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Design & implementation of solar weeding robot for cotton field

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Abstract - *The motive of this work "Solar Weeding Robot" is to present an overview on a new combined methodology for the efficient improvement in productivity as well as increasing the efficiency of the agricultural weeding operation with the help of Solar based technology, image processing concepts, other tools & techniques of Electronics engineering. Which are one of the most influential & most effective methodologies for atomization of the existing system or technology associated with the working process in order to make process leaner, sustainable and eco-friendly.*

Solar-based weeding robot hold promise toward the automation of hand operated weed task. Robotic technology reduce current dependency on labors and weedicides for particular weeding operation. Solar technology helps to reduce energy crisis in India. Integration of solar energy with agriculture has been the most prominent way to produce on – farm renewable energy. The renewable resources have an enormous potential for agriculture industries. The farmers should be encouraged by subsidies to use renewable energy technology. Traditionally, elimination of weeds done by humans with the help of mechanical tools like hand trowel and grub hoe. Line sowing method have advantage of inter-culturing process. Crops which having space between two rows that can take advantage of proposed solar Weeding Robot.

Key Words*: *Lean process, Sustainable technology, Solar Technology, Efficiency, Renewable resources, weeding robot, weedicides.

1. INTRODUCTION

India is a country of rural. It has approximate 640,867 villages. Most of the villages are associated with agriculture. 57 % (50 – 60%) people are depending upon agriculture for their livelihood. Agriculture contributes 18 % of Indian GDP. Indian agriculture have come up a long way from traditional to mechanization. Traditionally farming was done mostly by manual interference. Ploughing and weeding were main part of Indian Agriculture. Now, cultivator and tractor have replaced them. With increase in mechanization, farmers have adopted different machines, implemented to ease the farming and increased production. Recently robots started taking part in agriculture. For example, Drones are one of the widely used device to spray fertilizers. To overcome the pollution created by exhaust gases after the usage of diesel, solar weeding robot is proposed to replace the existing weeding technique. The machine utilizes solar energy for its operations and reduces the need of diesel, which contributes decrease in pollution and scarcity of diesel in remote area.

1.1 What is weed in Agriculture?

Any plant not sown in the field by the farmer called as weed. Weeds are Plant that grows where it is not wanted and do competition with cultivated plants. Moreover, it is also known as a plant that grows in wrong place where main crop grows in particular line. The term 'Weed' has no botanical significant. Because a weed sometimes valuable for the main crop and sometimes it is harmful for main crop. A plant called as a weed in one region of country may when grown in another part of country it has plenty of valuable uses or in a few cases may actually be cultivate.

Weeds are the unwanted and undesirable plants. Which interfere with the utilization of land and water resources. They are sometime productive, tenacious, competitive and harmful. In cropland and forests, weeds compete with the beneficial and desired vegetation, reducing the yield and quality of produce.

1.2 Weed Management and Its Important

Weed management plays vital role in agriculture economy. Weed management is a critical issue and can significantly affect crop production. Weed can controlled by mechanical and chemical process. In Mechanical process, farmers use hoe and sickle tool for removing weeds. Moreover, in chemical process farmers spray specific weedicides. Now a days, flame weeder are very popular and it kills weed by applying flame of fire on weed plant.

The total annual loss of agricultural produce various due various parts in India is as below

1) Weeds: 45%

2) Insects: 30%

3) Diseases: 20%

4) Other pests (Rats, wild animals)

A recent estimate shows that weeds cause annual loss of Rs. 1980 crores to Indian Agricultural, which is more than combined losses caused by insects, pests and disease. Weed pest is the enemy No.1 to the crops. Weeds compete with crop plants for plant for plant nutrients, soil moisture, space and sunlight. Weeds are hardy ad vigorous in growth habit.

2. Image processing

Signal processing is a discipline in electrical engineering and in mathematics that deals with analysis and processing of

analog and digital signals, and deals with storing, filtering and other operations on signals. These signals include transmission signals, sound or voice signals, image signals and other signals etc. Out of all these signals, the field that deals with the type of signals for which the input is an image and the output is also an image is done in image processing. As it name suggests it deals with the processing on images.

An image is nothing more than a two dimensional signal. It is defined by the mathematical function f(x, y) where x and y are the two co-ordinates horizontally and vertically. The value of f(x,y) at any point is gives the pixel value at that point of an image.

