Autobot for Precision Farming

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Abstract—Agriculture is reckoned as one of the orthodox occupations in India, due to the certitude of specialization and expertise we procure. Ancient farmer used their advanced skills and techniques to yield production from various sources, but in today's scenario farmers endeavor hard to cultivate the land and yield the production. The farmers today are not the congruent as yesterdays and the farmers present today may not be present tomorrow. Hence it is obligatory to perpetuate the knowledge and skills, considering this we have arrived with a robot to this critical situation with mechanisms fastened together. Right from scattering to harvesting the system pilots and rein the headway.

Keywords—Agriculture, Robot, Sensors, Auger Shaft, Image Processing, Android App

I. INTRODUCTION

Agriculture in India dates back to the Rig-Veda. In plantation yield, India echelon second worldwide. Virtually 14% of Gross Domestic Product is encrusting by Agriculture and federal sectors and around half part of the human resource necessitate in it. It is the outspread monetary precinct and engages a massive role in the overall monetary conglomeration of India. The cardinal complication encountered by the farmers today are dearth of infrastructure, less yield, swelling farmer felo de se, divergence of agricultural land for anti-agricultural impetus. The succeeding strands are the foremost rationale for skimpy yield in India: The median expanse of land possessions is very small. Scanty advocacy of current agriculture technologies and executions, impeded by lack of such practices, high costs and inapposite in the case of small land handlings. Over bearing of agriculture have enlarged costs, price risks and qualm. India has deficient infrastructure and amenity. Moreover the farmers in today's world are not as technically and practically proficient than those in the conventional time. If this present scenario sustains there will be no skilled farmers in the forthcoming decades. In order to submerge this scenario, steps have been taken by many engineers. Many innovations has been propounded by the researchers but were not enacted due to inadequate environment and cost. Many demerits were overlooked by the robots that were delineated in which some were successful. Here we have made proposal that can lessen the exertion and work of a farmer in the premise of both technical and skill. The apprehension of ancient farmers is conduct into the play with the robot that undertakes the total endeavor of the farmer.

II. COMPONENTS USED

The Robot runs with multiple components that assist it to role as a multipurpose robot. Sensors are objects that read the change or events taking place in the environment and then outfit the corresponding output. These sensors play a predominant role in today's world of scenario. The various sensors that are used in the system are fertilizer sensor,

moisture sensor, temperature sensor, pigment sensor, N-P-K sensor. The components work as a crew and contrivance the input thus constructing the robot as a potent machine. The various components used in the system are as follows:

A. Fertilizer Sensor

Specifications	
Voltage	DC 5V
Current	<20mA
Size of fix	3.2mm
Depth	37mm
Working Temperature	10 C to 30 C
Humidity	10% to 90%
Weight	3grams

B. N-P-K Sensor

Specifications	
Weight	5 grams
Dimensions	5.1*3.8*1 cm

C. Temperature Sensor.

Specifications	
Weight	100 grams
Dimensions	10.2*7.6*5.1 cm

D. Pigment Sensor

E. Auger Shaft

F. DC Motor

Specifications	
Voltage	12V
Torque	30Kg
Speed	7820 rpm
Shaft Diameter	3.0 mm
Weight	220 grams
Dimensions	37.5*75 mm
No. of motors	6

G. Solar Cells(Power Source)

Specifications	
Voltage	12V
Power Output	2W approx.
Max. Charging Current	200mA
Weight	200 grams
Dimensions	14*11.5 cm

H. Brushless Motor

Specifications	
Stator Diameter	22mm
Stator Length	13 mm
Stator Arms	12mm
Max. Current	20A
Max. Power	220/3 W
Rotor Diameter	28mm
Shaft Diameter	3.17mm
Biggest Thrust	1265/4
No. of motors	6

