CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

In the process of crop production we see many obstacles and hindrances such as the presence of insects and other pests or the growth of unwanted plants, that is weeds, in the field of cultivation. It is a tedious and inconvenient process of getting rid of these pests and weeds manually.

With the technological advancements over the years, it is now possible to do the above by the use of robots instead of human effort.

This project involves developing a robot that can be used for various maintenance and monitoring activities on the agricultural field. We will be using a raspberry pi and a pi camera that will transmit live images at high speed to the server controlled by the user. The robot will comprise motor drivers for its movement and will have a buzzer to avoid contact with obstacles on the field.

The robot will mainly perform maintenance and monitoring activities on the agricultural field. The focus is to eliminate human effort and increase work efficiency at the same time. The robot will perform activities such as weeding, ploughing, levelling etc. depending on the task required and the end attachment used.The robot will comprise of a basic chassis, raspberry pi, pi camera, dc & servo motors, ultrasonic sensors and LEDs.The various activities will be done by different end attachments that can be fixed to the extended arm, depending on the required task.

1.2 PROBLEM ANALYSIS

The current approach towards crop production and other farming practices are strenuous and highly demanding. It takes a lot of time and labour, as they have to be done manually.

In order to match these requirements, a solution needs to be proposed keeping in mind the tools and mechanisation available in the present technological landscape.

This is achieved by the robot that will take over and perform multiple tasks in the onerous process of farming. Furthermore, the farmer will have a user friendly feature provided for interaction & feedback with the robot.

1.3 MOTIVATION

- Developing and Maintaining an agricultural field is a diligent process. Like we know, it requires many tedious tasks and practices to carry out this process. Weeding, levelling and ploughing are some of those tasks that need to be done.

- Carrying out the above tasks and practices requires a lot of human energy, effort and time. Also, they need to be done repetitively and not just once.

- It is obvious to see that there is strain to human health and also a few of the tasks carry the risk of injury.

- So, this robot overcomes these barriers and obstacles by doing all the required activities on the field, reducing human effort, decreasing need for labour and also increasing efficiency.

- This will result in more productivity and higher overall output from the agricultural land and from each of the practices.

1.4 OBJECTIVES

- Robot moves in the predetermined path

- Takes task details from the webpage

- Input of land area is taken from the webpage

- Differentiates between weeds and crops

- Performs ploughing and leveling operations successfully updates progress to the webpage

CHAPTER 2

LITERATURE SURVEY

In recent years, the agricultural industry has begun adapting to numerous technologies that help in improving the quality of crops grown. Most of these new technologies aim at large scale farming at the order of thousands of hectares. The equipment that already exists is mostly huge and not preferable for smaller lands that are a few acres in size. They are also expensive for a farmer to afford. The new developments such as Agrobot aim to make smaller robots for agriculture but are still expensive.

The research and development in the field of agriculture is ever growing with new technologies that aim at improving the efficiency of the robots and reducing the size. The concept of precision agriculture has inspired the new age farmers to make use of the available technology to maximize their yield.

Some of the research published in this field are reviewed below:

Research and development in agricultural robotics: A perspective of digital farming. Redmond Ramin Shamshiri, Cornelia Weltzien, Ibrahim , Hameed, Ian J. Yule, Tony E. Grift, Siva K. Balasundram, Lenka Pitonakova, Desa Ahmad, Girish Chowdhary

This paper reviews some of the latest achievements in agricultural robotics, specifically those that are used for autonomous weed control, field scouting, and harvesting. This paper primarily focuses on digital farming, which is the practice of using sensors, actuators and data analysis for farming. Weed control and targeted spraying robots are specialized in remembering the place of crops. Harvesting robots are specialized in image processing. Field scouting and data collecting robots are specialized in collecting data and communicating the telemetry with the farmers. Furthermore, this paper highlights the major challenges faced in digital farming such as object identification, task planning algorithms, digitalization and optimization of sensors.

