CIE
SUMMER INTERNSHIP
2023

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BOLT

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TOPIC :

Precision Agriculture

ABSTRACT :

Precision agriculture, also known as smart farming, is a modern approach that leverages advanced technologies and data analytics to optimize agricultural practices. The main objective of precision agriculture is to maximize crop yield, minimize resource wastage, and reduce environmental impacts. This is achieved through the precise application of inputs such as fertilizers, water, pesticides, and seeds, based on real-time data and insights obtained from various sources like satellite imagery, GPS technology, soil sensors, and weather forecasts.The need for precision agriculture arises from the growing global population, which puts immense pressure on the agriculture sector to produce more food sustainably. In the workflow of our project, a rover equipped with soil sampling tools and sensors is constructed to collect soil samples across farmland. The rover then conducts on-site analysis of the samples, evaluating crucial soil parameters like nutrient content, pH levels, and moisture, subsequently generating fertility maps. These maps display the spatial distribution of soil characteristics, helping identify areas with high or low fertility, nutrient deficiencies, and moisture levels. The collected data and fertility maps are uploaded to a centralized server or cloud-based platform. Agricultural experts and farmers can access this server to extract relevant insights, enabling the development of tailored crop management strategies for specific regions within the field.

INTRODUCTION :

India, with its burgeoning population and reliance on agriculture, faces a critical challenge in the form of overfertilization in its farming practices. Overfertilization, characterized by the excessive application of nitrogen, phosphorus, and potassium fertilizers, has accelerated soil degradation, adversely affecting soil structure, fertility, and microbial diversity.These nutrients are heavily used to meet the global food supply and ensure healthy crops. But these fertilizers should be applied with the correct ratio for the crops to be healthy. When NPK is overused, it is harmful, but it is still vital.Therefore, it is essential to detect the available nutrients present in the soil before using them again. Some ways or developments can detect the levels of NPK in soil, and there are a lot of technological advancements that can help monitor these vital parameters for a better yield and healthier crops. Since their macro-nutrients vary even on a small scale in a cultivated field, several researchers have attempted to develop sensors to map these nutrient contents.

We too made such an attempt. We decided to build a rover to test soil samples and create fertility maps involving a systematic process to optimize agricultural practices and support farmers in making informed decisions. Firstly, the rover, equipped with soil sampling tools and sensors, is designed and assembled. The rover's mission is to traverse the farmland, collecting soil samples at various locations. Once the samples are gathered, the rover analyzes them on-site using advanced technology to assess key soil parameters, such as nutrient content, pH levels, and moisture.

Next, the rover compiles the collected data and generates a comprehensive heat map or fertility map of the entire field. This map visually represents the spatial distribution of soil characteristics, highlighting areas with high or low fertility, potential nutrient deficiencies, and moisture levels. The fertility map serves as a valuable tool for understanding the field's variability, enabling precise agricultural interventions.

Upon completion of the soil analysis and map generation, the rover uploads the data to a centralized server or cloud-based platform. This data sharing process is crucial as it facilitates easy access and storage of valuable agricultural information, making it readily available for further analysis and decision-making.

Finally, agricultural experts, agronomists, or the farmers themselves can access the server to extract the relevant data and insights. Using this information, they can develop tailored and efficient crop management strategies for specific regions within the field. Precision recommendations, including optimal fertilization plans, irrigation schedules, and crop choices, can be deployed back to the farmer via digital interfaces or mobile applications.

This integrated workflow of building a rover, creating fertility maps, uploading data to a server, and deploying customized solutions to farmers revolutionizes traditional farming practices. By harnessing the power of technology and data-driven insights, precision agriculture optimizes resource utilization, minimizes environmental impact, and ultimately enhances agricultural productivity, benefiting both farmers and global food security.