I. Thermal Camera

Specifications	
Color	Multi
Weight	222 grams
Dimensions	4.1*1.9*1.5 cm

J. Camera

Specifications	
Weight	9 grams
Model Type	OV7670 Camera Module

K. Spraying Mechanism

L. Field Pump

M. Arduino

To reign the sensors we have utilized Arduino. The type of Arduino used in this circuit setup is Arduino Uno R3, which is a microcontroller based on the ATmega328P. The arduino micro controller is used to process many functions as required. It is a platform where a large number of controls could be controlled and executed according to the conditions required. It has specified digital I/O pins in which 6 can be used as PWM outputs, analog inputs, a 16 MHz crystal oscillator, and a reset button. It has many micro ICs which helps the processor for precise functioning of the conditions.
Fitting output required. This Arduino controls the other components using the program fed into it. Considering the programs can be written with the open source software and can be fed to the Arduino. When the components to be controlled are attached to the processor depending upon the program the processor make the functions and gives the required output. The other components such as the motor, actuators, auger shaft are also controlled by this micro controller.

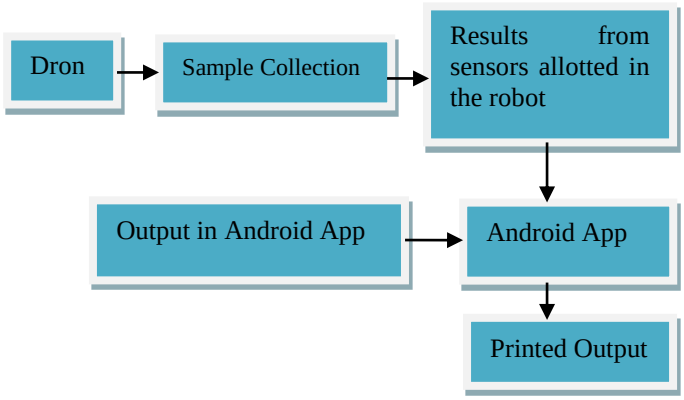
Specifications	
Model	Arduino UNO R3
Weight	259 grams
Dimensions	6.9*5.3*2.5 cm
Microcontroller	ATmega328P
Voltage	5V
Digitals I/O Pins	14
Flash Memory	32KB

III. WORKING

This ‘Autobot’ utilizes number of mechanisms and a number of sensors together to trace and acquire information everything related to farming. It caters to all the basic needs of farming such as measuring the moisture content in the soil, minerals in the soil etc., using sensors and seeding of crops in the soil is done according to the data collected from the fertility and moisture sensors, the area of the farm is also taken into account for calculative purposes, then basic irrigation techniques of agriculture such as sprinkler irrigation, drip irrigation are also done automatically with pre-installed setup.
The multiple systems in the robot would function according to the condition given by the database. The prior information of all the crops would be stored in the database used by the farmer. These data are collected from the respective

government since they already have a registered data of these respective crops.

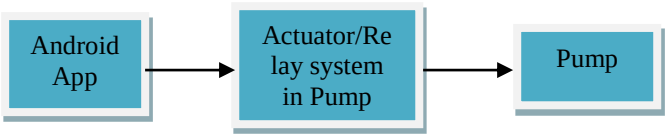
But the most useful and effective task done by this machine is tracing the farmlands for diseases and pesticide infections and spraying of necessary pesticides and insecticides after analysis of the type and genome of the infected crop which is done by another set of sensors which work similar to the fertility measuring sensors. Before the sowing process the application would order the drone to compare the parameters and produce the suitable recommendations as shown in the block diagram 1.



Block Diagram 1

This can be further improved by microscopic thermal imaging of a sample leaf from one part of a land and comparing with the image of a healthy leaf. This should be followed in each and every part of the land to ensure that any planted crop is not affected. The system is controlled and maintained by the database stored in the android application. The system takes a higher altitude to capture the thermal image and also in places where the robot could not intervene. The process taken by the drone is shown in the block diagram 2.

The system makes use of the solar power in order to power the components in the system. The output result of every action would be recorded and displayed in the application installed in the farmers mobile. The result could also be generated in the form of printed output as indicated in the block diagram. The water is pumped to the field at the required rate and required condition by the system controlled by the android app as shown in the block diagram 3.