Agricultural Robot: Intelligent Robot for Farming. Nidhi Agarwal, Ritula Thakur International Advanced Research Journal in Science, Engineering and Technology ISO 3297:2007 Certified Vol. 3, Issue 8, August 2016

This paper presents an Agricultural robotic system which can be modelled using algorithms for comfort to farmers and can be interfaced using Arduino boards and various types of sensors. Various aspects show Agricultural robots serve better than any manual system. Multifunctional systems help in faster return on investment. The smart mechanization system of the agriculture robot helps the people to establish an efficient agriculture system. For establishment of seedbed preparation, seed mapping, depth of seed placement. Simple system is designed to record the position of seeds dropped on land.

Design and Operation of Agriculture Based Pesticide Spraying Robot Amruta Sulakhe, M.N. Karanjkar. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064

The experiment showed that the robot can basically complete the work of automatic control and meet spraying requirements in the greenhouse. The control system has good stability and reliability. The spraying part can adjust position within a certain range according to the height of target, and reduce leakage spray and heavy spray as much as possible.

Agricultural Robotics Unmanned Robotic Service Units in Agricultural Tasks Fernando A. Auat Cheein and RICARDO CARELLI. IEEE industrial electronics magazine , September 2013. Digital Object Identifier 10.1109/MIE.2013.2252957

This article surveyed the state of the art in unmanned service units in agricultural environments and presented the four core abilities of such vehicles when performing agricultural tasks: detection, guidance, mapping, and action. A detailed analysis of each ability was given, showing both how the four abilities are related to each other and how the accuracy of the localization system is crucial to ensure the success of an agricultural task.

CHAPTER 3

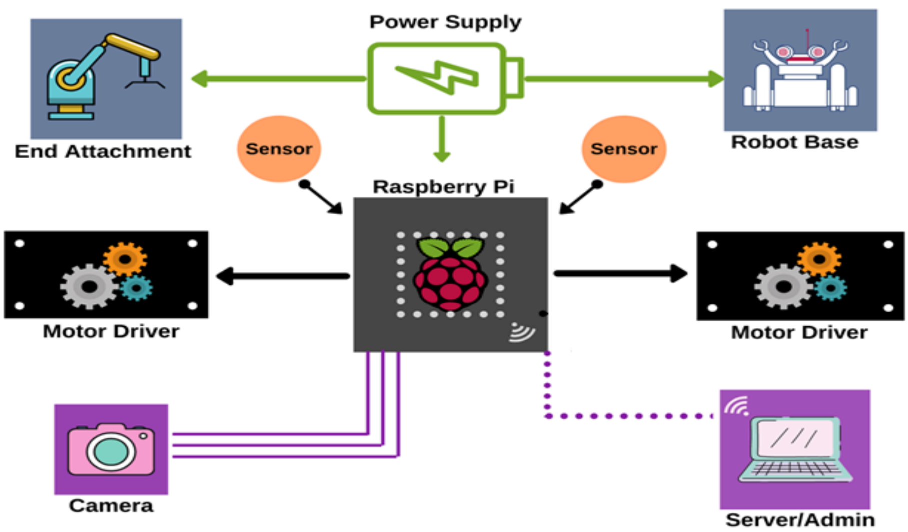
METHODOLOGY

3.1 SCOPE OF PRESENT WORK

The Agricultural Land Maintenance Robot we have developed has the ability to perform routine maintenance tasks without much user intervention. This is a primary concern in the agricultural industry as the lack of labour causes loss of crops. This robot also helps to perform these tasks in a fraction of the time taken by humans. The comparative cost of the robot can be significantly decreased by local production using durable but cheap raw materials. The labourers are at risk for injury while working in the fields. This can be avoided using robots.

The Indian agriculture industry in particular is undergoing a major evolution as advanced technologies are being developed. The younger generation of farmers are keen to learn and implement fast, secure, efficient and automated solutions. These are especially helpful for use in agricultural fields that cover extremely large areas of land of hundreds of hectares.

3.2. PROPOSED MODEL



3.2.1 Raspberry Pi 3

This is the processor used in our project to communicate with the web page, to control the movement of the robot using an ultrasonic sensor. Raspberry Pi has been chosen due to its low cost, small size computer which can be connected to keyboard and monitor through its in-built ports and easily programmed. It has many interfaces such as HDMI, multiple USB ports, Ethernet, Onboard Wifi and Bluetooth, powered through USB.