3. Methodology

The agricultural weeding robot is designed to de weeding operation in cotton field during almost the entire cycle of growth and post harvest in large area. However, it is operated by solar panels so it does not require high power as other agriculture products require. The robot is based on two parts. Hardware part and software part. Hardware contains raspberry pi model, camera, motor driver, relay, IR sensor/ ultrasonic sensor, motors, solar panel, rotavator, etc. On the other side, software part consist python codes which will executed in raspberry pi model.

To achieve this all functioning of robot we first started field visits. During this period, we come to know about very basic things about cotton plant from regular farmers who grows cotton yearly. The received data from farmers and our observation is mentioned below.

3.1 Field study

A detailed field study has conducted by visiting farmers places situated in Vijapur, North Gujarat and Surendranagar. The observations from cotton (Gossypium barbadense) field are noted down below:

Table 1: Field data

Space between two rows of cotton	Approximately 75 cm
Space between two plants of cotton	Approximately 30 cm
Period of cotton crop until harvesting	250 days (It has long vegetation period)
Suitable soil	Sandy loam soils
Weeding process	At least 4 times. • When plant is not mature • When plant is mature • After rain • When fruiting is there
Name of weeds exists in North Gujarat	Abutilon indicum, Acalypha ciliata Forsk, Acanthospermum hispidum, Alternanthera sessilis, Amaranthus spinosus, Amberboa ramosa (Roxb.) Jafri, and so on.

3.2 Weed affected cotton field

Fig. 1 weed affected cotton field

During the discussion with farmers, they come up with one problem that quantity of weed is more at the time of harvesting the cotton. Here, it is observed that presence of weed is high around the plant. Images captured from the district surendra nagar, Gujarat.

3.3 Architecture

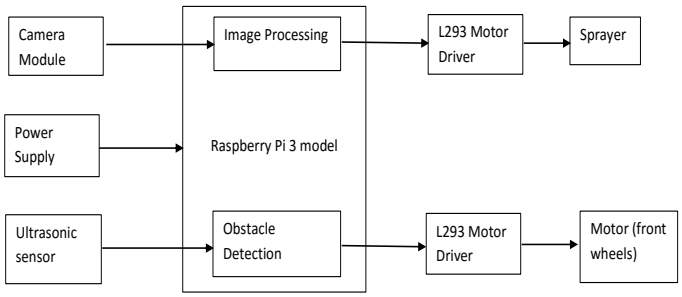

Fig. 2 Architecture of the system

In this proposed project, our primary aim is to detect the weed in the crop by using image processing. Then we will give the inputs of the weed areas to an automatic spray weedicide only in those areas. For this, we need to take a photograph of the field with good clarity to detect the weeds with more accuracy. Taking a photograph can be done by attaching a camera to a robot or taking them manually. Then we will apply image processing to that image using PYTHON to detect the weed.

Actuator unit contains different actuation processes like spray mechanism, wheel motor rotation, cutting tools operation and battery switching system. Solar operation achieved by using solar panels and dc batteries. It is necessary to run robot in a line where crop is not grown. In between two lines of crop, whatever plant is there it is either weed or crop, it will consider as an unnecessary plant. For this purpose IR sensor/ Ultrasonic sensor will be use. To detect the presence of any object in between row of crops

ultrasonic sensor will be used. It contains camera, which will be take images and compare it with the inbuilt stored images. Liquid level detection sensor will be used for detection of level in herbicide container.

3.4 Components of system

System has following components.

- Raspberry Pi 2 board
- Solar panel
- Raspberry pi Camera module
- Ultrasonic sensor
- L298 Motor driver
- DC Motor
- Rotavator