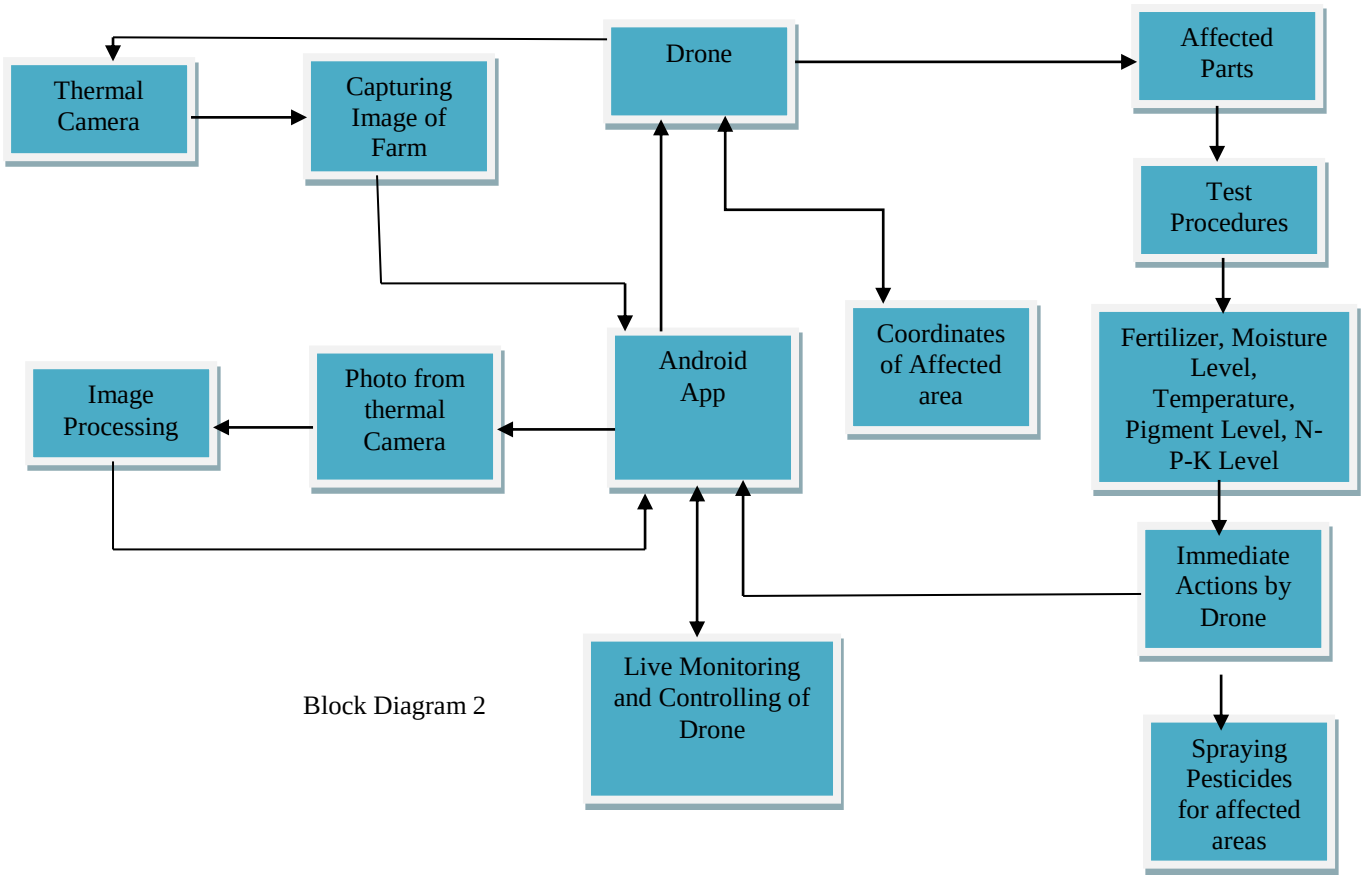


Block Diagram3

Another system which can forecast the quantity (tonnage) of crop which can be harvested from the planted field area has also been integrated in this system. This system uses the area of the farmland and average measure of yield from 1 acre to estimate the quantity of yield of total area. The proposed prototype is shown in fig 9 and fig 10.