3.2.2 Camera

An external webcam of 720p/30Fps, Wide angle view is connected through one of the USB ports. The camera is enabled through the motion library of python and a live stream of the video is relayed on the website for remote monitoring by the farmer. Snapshots are captured from the live stream and processed by the python program

3.2.3 Ultrasonic Sensor

Ultrasonic sensor HC-Sr 04 is the most commonly used sensor for obstacle detection and avoidance. It is a low cost sensor with a range of 2cm to 400cm. It has a 30 degree cone and can detect obstacles in a wide range. It gives an output of the distance of the obstacle from the ultrasonic sensor. It is mounted at the front of the robot.

3.2.4 Motor Driver

A motor driver module L293D is used to control the speed and movement of the DC motors. The motor driver module can directly control 2 motors at the same time. We have used 2 DC motors for the two front wheels.

3.2.5 Robot Base

For mechanical support, an acrylic chassis set is used. It has a holder for an ultrasonic sensor. Slots to connect DC motors and mount the other components.

3.2.6 End attachments

The end attachments help the robot to perform different activities like ploughing, levelling. The end attachments are moved up and down using servo motors.

3.2.7 Power Supply

The complete system is powered using two 3.7V, 2500mAh 18650 Lithium Ion Batteries. They are mounted on the base of the robot and connected to the raspberry pi and motor driver.

3.3. FLOW OF THE PROCESS

- There will be an active web page through which the dimensions of the working field and the task to be performed have to be specified.
- The webpage then tells us the approximate ground dimensions for the specified task
- The movement of the robot is through DC motors and the ultrasonic sensors will detect any obstacles in the direction of the robot giving an alarm through the buzzer.
- The robot will perform many agricultural activities. Say for weeding, the Pi camera will detect weeds to be plucked.For leveling and ploughing the robot just continues to move forward through the mapped area.
- With any of the above activities going on, the webpage keeps updating in real time and tells us how much work is done.

CHAPTER 4

TECHNOLOGIES USED

4.1 OPENCV

OpenCV is a huge open-source library for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Python, C++, Java, etc. It can process images and videos to identify objects, faces, or even the handwriting of a human.

OpenCV-Python is the Python API of OpenCV. It combines the best qualities of OpenCV C++ API and Python language. And the support of Numpy makes the task easier.

Numpy is a highly optimized library for numerical operations. It gives a MATLAB-style syntax. All the OpenCV array structures are converted to-and-from Numpy arrays. So whatever operations you can do in Numpy, you can combine it with OpenCV

So OpenCV-Python is an appropriate tool for fast prototyping of computer vision problems.OpenCV is extensively used in companies, research groups, and governmental bodies. Well-established companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota employ this library. Applications of computer vision are object detection, face recognition, medical diagnosis, etc.

We have used OpenCV in the weed detection part of our project. The Pi camera connected to the Raspberry Pi 3 captures images of the crops and these images are processed by a Python program that uses OpenCV library to identify and differentiate weeds from crops. Our program calculates the percentage of weed in the picture and displays an outline around the weeds

4.2 HTML

HTML (the Hypertext Markup Language) and CSS (Cascading Style Sheets) are two of the core technologies for building Web pages. HTML provides the structure of the page, CSS the layout, for a variety of devices. Along with graphics and scripting, HTML and CSS are the basis of building Web pages and Web Applications.

HTML gives us the means to :

1)Publish online documents with headings, text, tables, lists, photos, etc.

2)Retrieve online information via hypertext links, at the click of a button.

Design forms for conducting transactions with remote services, for use in searching for information, making reservations, include spreadsheet, video clips, sound clips, and other applications directly in their documents.

4.3 CSS

CSS is the language for describing the presentation of Web pages, including colors, layout, and fonts. It allows one to adapt the presentation to different types of devices, such as large screens, small screens, or printers. The separation of HTML from CSS makes it easier to maintain sites, share style sheets across pages, and tailor pages to different environments.

CSS is designed to enable the separation of presentation and content, including layout, colors, and fonts. We use CSS in our project website to improve content accessibility, provide more flexibility and control in the specification of presentation characteristics, enable multiple web pages to share formatting by specifying the relevant CSS in a separate .css file which reduces complexity and repetition in the structural content as well as enabling the .css file to be cached to improve the page load speed between the pages that share the file and its formatting.

