Tech Expo, Fall 2025 – Team 02

Asparagus Harvesting Robot

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Problem Statement

Peru is world's second largest producer of asparagus, which contributes greatly to the food supply chain in Peru and many surrounding countries in South America. There are issues with asparagus harvesting such as labor shortages, working conditions, and labor availability that negatively contribute to the production/supply of fresh asparagus. An engineered mechanism to aide harvesting could be the solution to improve production and cost of food.

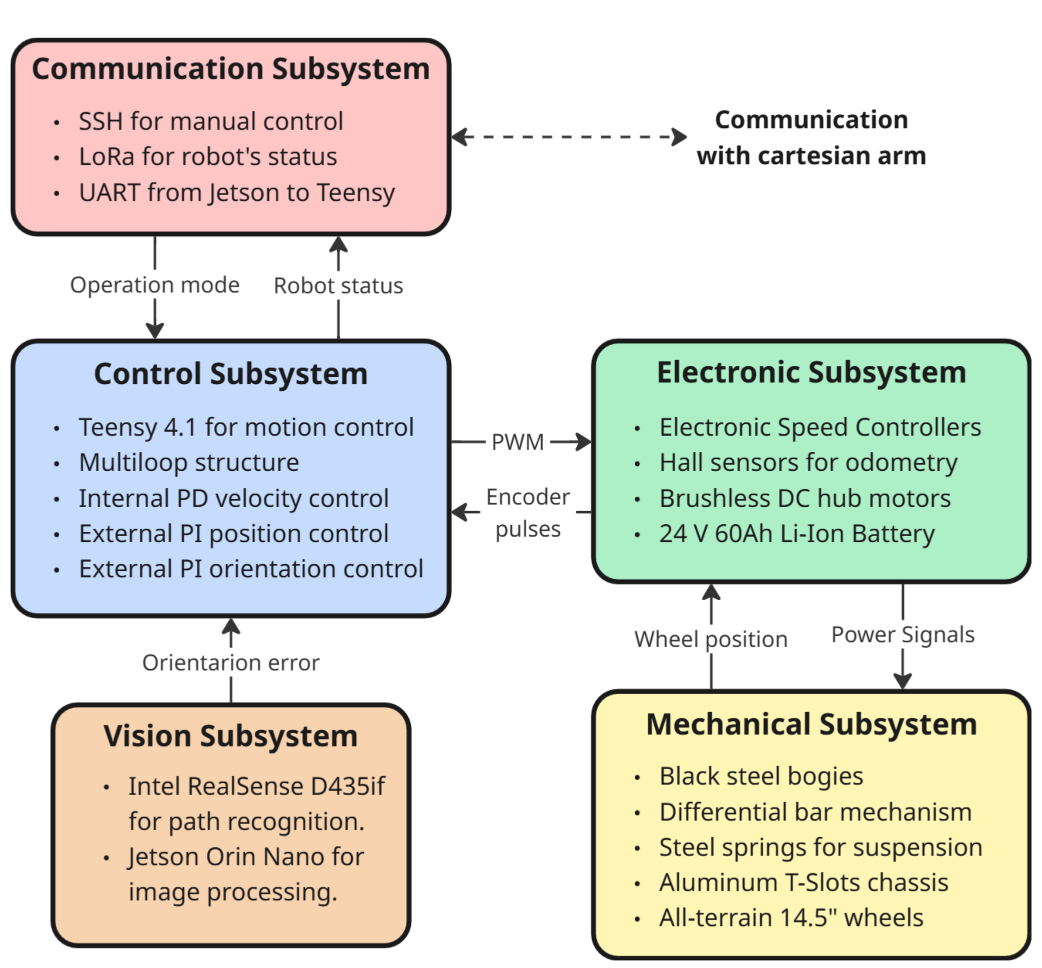
Customer Background

UTEC (Universidad de Ingeniería y Tecnología) located in Lima Peru works closely with Danper, the largest providers of asparagus in the region, to develop mechatronic solutions for real life problems. Our team is working with a group of engineering students at UTEC to develop, integrate, and test an autonomous asparagus harvesting robot to be used for the agricultural supply chain in asparagus farms in Northern Peru.