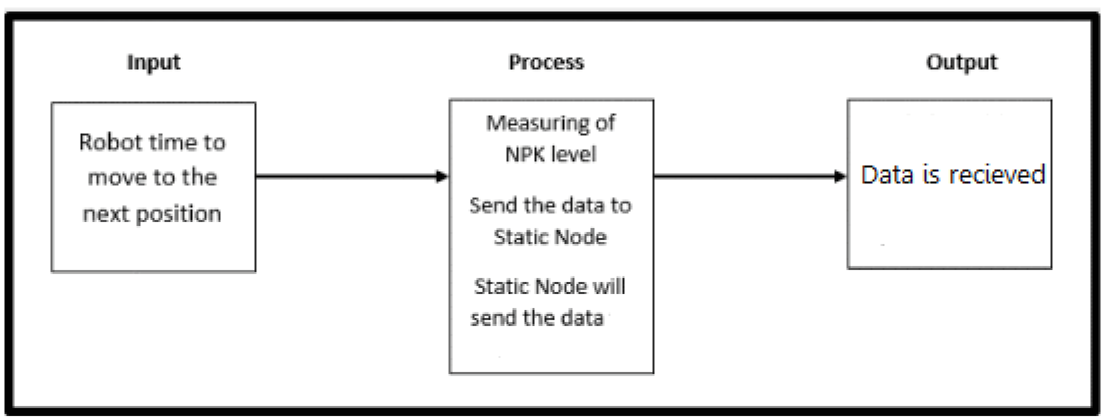
MOTIVATION :

By adopting precision agriculture techniques, farmers can make informed decisions, enhance resource efficiency, increase crop yields, and ultimately contribute to food security, and optimizing their economic returns.This will prove to beneficial especially for Indian farmers, because with the increasing cost of living, they need to produce more from an average land size of 2.5 acres. Hence, developing an economically available and sustainable solution became the need of the hour.

<u>ARCHITECTURE AND IMPLEMENTATION</u> :

<u>Design Implementation Overview</u> :

We chose “**Precision Agriculture Detecting NPK Level Using a Wireless Sensor Network with Mobile Sensor Nodes”** as our base paper, and tried to implement it in a more economical way :

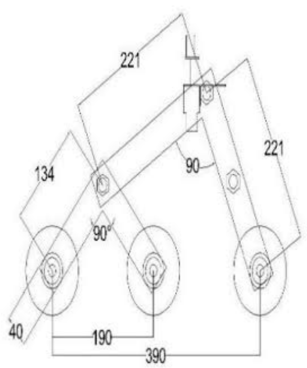


<u>Mechanical Implementation</u> :

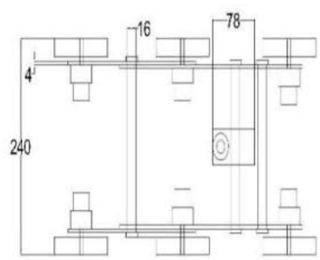
Rover was designed with the prime goal of making it move through uneven and rocky terrain. The prototype 1.0 was built using pvc pipes and 6 of 12V DC Motor, composite wood, 12 volt battery. We came across multiple problems during the process :

- To join the rear end and the front end of the chassis, we clamped the two chassis against sand board plates which were too brittle.

- We again failed when we tested it using a stainless steel scale which was too flexible. And finally we found composite wood as the perfect solution for it .
- As we built a rigid chassis we connected the motors in parallel to a 12V battery and ran the rover. Which took a circular path. Due to all the wheels spinning at different rpm due different current input, and we also reduced the distance between the axis of the wheels and chassis which was too big earlier, due to which the shaft was not able to bear the force and was having a bending moment which made the wheels rotate at different angles.