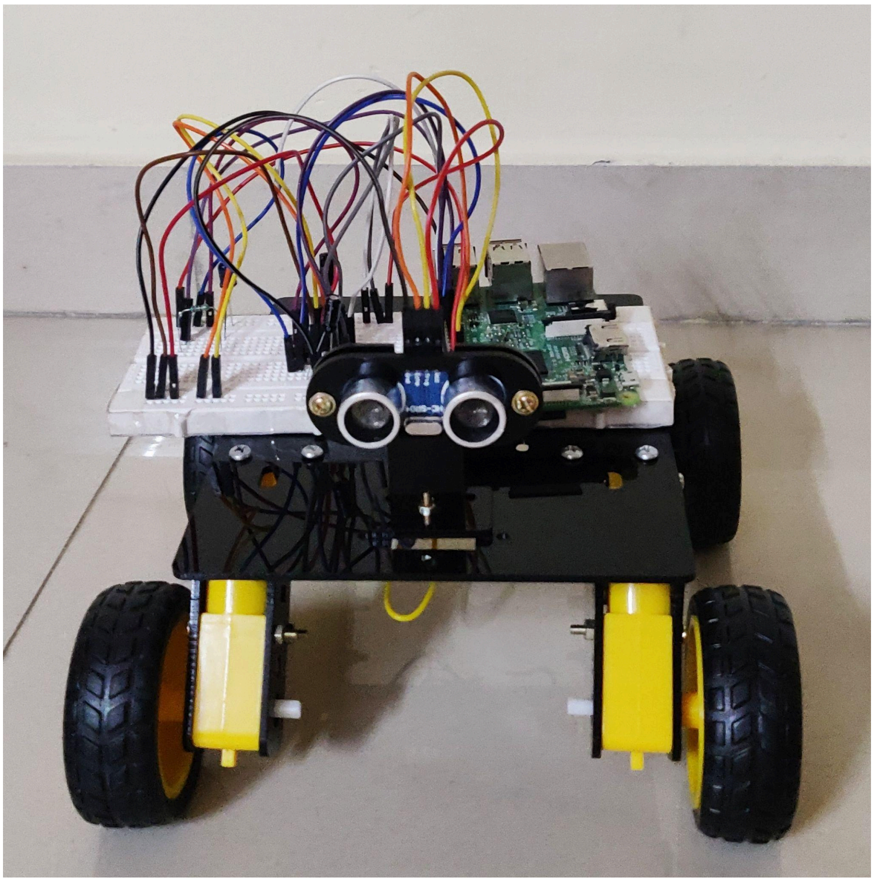
4.4 RASPBERRY PI

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a unique theme.Raspberry Pi OS looks similar to many common desktops, such as macOS and Microsoft Windows. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock.

We have used Raspbian OS on our Raspberry Pi 3 to control the robot. We used Python 3.7 on the Raspbian OS to run the weed detection program. The Raspbian OS takes input about the dimensions of the farm from the web page and updates progress back to the webpage