IV. Image Processing Technique

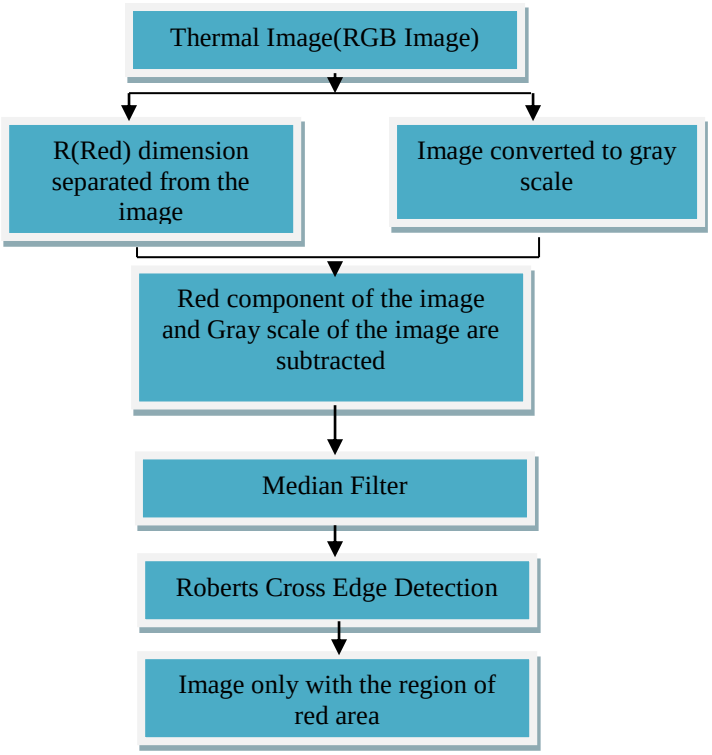
The images acquired from the Terrain robot undergoes image processing techniques to obtain the necessary details needed for the final processed thermal image. The Image Processing technique is done using MATLAB with Image processing Toolbox. The image acquired from the robot is a color image that is three dimensional, consisting of red, green and blue color in each dimension respectively. As our area of interest is to obtain the red colored region where the moisture is very low in the field from the thermal image, it is processed by taking the first dimension (Red) of the color image. The obtained dimension of color image is subtracted with the gray scale of the original image. The result by doing so is shown in fig (2).The image has minute noise in it due to the compression.



Block Diagram 2

It is removed by using a median filter where a median filter imposes a pixel with the median from the neighboring pixel group. The image obtained after using median filter is shown in the fig (3). As it is observed that the white spots resulted after the filter, denotes the presence of red component and rest of the image is black. The image is then subjected to edge detection algorithm to get the areas of the red color regions (in the original thermal image) and the white regions in the filtered image. The output of the edge detected image is shown in fig (4).

The algorithm used in edge detection is Roberts cross. The Roberts cross algorithm is implemented by convolving (1) and (2) patches to the image of fig(3)By doing so the gradient of image in X and Y co-ordinates is acquired. The obtained G_x and G_y is then used to compute the combined gradient of the facsimile utilizing the formula (3) and the orientation of the slope is computed using (4).The obtained gradient with the direction gradient after implementation is the output of the edge detected image as in fig(4).



Flowchart depicting the step by step process in following the image processing technique.

A. Formulae

$$G_x = \begin{bmatrix} +1 & 0 \\ 0 & -1 \end{bmatrix} \text{----------(1)}$$

$$G_y = \begin{bmatrix} 0 & +1 \\ -1 & 0 \end{bmatrix} \text{----------(2)}$$

$$G = \sqrt{{G_x}^2 + {G_y}^2} \text{----------(3)}$$

$$\theta(x,y) = arctan\left(\frac{G_x(x,y)}{G_x(x,y)}\right) \text{----------(4)}$$

B. Thermal Images

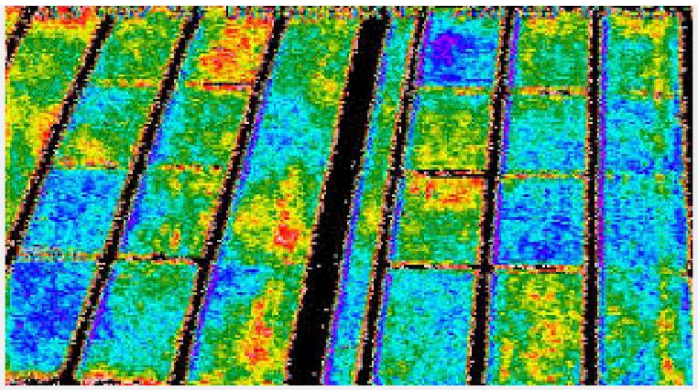


Fig.1. Thermal image of the field under surveillance.