FRONT VIEW

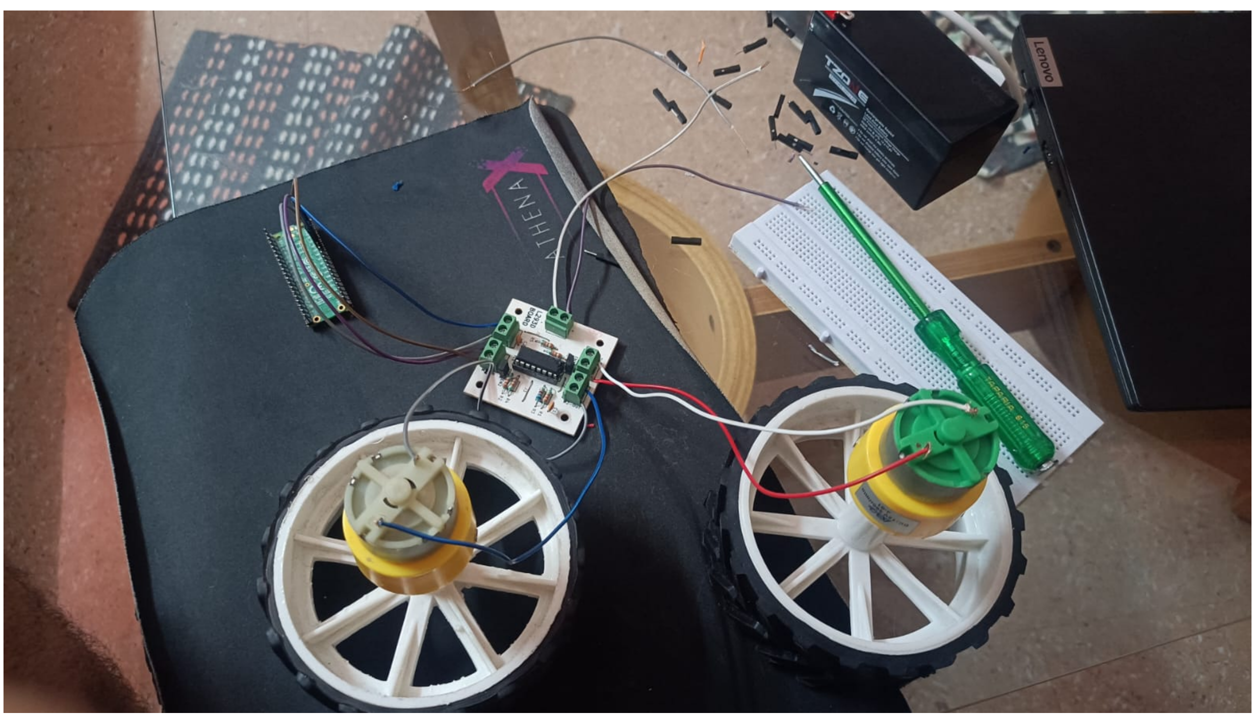


TOP VIEW

Software Implementation :

- When brainstorming as to different ways to get the rover to go around the field autonomously, we shortlisted a couple which we thought were feasible given the time we had and we decided that we'd use flags or rather color as the input to steer or rover across the field.

- We soon realized that the field of vision of a color sensor is not enough, hence we decided to use an esp 32 cam module.
- Initially we started working on the object detection part of our project by considering basing our model upon yolo(you only look once) but we soon hit a roadblock as a yolo model would be very compute intensive for an edge device.
- So we started researching upon tinyML, and we found a platform called edge impulse which use the tensorflow deep learning framework to build the object detection model.The algorithm used is FOMO(Faster Objects More Objects).this tensorflow model is converted to a tf-lite model in order for it to run on the edge device which in this case is the ESP32CAM.
- The objects that we built this model to recognize were bottles and boxes, for which we made our own dataset and labeled the images before training the model on them.