CHAPTER 5

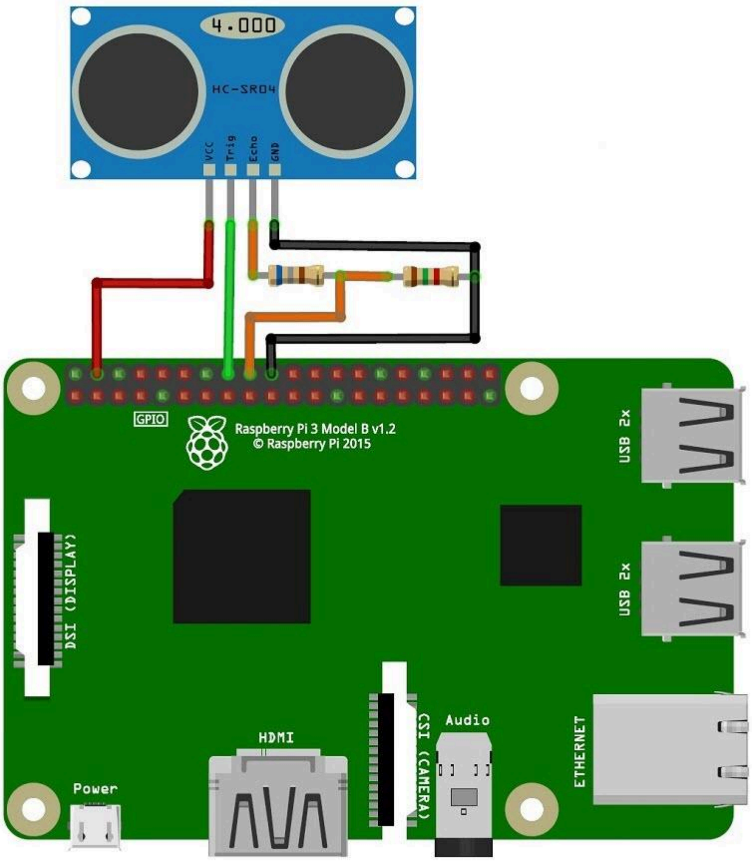
IMPLEMENTATION



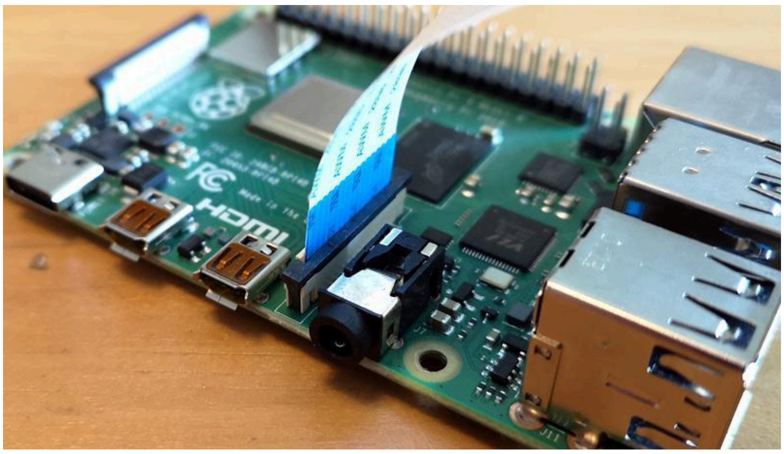
5.1 HARDWARE IMPLEMENTATION

The integral hardware component of our project that controls and monitors all the operations is the Raspberry Pi 3. It is connected to the Ultrasonic sensor through the GPIO pins. The Trig Pin of the HC-SR04 Ultrasonic Sensor is connected to a Physical Pin of the Raspberry Pi. A combination of resistors are used to supply the Echo pin 3.3V Logic and it is connected to a Physical Pin 18 of the Raspberry Pi.

Finally, +5V and GND connections are made to the Ultrasonic Sensor from the Raspberry Pi Pins.

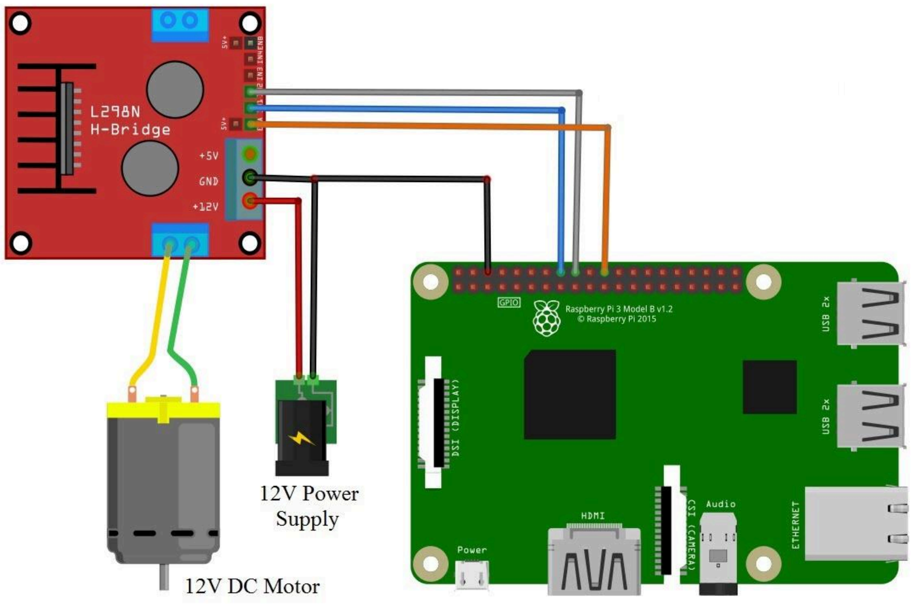


The Pi Camera is connected to the Raspberry Pi through the Camera slot on the Raspberry Pi. The camera module is then configured on the Raspberry Pi Configurations Tool. The interfacing options on raspi-config are configured as required



