405.18551
- Photorealistic Robotic Simulation using Unreal Engine 5 for Agricultural Applications
- Summary of Report
  - Presents a new robotics simulation environment built on Unreal Engine 5 (UE5) for agricultural image data generation.
  - The paper utilizes UE5's real-time rendering engine to provide realistic plant images for agricultural applications.
  - Compares UE5's rendering accuracy to existing tools and assesses its positional accuracy when integrated with robotics middleware.
  - Develops a photorealistic simulation environment for agricultural robotics using Unreal Engine 5.
  - Evaluates UE5's rendering and positional accuracy for agricultural image generation and integrates UE5 with robotics middleware for robotic simulation capabilities
- Relation to Project
  - Moving forward with the simulation we are looking for research papers on simulating agriculture processes online using rovers.
  - Provides a new platform for simulating agricultural robotics with highly realistic visuals and enables generation of synthetic agricultural image data for training and testing algorithms.
  - Offers integration with robotics middleware, allowing for testing of robotic control algorithms.
- Motivation for Research
  - To create more realistic simulations for agricultural robotics to improve algorithm development and testing.
  - To leverage advanced rendering capabilities of game engines for scientific simulations of agricultural robotics.
  - To provide a tool for generating large amounts of realistic agricultural image data for machine learning applications.

Action Item 4: Simulation Approach in V-REP, ROS and MATLAB – 3 hour(s).

Project Work Summary

- http://dx.doi.org/10.5772/intechopen.73861
- Robotic Harvesting of Fruiting Vegetables: A Simulation Approach in V-REP, ROS and MATLAB
- Summary of Report
  - The paper presents a simulation and control platform for designing, testing and calibrating visual servoing tasks for robotic harvesting of sweet peppers.
  - It uses V-REP, ROS and MATLAB to create a virtual environment for experimenting with sensors and manipulators.
  - The goal is to provide a simulated workspace for improving visual servoing through easy testing of control algorithms without risk to real equipment.
- Relation to Project
  - Moving forward with the simulation we are looking for research papers on simulating agriculture processes online using rovers.
  - The paper also demonstrates use of V-REP for creating virtual agricultural environments and robot models.
  - Shows integration of ROS and MATLAB for control and image processing algorithms, highly relevant for the agricultural robotics.
- Motivation for Research
  - This paper provides a highly relevant example of simulating agricultural robotics online using widely available software tools, which aligns well with the stated goal of finding ways to conduct

such simulations.
    - The approach of combining V-REP, ROS and MATLAB offers a flexible framework that could potentially be adapted for agricultural robotics.
    - Ways for simulating agriculture robotics without even working with the hardware for the robotic used.

Action Item 5: Research on simulating GNSS online with MATLAB – 3 hour(s).

Project Work Summary

- https://www.mdpi.com/2072-4292/12/21/3532
- GNSS-TS-NRS: An Open-Source MATLAB-Based GNSS Time Series Noise Reduction Software
- Summary of Report
    - Describes an open-source MATLAB software called GNSS-TS-NRS for processing and analyzing GNSS time series data.
    - Implements various noise reduction and filtering algorithms and provides tools for visualizing and statistically analyzing GNSS time series.
    - Implements classic EMD and EEMD algorithms as well as 3 new improved EMD-based algorithms.
    - Includes 5 spatial filtering methods for common mode error mitigation and provides tools for outlier detection, correlation analysis, spectral analysis, etc.
- Relation to Project
    - Since the project is moving toward GNSS for the localization of the agriculture robot, we need a tool to simulate the it online.
    - Enables noise reduction and filtering of GNSS time series data and allows visualization and statistical analysis of GNSS time series.
    - The paper also facilitates extraction of geophysical signals from noisy GNSS data.
- Motivation for Research
    - Existing software lacked user-friendly interfaces or were not open-source and there is a need for license free simulation.
    - There is a need for software that integrates multiple noise reduction and analysis techniques.
    - Moving forward with the simulation we are looking for research papers on simulating GNSS localization process online.