4. Flow chart for weed detection

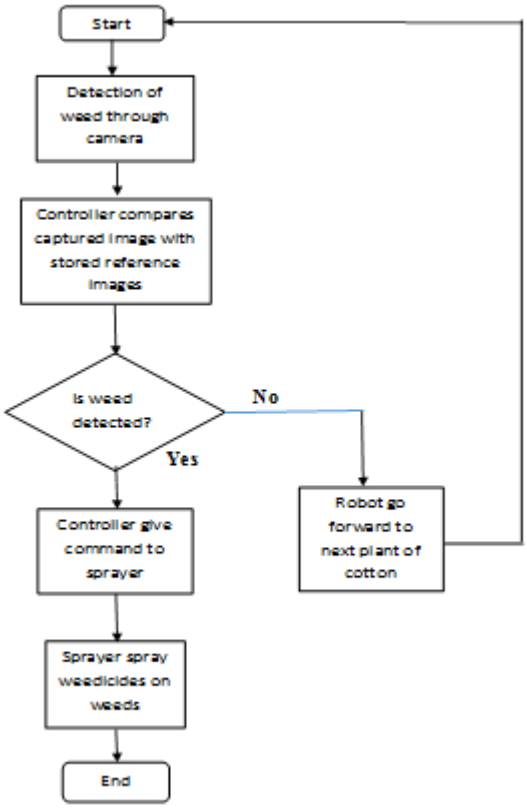

Fig. 3 flow chart for weed detection

After the proper placing of camera, camera will take images and gives to the processor. Apart from that it will simultaneously clicks the images. Raspberry pi will compare the captured images with stored images. Moreover, reference images will be the weeds, which grows commonly in cotton field. We can store number of reference images in raspberry pi but it is always advised that to keep less no. of images for the reference. It will minimize the system load.

4.1 Finalized robot design

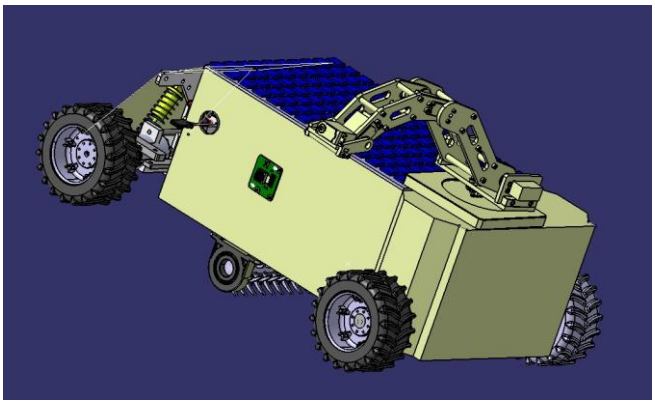

Fig. 4 Finalized robot design

Whole design of robot with the Raspberry pi camera module, rotavator and sprayer attached. Sprayer is attached on the water tank to spray weedicides.

4.2 Prototype of weeding robot

We have developed a robotic vehicle having three wheels and steered by dc motor and IR sensor arrangement. This vehicle will control the weeds in the farm by considering particular rows per column at fixed distance depending on the crop and also detects the obstacles present in the path of vehicle. The whole algorithm, calculation, processing, monitoring are designed with motors and sensors interfaced with Raspberry pi module.

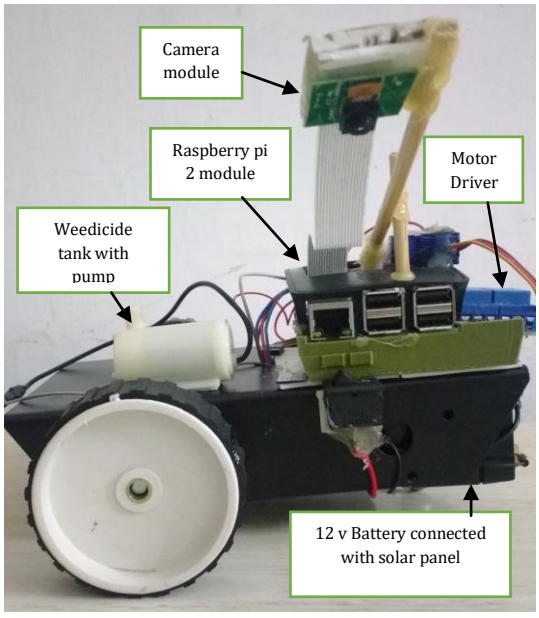

Fig. 5 Prototype of weeding robot

3. CONCLUSIONS AND FUTURE WORK

As it was expected to come up with a few solutions that can be immediately implemented so as to increase the efficiency of system. It is a practical way for weed detection using an

area-based feature to discriminate from crop. This study was limited to periodical weed removal tasks, whereby weed size is smaller than the crop size to carry out the approach reported.

Future work on the current topic is aimed to use crop rows to estimate a grid, in which weed detection includes plants position, offering to the system other descriptor to discriminate crops, due to random behavior of weeds and include shape features.

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