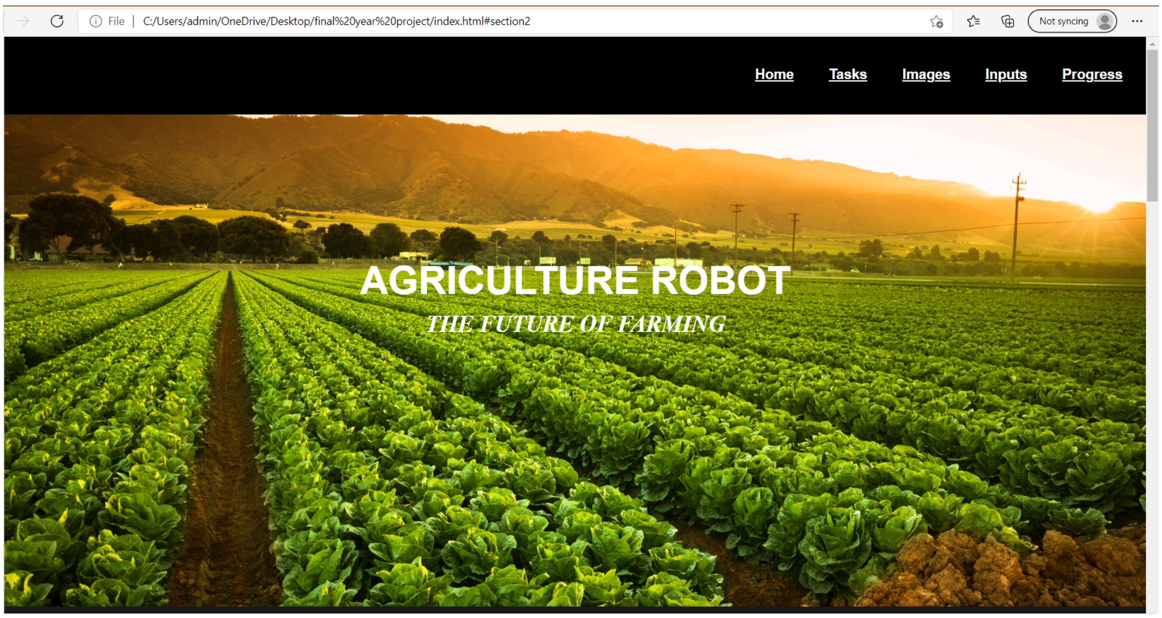
The motor driver is also connected to the Raspberry Pi through GPIO pins. These motor drivers control the 2 DC motors attached to the wheels of the robot. There is an additional castor wheel at the front of the robot.The Power Supply is connected to L298N Motor Driver Module. The GND terminals of Raspberry Pi and L298N Motor Driver Module are connected together.To connect each of the DC motors, connect the ENA pin of L298N to a Physical Pin of Raspberry Pi. The Inputs of the Motor, IN1 and IN2 of L298N