Requirements

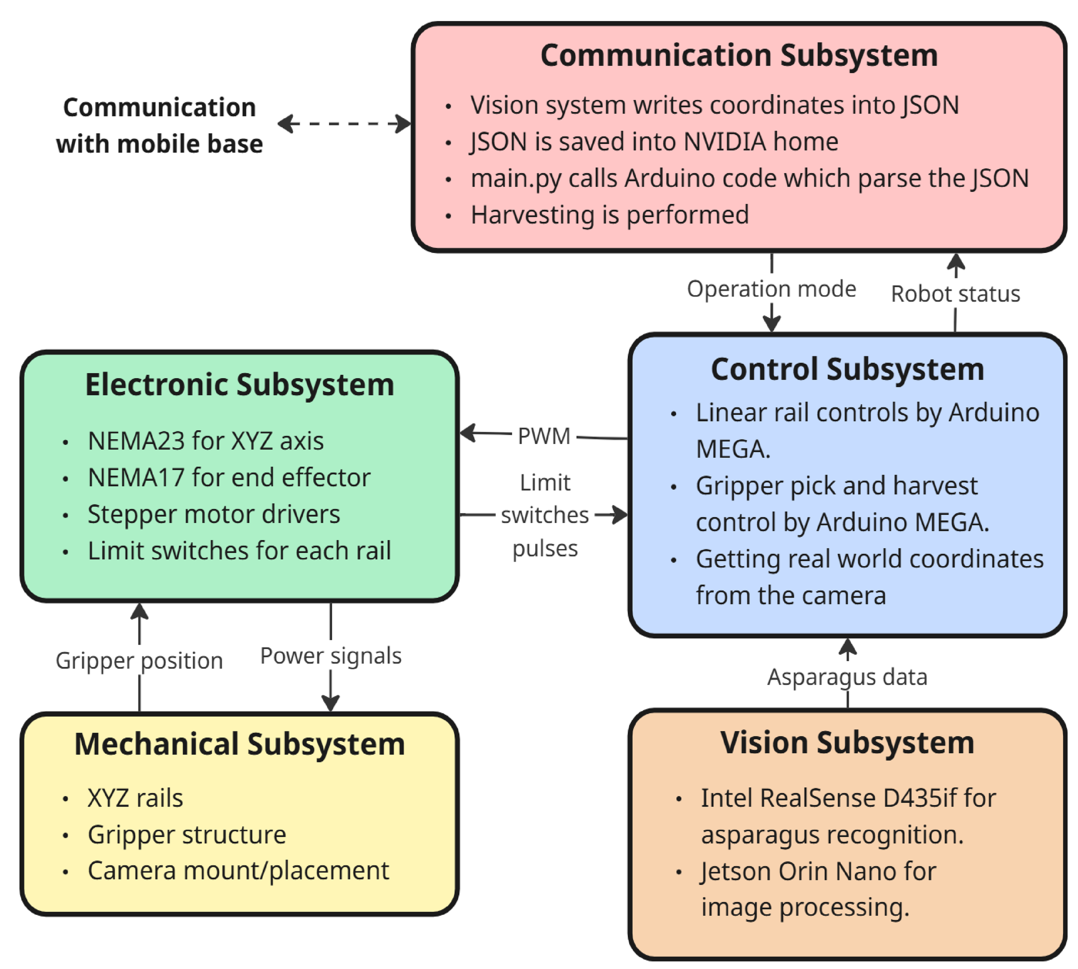
- Detect ready-to-harvest asparagus in a 120 cm range.
- Identify the cutting point of any spear (2 cm over ground).
- Harvest (cut, collect and store) 10 spears per minute.
- Work over crops lines of 1.80 meters in width.
- Adapt to non-planar irregular terrain (soil and dirt).
- Achieve autonomous motion and harvesting.
- Obtain system data through wireless communication.
- Withstand the environment conditions (dust, dirt, water).