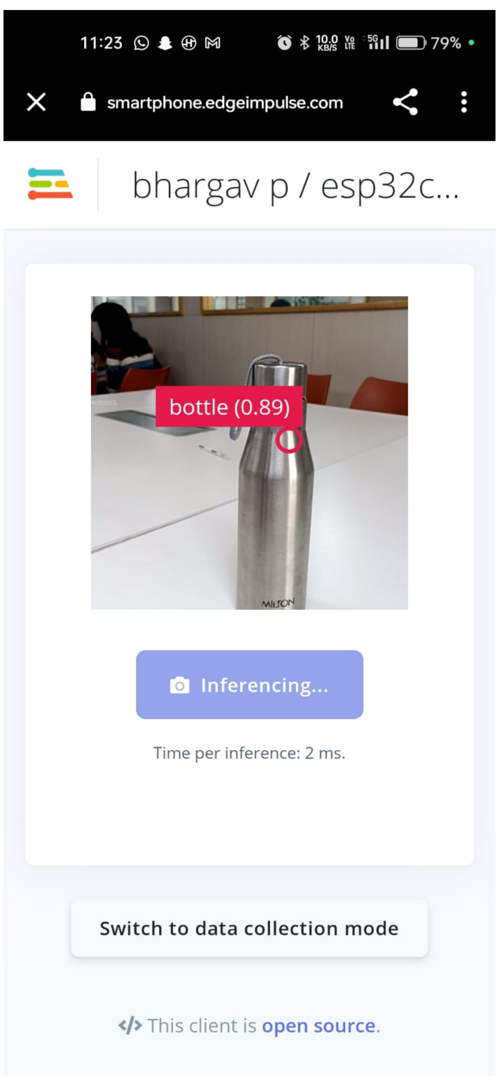


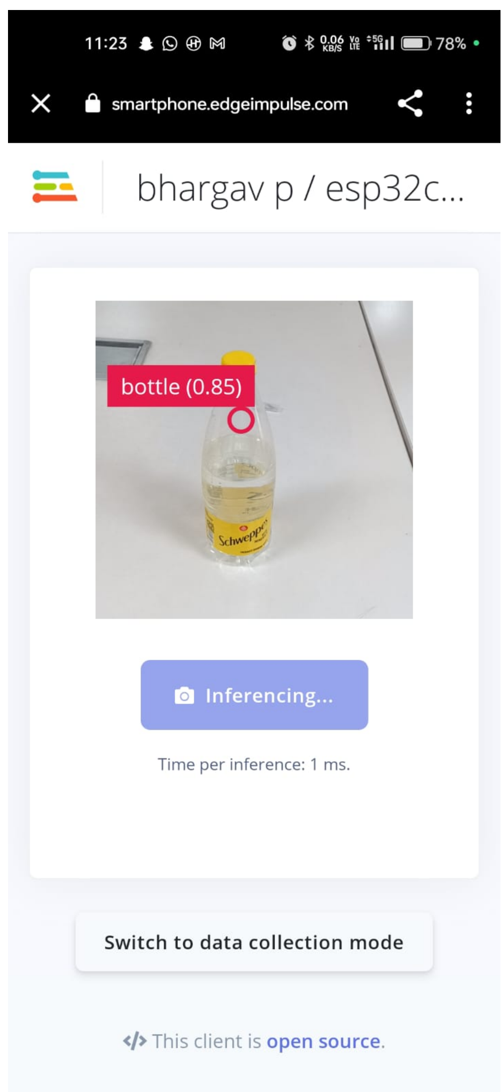
RESULTS :

The implementation of our project comprised the following outcomes:

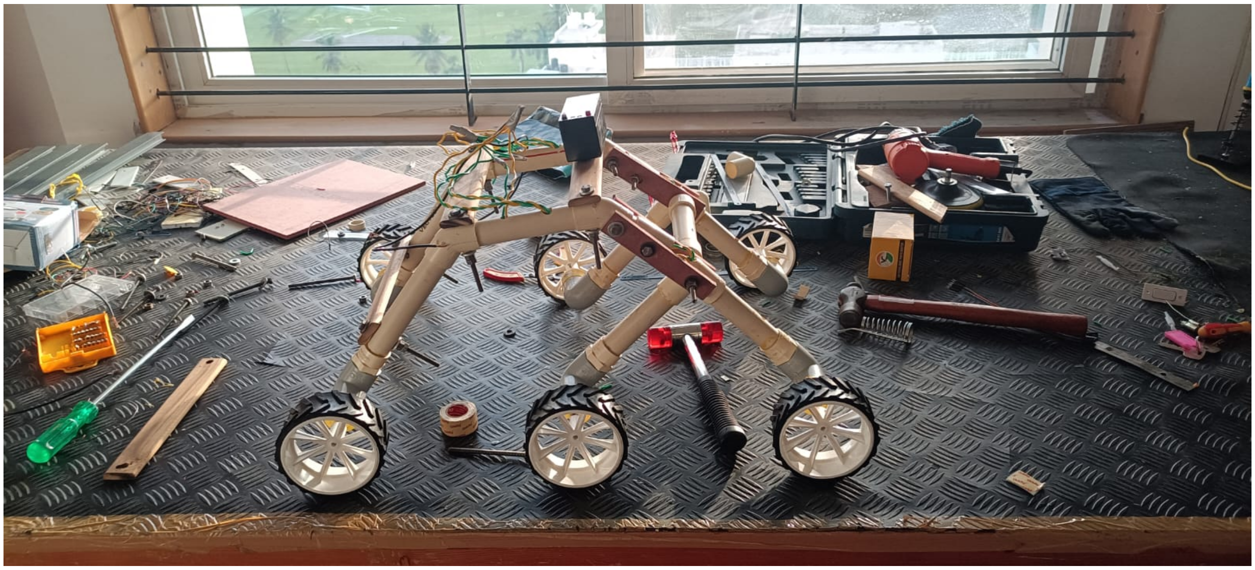
Firstly, the object detection model trained on a tailored dataset of roughly 100-150 images that yielded a maximum accuracy of 89.2%, with the other results being 85%, 82.7% etc on subsequent efforts. Secondly, an automated rover driven by the motor driver to run in the field as demonstrated earlier.

