McGill Agriculture Robotics Squad Cotton Rover

Mohamed Debbagh*, Kyle Geddes, Andres Rello, Xintong Jiang, Karim Abdalla,
Gunes Arev Citak, Philippe Leblond, John Lan, Jasmine Brar, Robin Le Vigouroux, Xuehai Zhou

Supervisors: Viacheslav Adamchuk, Shangpeng Sun

Overview

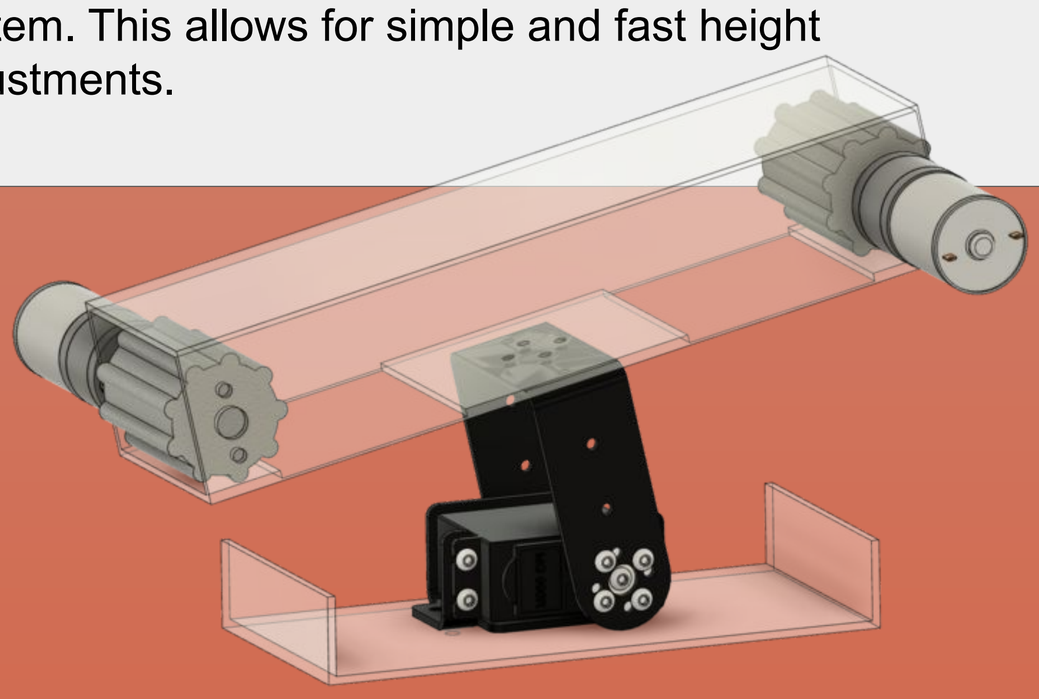
The Cotton Rover (CR) is an autonomous robotic system specifically designed for the automation of cotton harvesting. The CR integrates several subsystems including a navigation system, cotton detection and mapping system, harvesting mechanism, and delivery system. The CR demonstrates the application of robotics in the context of agriculture contributes to advancements in automated precision agriculture technology.