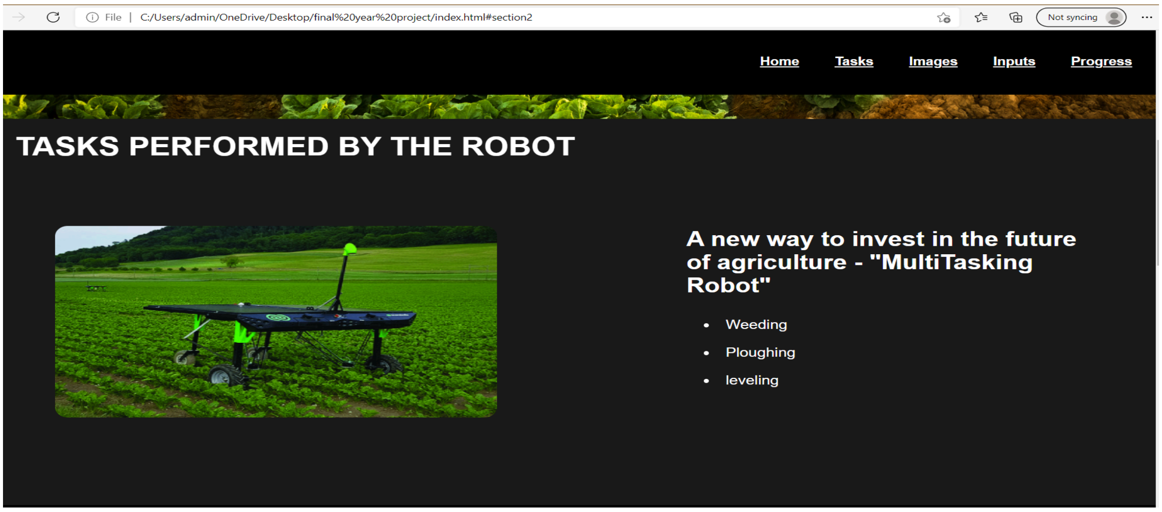
Module are connected to Physical Pins on the Raspberry Pi

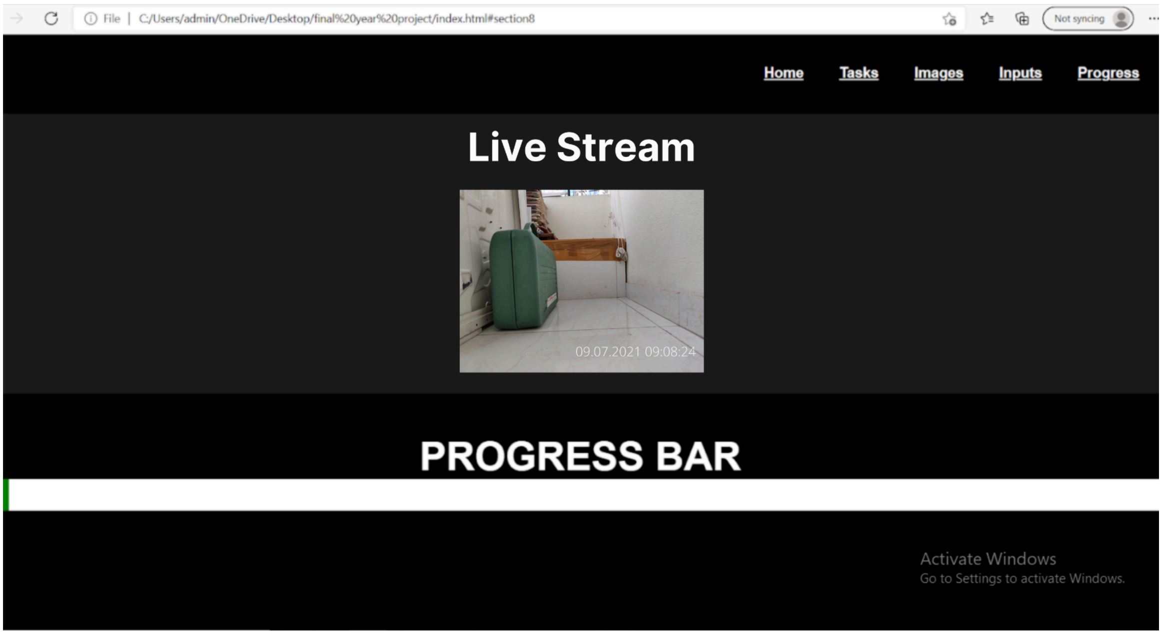


The power supply to the system is through a Lithium ion Battery. Power supply is connected to the Raspberry Pi, Motor driver.

