Description

The Project:

The project is to design a differential drive agribot equipped with GPU, IMU, RGB-D and Thermal Imaging Camera with on-board computer which can traverse the fields along the defined paths in lanes while capturing images in visible and thermal format to analyse the water content so as to determine what plants or lanes need watering. Other characteristics like the quality of the crop can also be determined by processing the data.

Social Relevance:

By gaining insights from the processed data, we can optimize the use of water resources and provide irrigation to only those plants that need it. This can help save a lot of water while also keeping the quality of crop in check. It can also save the crop from failure by determining where water is required more or where the crop is getting more water than needed. In uncertain conditions, it can give exact insights about the water content required and thus guarantee optimum quality while also saving significant amount of water resources.

1 Late Day is utilised for the completion of this project.

Power

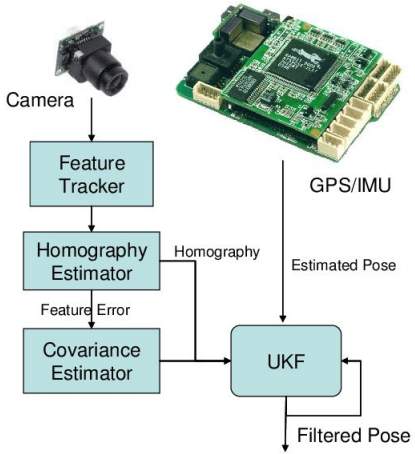
Sensor	Weight (g)	Size (mm)	Voltage (V)	Current (mA)	Power (W)	Cost (USD)
GPS (U-blox NEO-6M)	12	22*30*4	2.7-3.6	45	0.15	$11.99
IMU (MPU9250)	3	20*40	2.7-3.6	6	~0.02	$20.30
RGB-D (Intel Realsense D435) (1280 x 720)	308.44	143.51*92.71* 52.07	4.75-5.25	700	3.5	$307.00
Thermal Camera (Teledyne FLIR)	113.398	57.404*44.45	4.8-6.0	500	2.5	$1,599.00

- Processor: Raspberry Pi 3 Model B+ BCM2837B0 (5V, 2.5A) (82mm x 56mm x 19.5mm, 50g)
- Robot Weight: 15 Kg (All Inclusive)
- Operation Time: ~2.5 hrs
- Maximum Velocity: 1 m/s
- Acceleration: 0.5 m/s^2

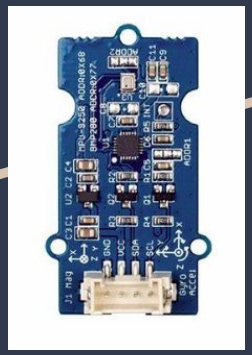
Battery: 12V 100AH Lithium Battery, LiFePO4, 10.8862 Kg, $317.00
Motor Rating: RPX52 Brushless DC Motor (52mm, 700mNm, 12V, 360g) (2 units) ($300.00)
Total Power: 460 W
Total Cost: ~$3,000.00

Navigation

- The agribot has to navigate in a known environment which is the field. Generally, fields have defined lanes where plantations are done and the bot can navigate between the spaces.
- The mapping can be done initially and then the route can be defined into the robot's system for it to traverse the whole field in one go.
- The bot is equipped with GPU, IMU and an RGB-D camera which while does have other purpose, can also aid in the navigation. Sensor fusion with the above sensors can help the bot navigate in a precise and accurate manner.
- It is only natural for the planned path to throw out errors which will accumulate over time and throw the agribot off it's desired path.
- Control algorithms can be used to minimize the errors so that no significant deviation is observed.
- ROS packages have a lot of functionalities which when combined with the sensor and the odometry data can aid the navigation of the agribot through the field.
- AprilTags can be used as markers at certain places which the agribot can utilise to validate its position in the previously known environment while significantly minimizing the error that is accumulated over time.



Sensors



Sensors Used:

- GPS
- IMU
- RGB-D
- Thermal Camera

The agribot is equipped with a network of sensors that allows it to navigate through the fields and perceive its environment to collect data and draw insights after image processing. All the sensors are necessary and they need to be robust, precise while also configured to work in real-time. Kalman filter can also be used to estimate the state of the robot.

The data from GPS, IMU and RGB-D camera can be fused to achieve precise position. IMU provides the instantaneous position and orientation, acceleration, velocity and other parameters.

The RGB-D camera and the thermal camera captures data in visible and thermal format respectively as the robot navigates through the fields. A raspberry pi 3b+ serves as an onboard computer. The processing can be done in real-time while sending the location of the portion of crop that is in dire need of water or can be later processed as a whole on a server computer after analysing the collected data.

The data from both these cameras is to be cleaned and then fused in order to draw insights about the water content and the quality of the crop.

In this manner, after the robot completes its path in the field, we will have precise information about what part of the field is in need of irrigation and also about the quality checks of the crop.

Computing Platform, Software and System Integration

Computing Platform:

Raspberry Pi 3B+ is used as an onboard computer for this agribot.

All the sensors are interfaced with the Raspberry pi where programs are running for the bot to function.

Scripts can also be executed remotely as and when required for custom functioning.

Software:

The data collection and analysis scripts are in python.

OpenCV, alongwith other state-of-the-art image processing tools are used to analyse the data from RGB-D and Thermal Camera and fused in order to draw insights about the crop in the field.

System Integration:

The agribot is a complex system consisting of a network of sensors, an onboard computer and other components which requires proper handling of data and efficient communication between various different parts of the system.

All of these is integrated using the Robot Operating System (ROS) framework.

ROS does the task of integrating the complete system and streamlining the process of collecting the data while also serving as a central platform/framework which controls all the processes be it navigation, perception or sensing.

It is functional on Raspberry Pi 3B+ and can also be integrated with OpenCV if the need be or the data processing can also serve as isolated unit. The agribot can also be monitored from a remote computer with the help of ROS and can also provide teleoperation functionalities when required.