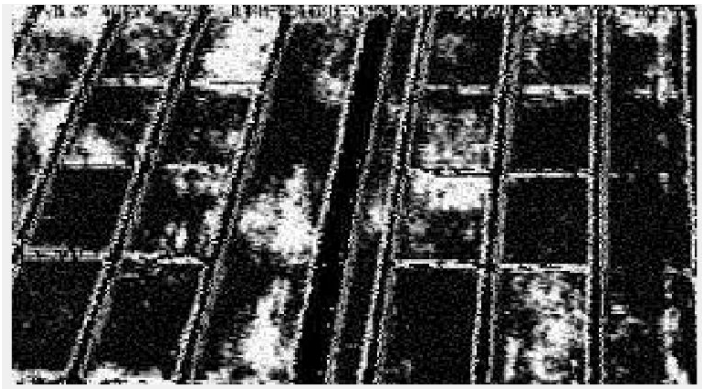


Fig.2. Image after extracting red component

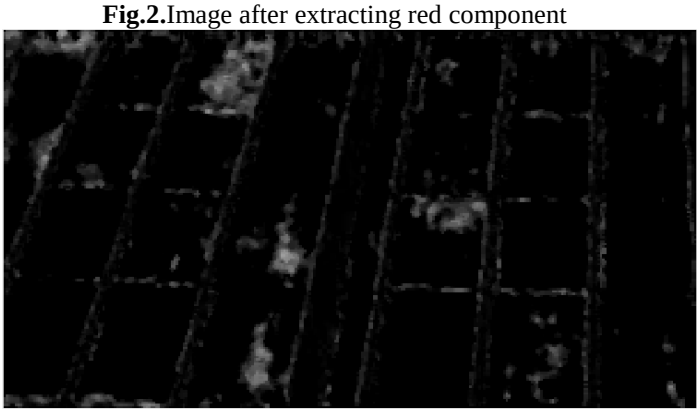


Fig. 3. Image after subjecting to noise removal filter.

Fig .4. Image after edge detection technique

V. Android Application for Autobot

A. Android

Android is an open source, readymade, low cost, customizable operating system which is currently developed by GOOGLE which is based upon Linux, a Graphical User Interface, a web browser and an end user application that can be downloaded. Android is the largest downloaded and widely used operating system of any kind. It is designed for touch screen mobile devices whose user interface is based on direct manipulation such as touching gestures. The android application that extends the functionality of a device can be usually written using java programming language.

B. Eclipse IDE

We use Eclipse tool for Android programming. It contains the base workspace and extensible plugging system .It is usually written using java programming language. tools like Android Development Tools (ADT) is the Google provided plug-in for the Eclipse IDE which is designed to provide an integrated environment to build android applications. It extends the capability of Eclipse to set up new Android projects, create an application user interface, add packages, debug their applications with android SDK tools and export .apk files to distribute their applications. It was the official IDE for Android but later replaced by Android Studio.

C. Software Development Kit (SDK)

A software development kit that enable developers to create applications for the Android rostrum. The Android SDK comprises sample projects with source code, development tools, emulator and required libraries to build Android implementations.

D. JAVA

Java is an object oriented, high-level, statistically typed programming language. Java is the recommended language for developing Android applications. Java is platform independent and hence it can run on any device. Android applications run in a special virtual machine called Dalvik VM. The build process of java projects will be saved in a file with Java Archive (JAR) and the android applications takes the .JAR and deploy them as Android Package with .apk extension.

E. XML(*eXtensible Markup Language)*

XML standards are a flexible way to create information formats and electronically share structured data. In android we use XML to declare and manage application user interface. With the help of XML we can define the components, build layout, define animations and specify resources of the application.

