WEED Cutting Autonomous Robot

The robot presented is designed primarily for weed cutting purposes, Usually crops are destroyed by weed plants that grow at the base of the planted crop and end up destroying the yield by 10%.

It is estimated that the crop yield is destroyed by upto 30% if the weeds height is beyond 4.5” and kept unchecked.

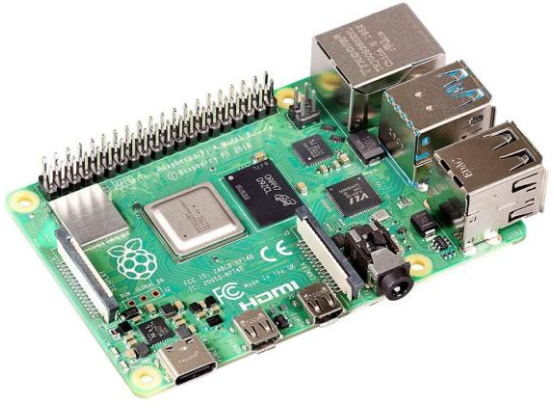
This bot would keep in check the potential weed height and help the farmer increase the yield.

Other application this bot could be used for detecting plant health as well as report any issues at the farm level being diagnosed by the CV algorithm used.

The bot will be totally autonomous and only the application will be need to be monitored by the farmer for plant health diagnostics as well as any maintenance requests.

Sensors and Hardware

- Camera – Raspberry Pi Cam 2 [5 Mp]
- Motor for Drive – Dynamixel mx-28ar [Nominal Torque 2.5Nm]
- Motor for Cutting - Dynamixel mx-28ar [Nominal Torque 2.5Nm]
- IMU – LSM6DSL / LIS3MDL
- GPS - CAM-M8
- 360 LiDAR – LDS 02
- Raspberry Pi 4
- Track Drive with variable wheel height for terrain adjustments
- Weed cutter assembly
- Battery



Sensors Hardware and Algorithms

Positioning :- The GPS can be used for accurate location estimation and the IMU can be used for odometry as well as dead reckoning

Mapping :- The LiDAR along with the camera and April tags will better help map the farm and use of visual SLAM can be used for better trajectory design.

Pattern Recognition and CV :- The seeding can be mapped and can be used for trajectory definitions, Plant species can be identified based on color, shape and specific distuingishing features, pattern recognition in plant spacing can be used to design intra laned trajectories. These mechanisms can be used for obstacle detection, avoidance and new trajectory planning.

OS: The ROS platform will be used to combine the CV, SLAM and the positioning algorithms and the raspberry pi 4 is good fit for this application as it has a good arm processor and the size and power factors are well suited for mobile robot applications.

Cutting Blade Mechanism :- The nylon string cutter would be the best for this application. It is a nylon string that when rotated at 6000rpm creates a cutting action and the improper cutting angle leads to stubbed growth of the weed plant, the assembly is 0.25 m above the ground which is sufficient to avoid any irregularities in the ground as well as maintain the weed height below 4.5 inches to increase crop yield. The selected motor provides an rpm of 60 and using a gear reduction ratio the 6000 rpm with minimum/low torque would be sufficient for this application

Navigation

The total weight of the robot is approx 3kg (considering the assembly, sensors, battery and motors) . The torque required to propel this bot at a velocity of 1m/s is approximately 3.3 Nm which is provided by the selected motor. The wheel size is 0.5m as the blade needs to be 0.25m from the ground and hence the ground irregularities can be overcome.

The Track drive system for propagation will be used as it is proven to be better used in an irregular terrain. The turning can be achieved by rotating one side faster than the other side.

The Visual SLAM with the help of the camera and by placing April Tags at lane entries the defined trajectory for the bot can be decided based on the farm and the conditions detected by the camera and the LiDAR. The GPS as well as the IMU will be used for localization in the farm frame and the LiDAR and camera can decide which is the planted crop and which is a weed. The camera can be used to capture moving objects in the farm (rodents, farm animals) and can be reported to the farmer in the app. The camera can also be used for monitoring plant health and reporting the same to the farmer.

Power

- The total watts are 205 and to get the bot running for 1 hour we would need 205 Watt Hours, ie 10 Ah. The required battery would be a 4s7p config of a 3.6V Samsung INR 18650 cell. This battery weighs about 1.2Kg with the cell housing and hence the total bot weight comes to be about 2.9Kgs. The cell selected has an energy density of 110Wh/Kg, the nominal cell voltage is 3.6V and the current capacity is 1.25A so the cell can be used at 2C for drive.

Sensor	Weight	Cost	Power Consumption
Motor for Drive	0.77Kg	269$	2.5 Watt
Motor for Cutting	0.77Kg	269$	200 Watt
LiDAR	.131Kg	200$	2 Watt
RaspberryPi4	0.050Kg	35$	2.4 Watt
Berry IMU GPS	0.004Kg	75$	0.1 Watt
RPI Cam	0.005Kg	5$	0.1 Watt
Battery	1.2Kg	150$	
Total	**2.9Kg**	**1000$**	**210Watt**