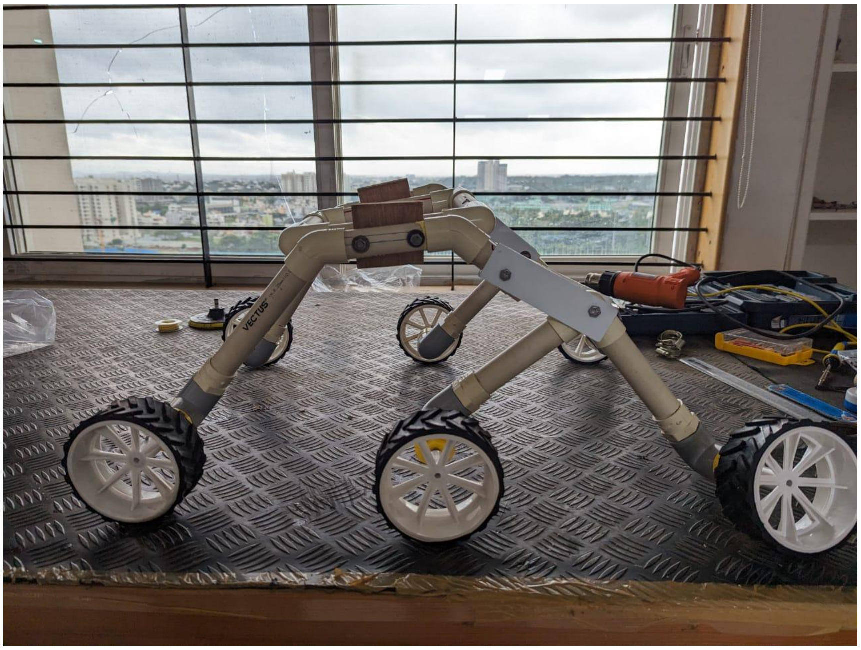
Object detection model :

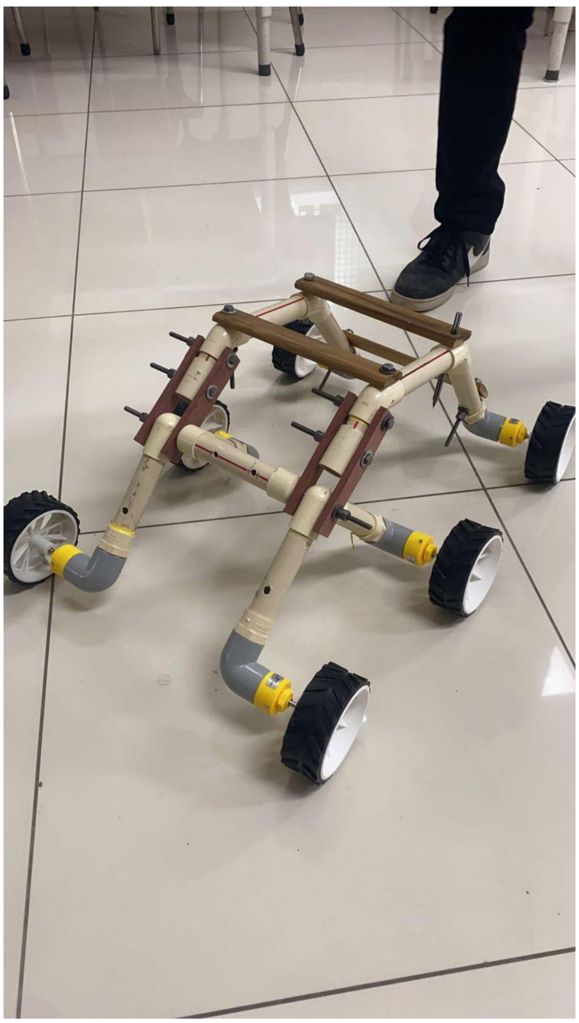




Automated rover:




VECTUS



CONCLUSION:

In conclusion, farmers' inability to maintain balanced NPK ratios in agricultural soils jeopardizes sustainable farming. Excessive or insufficient fertilizer use wastes resources, pollutes the environment, and negatively impacts agricultural development. The revolutionary rover equipped with NPK sensors along with the object detection model represents a promising solution for increasing production and resource efficiency while also improving agricultural sustainability.

FUTURE WORK :

For the rover as it is now, we devised options that may be applied to increase yield and efficiency.

- Creating a geofence around the target farmland. This will help us in mapping
- Implementing a protruding mechanism that measures NPK values present at certain distances using an NPK sensor.
- Building the fertility map from the obtained values.
- Developing a model to acquire the NPK values from the already obtained fertility maps.