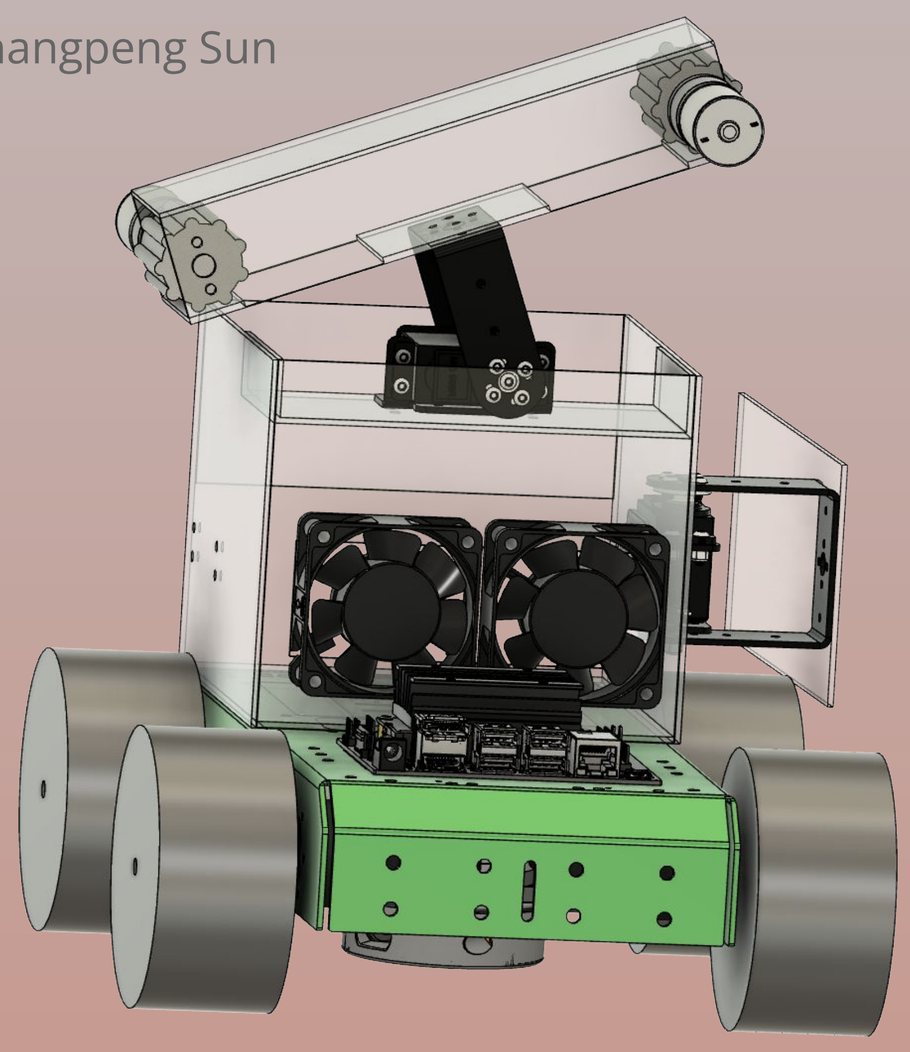
Navigation

The Cotton Rover's navigation system encomposes its sensor system for localization as well as its locomotion mechanism. The CR is equipped with both a LiDAR sensor and a gyroscopic/accelerometer sensors to determine its position from the boundaries of the playing field and orientation. The CR is also equipped with mecanum wheels individually driven by 4 high torque DC motors, which allow the robot to traverse through the course with little limitation in motion, direction and orientation.

Harvesting System

The harvesting process relies primarily on a dual-roller system, which has been designed to efficiently separate cotton bolls from their husks. The two rollers, characterized by their serrated surface, provide sufficient traction to enable secure handling of cotton bolls.To accommodate the natural variation in cotton plant sizes, the dual-roller system is attached to a tilt-adjustable end-effector. This end-effector is capable of altering the position of the rollers to target cotton bolls positioned at heights between 7" and 11" using a tilt based servo system. This allows for simple and fast height adjustments.

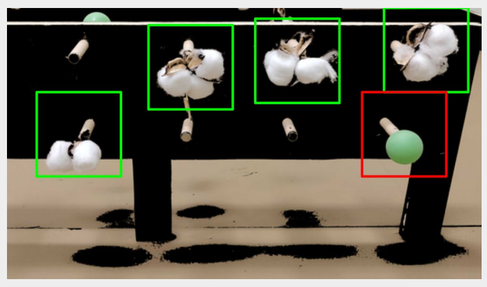




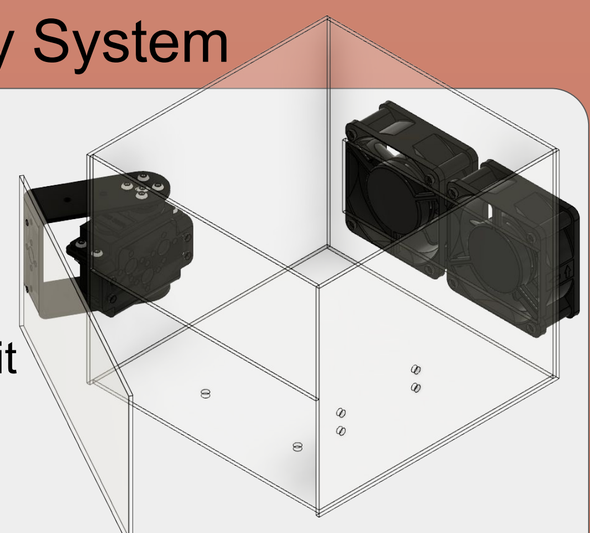
Cotton Detection

The CR utilizes a computer vision based approach specifically designed to work within the processing constraints of a Jetson Nano platform. The primary imaging hardware of the CR is a standard webcam or a Raspberry Pi Camera Module. The CV pipeline is as follows:

Color thresholding Segmentation → Classification by a Support Vector Machine (SVM) → Mapping



Delivery System



The delivery system is composed of two main components: a storage unit and a cotton expulsion mechanism.

storage unit is the initial repository for the harvested cotton bolls, which are funneled into the unit through a chute connected to the harvesting mechanism.

The expulsion mechanism is comprised of servo-controlled flap which opens, followed by a pair of DC computer fans, which activate to expel the cotton bolls.

*McGill University. Department of Bioresource Engineering, 21111 Lakeshore Rd, Sainte-Anne-de-Bellevue, Quebec H9X 3V9
Project page: https://moha7108.github.io/2023/06/12/ASABE-Robotics-2023.html, maintained by Mohamed Debbagh.
Contact email: mohamed.debbagh@mail.mcgill.ca