Mobile Base



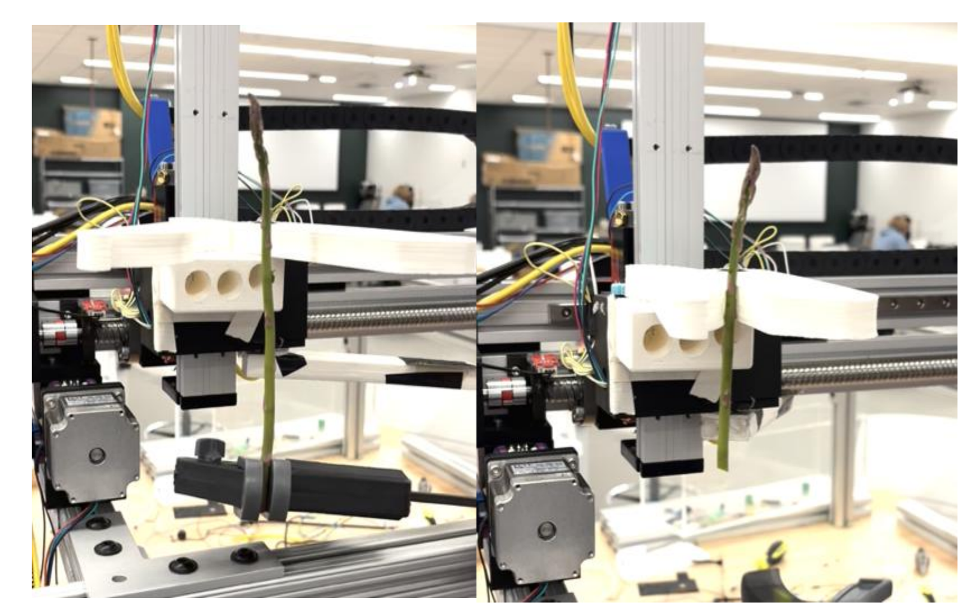
Subsystem diagram of Mobile Base

Cartesian Arm



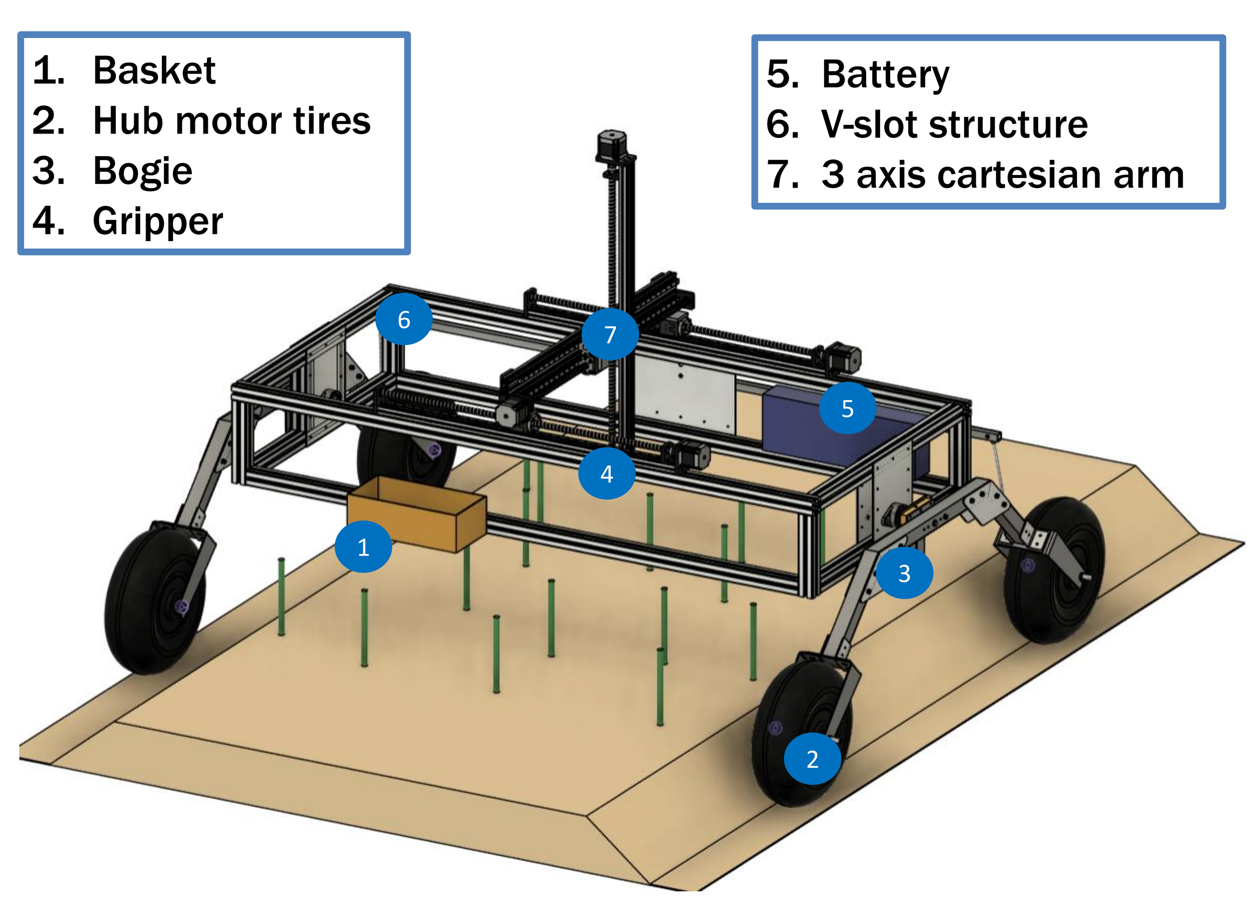
Subsystem diagram of Cartesian Arm

A cartesian system design was decided upon through research of previous agricultural harvesting machines. The gripper was designed with two stepper motors that work in opposite directions with separate gripping and cutting sides. The computer vision was developed using thousands of images of asparagus and through the use of machine learning models.


Prototype of end effector shown in grasping, cutting, and carrying stages