F. SQLITE Database

SQLite is an open source SQL database that store data to a text file on a device. Android is available with built in SQLite database implementation. It supports all relational database features and hence there is no need to establish any kind of connections for it in order to access it.

VI. Module

A. Login Module

The first step the farmer can do is logging into the android application by entering their username and password. Each user will be provided with some unique login and password. When the user enters the value, it will be validated by comparing the data in the database. In case of invalid user a alert message will be displayed. The steps could be seen from fig(5).

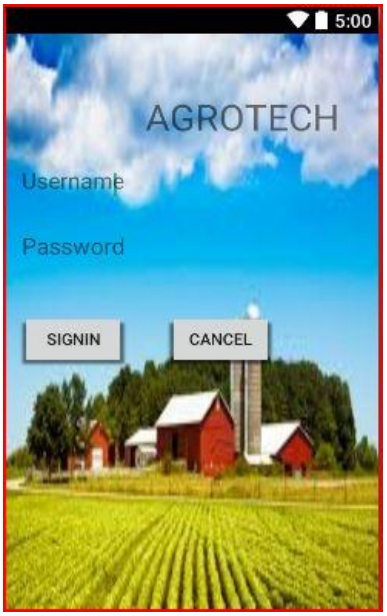


Fig.5. Login Page

B. Selection and Display Module

After validation of valid user, the user will be directed to the selection page which displays the crops and the user should select the crop of their wish. Then the user will be moved to the next page which shows the necessary conditions to be maintained for the crop. The lost of crops displayed in the app is shown in fig(6) and the respective conditions for each crop is shown in the fig(7).

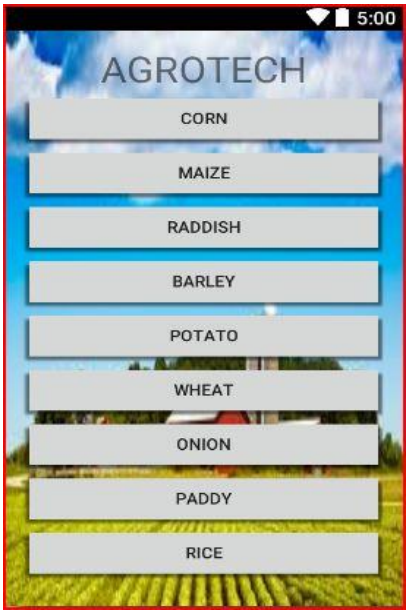


Fig.6. List of Crops shown in the App

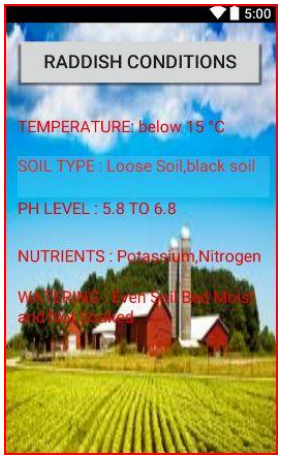


Fig.7. Condition for the raddish

C. Bluetooth Module

The android application and the drone is connected with the help of Bluetooth. The input to the drone will be given from the android application by establishing Bluetooth connection. The movements of the drone like moving left, right, fly is given as input from the application. These controls are shown in the fig(8).

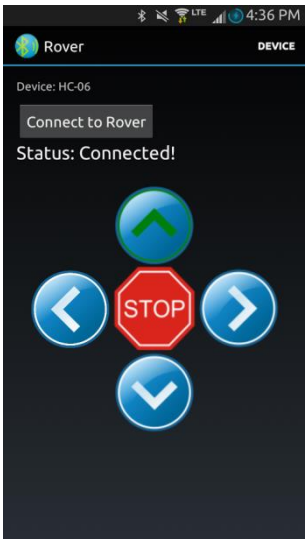


Fig.8.Page showing the controls of the Autobot using App

VII.PICTURE OF THE PROTOTYPE

Fig.9.Prototype view 1

Fig.10.Prototype view 2

VIII.ACKNOWLEDGEMENT

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