5.2 WEB PAGE IMPLEMENTATION





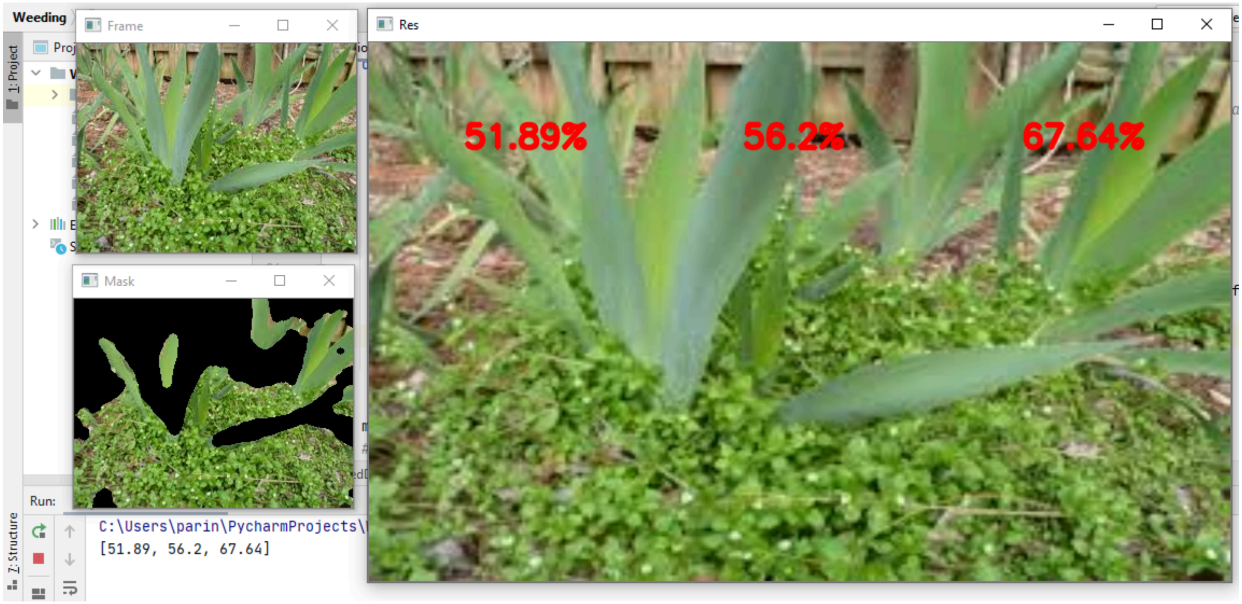


We have developed a webpage using HTML and CSS as the front end user interface. The webpage is used to select the task to be performed by the robot and takes the input parameters such as length and breadth of the agricultural land. There is another section that consists of a progress bar which displays the progress of the task in terms of percentage.

5.3 PYTHON PROGRAM TO IDENTIFY WEEDS

A python program for image detection is used to perform weeding. The input to this program is the image captured by the Pi camera. The image is processed using the OpenCV library in python. The output of the program is the image along with the percentage of weed detected in that particular image. An array of images can also be processed using the NumPy library. Here, each element of the array will be an image.

This program is run on the Raspbian OS on Python 3.7 IDE. The program also has the ability to outline the weeds.



Chapter 6

RESULT AND DISCUSSION

- Robot moves using the ultrasonic sensor output given to the Raspberry Pi
- Web Camera sends a live stream to the webpage.
- Python weed detection program runs on the snapshots of the livestream.
- Image processing is performed using OpenCV to differentiate weeds and plants for an array of images and the percentage of weed present in each snapshot is calculated.
- In case of ploughing and leveling, the respective end attachment is lowered based on the task selection on the webpage.
- Progress of the task is displayed on the webpage

Chapter 7

CONCLUSION

The Agricultural Land Maintenance Robot we have developed has the ability to perform routine maintenance tasks without much user intervention. This is a primary concern in the agricultural industry as the lack of labour causes loss of crops. This robot also helps to perform these tasks in a fraction of the time taken by humans. The comparative cost of the robot can be significantly decreased by local production using durable but cheap raw materials. The labourers are at risk for injury while working in the fields. This can be avoided using robots.

The Indian agriculture industry in particular is undergoing a major evolution as advanced technologies are being developed. The younger generation of farmers are keen to learn and implement fast, secure, efficient and automated solutions. These are especially helpful for use in agricultural fields that cover extremely large areas of land of hundreds of hectares.

Future Scope

This robot can future be modified to enhance its functionality by adding other end attachments, improving the user interface, adding more features to the webpage, increasing the accuracy of weed detection, GPS can be interfaced with Raspberry Pi inorder to track the exact location of the robot .

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