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

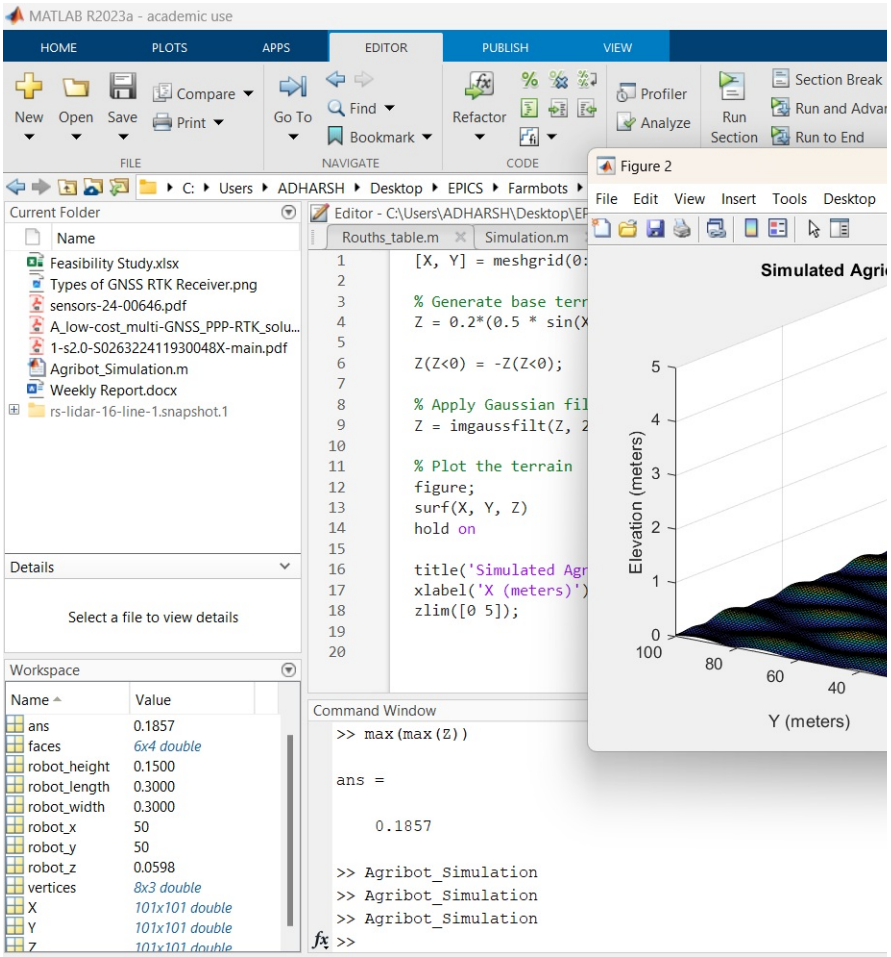
Project Work Summary

- Created word document layout to write contents of the weekly progress.
- Created relevant subsections in the epicspro website and documented 20 hours of weekly progress.
- Collected relevant documents research papers, relevant links and company's objective from their portal.

Action Item 7: More refined simulation environment of the farmland – 2 hour(s).

Project Work Summary

- The base farm land created last week had less randomness in the bumps and was more periodic and less realistic.
- Reduced the maximum bump in the lab within 0-18 cm range and added more randomness to the base.
- Created a more realistic version of farm land for simulating the robots in more realistic environment and get better understanding of the agri-robot.



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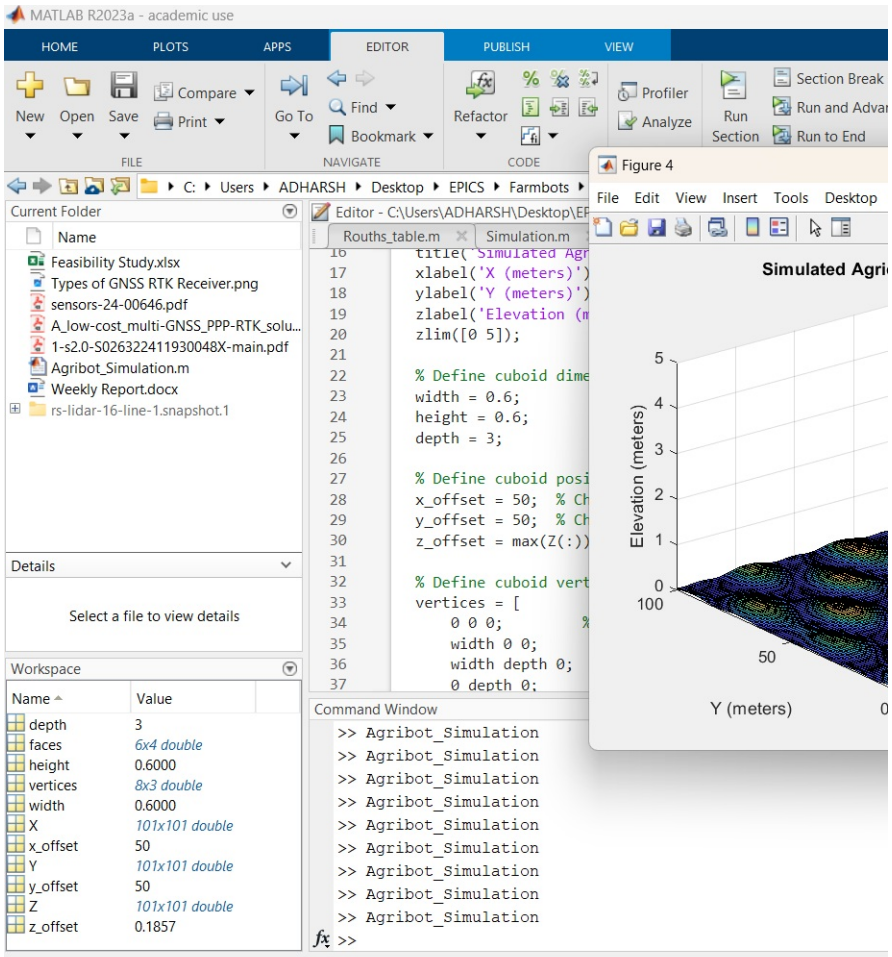
Action Item 8: Rover imported to the Farmland MATLAB environment – 3 hour(s).