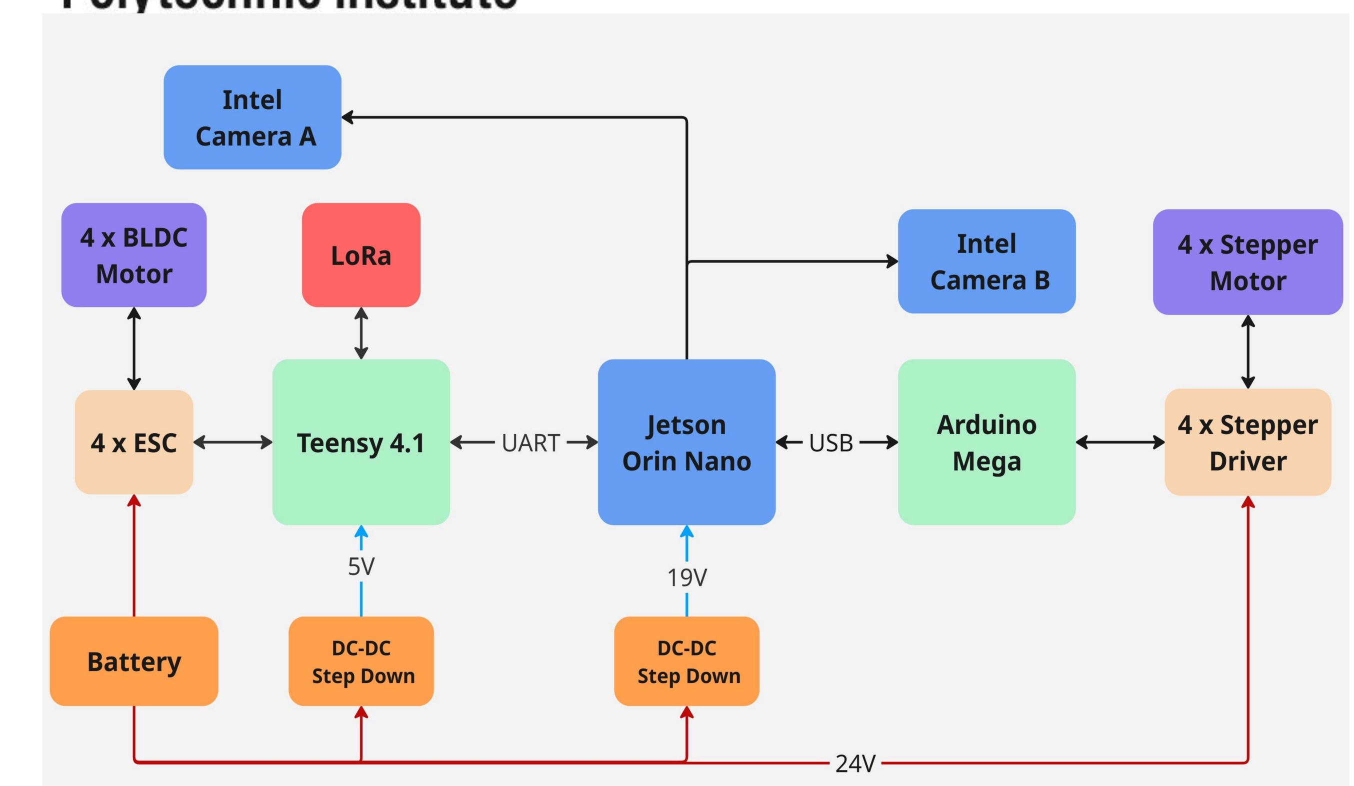
Final Design

The final design was assembled in Peru over the course of a week. The cartesian system features FUYU stepper motors with drive belt that are able to move in an x,y,z direction based on coordinates inputted through code, given through computer vision. The end effector features a gripper with a soft piece made of TPU to cradle asparagus and secure it, while a cutting motion is performed by a piece fixed with a razor blade. This final design was able to be integrated and fixed to the final design of UTEC's bogie system.