Project Work Summary

- The overall design of the agriculture rover we finalized is of the shape of a cuboid with dimensions 30x30x15 cm.
- Hence used the patch function of the MATLAB and initialized necessary vertices and faces to match the above mentioned dimensions.
- The with the patch function displayed the simulation element of the agriculture rover onto the MATLAB simulation environment.
- Then imported the rover object onto the already created farmland created in the MATLAB simulation environment.
- Created the base to simulate the agriculture robot on to the simulated farmland environment, going forward we can start implementing the agricultural processes.


MATLAB R2023a - academic use
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Run and Advance
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Weekly Report.docx
rs-lidar-16-line-1.snapshot.1
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Simulation.m
16 title('Simulated Agr
17 xlabel('X (meters)')
18 ylabel('Y (meters)')
19 zlabel('Elevation (m
20 zlim([0 5]);
21
22 % Define cuboid dime
23 width = 0.6;
24 height = 0.6;
25 depth = 3;
26
27 % Define cuboid posi
28 x_offset = 50; % Ch
29 y_offset = 50; % Ch
30 z_offset = max(Z(:))
31
32 % Define cuboid vert
33 vertices = [
34 0 0 0; %
35 width 0 0;
36 width depth 0;
37 0 depth 0;
Details
Select a file to view details
Workspace
Name
Value
depth 3
faces 6x4 double
height 0.6000
vertices 8x3 double
width 0.6000
X 101x101 double
x_offset 50
Y 101x101 double
y_offset 50
Z 101x101 double
z_offset 0.1857
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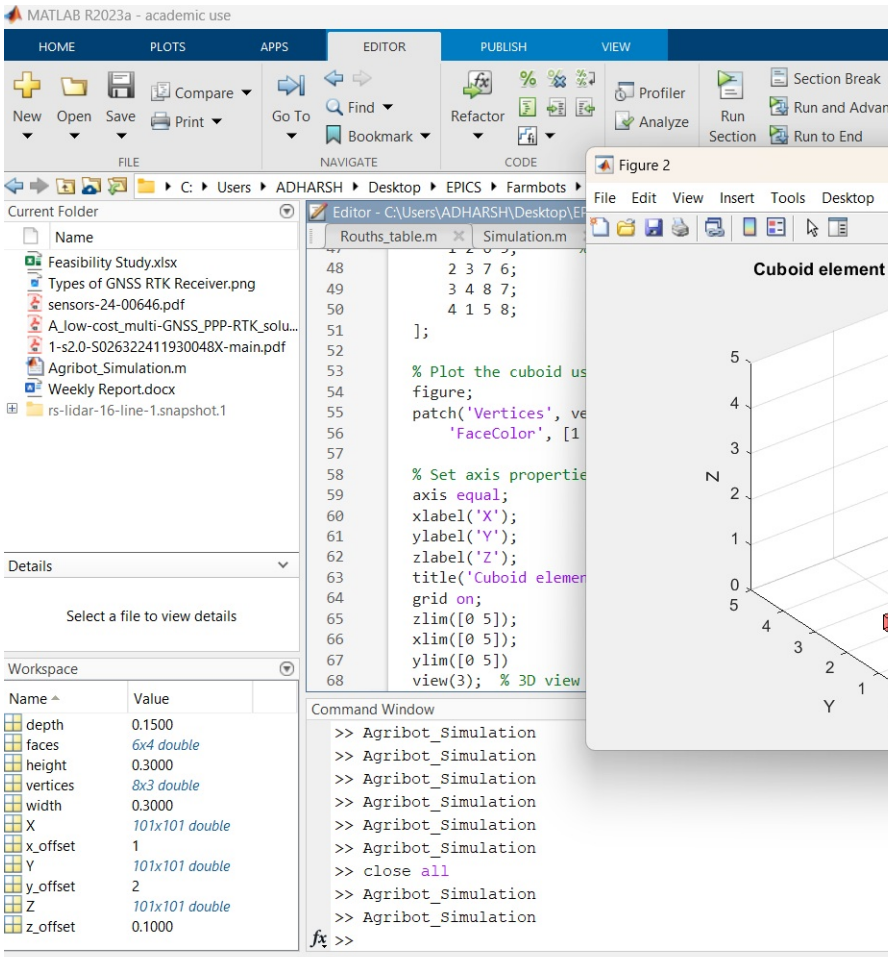
Figure 4
File Edit View Insert Tools Desktop
Simulated Agri
Elevation (meters)
5
4
3
2
1
0
100
50
Y (meters)



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