Finalized CAD model


Purdue x UTEC at UTEC's campus



- Camera A for path recognition
- Camera B for asparagus recognition

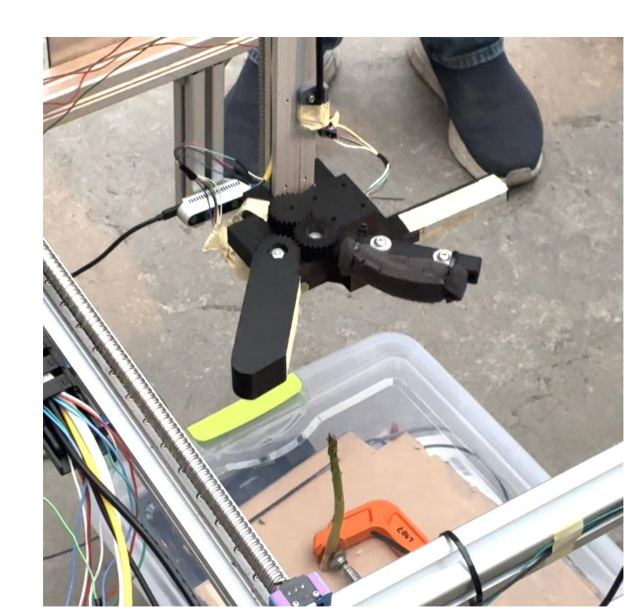
Block diagram of robot

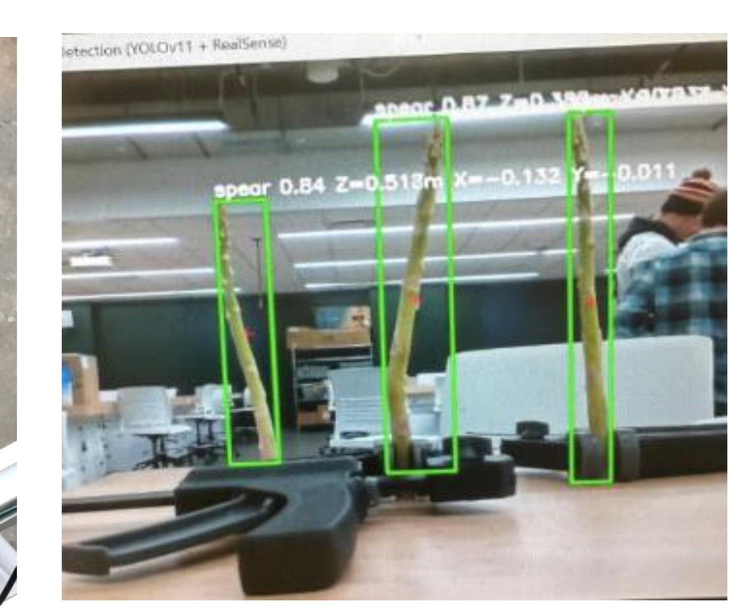
Testing and Results

The testing process consisted of the robot moving **70 cm** while **Camera B** detected mature asparagus spears along the path. When a spear was identified, the integrated gripper performed the harvesting cycle gripping, cutting, and collecting the asparagus. This process was repeated until all mature spears within the test area were fully harvested.

- The Intel RealSense camera achieved an accuracy of 85% for asparagus detection.
- The average asparagus harvesting time was 15 **seconds**.
- The battery provided an operational duration of **2 hours**

Results were successful. The bogie system navigated as required, and the cartesian mechanism accurately identified and harvested individual asparagus stalks. Although the full harvesting cycle was achieved, there is room for improvement. Future work includes enhancing furrow detection with machine learning, enabling detection while the robot is in motion, increasing harvesting speed with improved motors, exploring alternative steering systems such as Ackermann or a 4-drive/4-steer platform, and refining gripper orientation for greater precision.


Integrated Final model in action


Computer Vision of group of asparagus developed using machine learning