Crop Monitoring using Visual Sensors and IOT

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Abstract—
The trending and future technologies like IOT, digital image processing alongside sensor networks has demonstrated their evitable accomplishment in different applications individually, but the combination of these is so far non-existent. The idea of work manages combining these advancements in agricultural sector which requires present day mechanical impressions. The principle objective required for product development (crop) is information, that is the data about the climatic, soil and water conditions. All the information about the dynamic ecological conditions are detected utilizing wireless sensors. While the monitoring of the field is done by capturing the crop at regular intervals using camera these pictures undergo image processing to perform histogram analysis in the MATLAB software. Results of above processes are shared using IoT to Client through Cloud.

Keywords-*Digital Image Processing, Internet of Things, Wireless Sensors ,Histogram Analysis, Matlab , Cloud*

I. INTRODUCTION

Agriculture is the science or practice of farming with cultivation of soil for growing of crops and other products. India owns agrarian economy with 70% of population depending upon agriculture directly or in –directly [1]. In such a developing country where digitization is given high priority, technology is showing its optimization in various fields whereas it still requires footprints into agriculture so modern smart move in the field is greatly recommended. The problem with current agricultural system are (a)Scarcity in water and electricity actually required for plant growth (b)Traditional methods of farming are followed requiring-much man-power (c)Non-remunerative for the farmer as the cost of production is increased (d)Prices are fixed diminishing farmers profit margin

(1) Production cost = Electricity cost + Pesticide cost + Transportation cost +Labor cost + other

(2) Profit = Selling price – Production cost.

As the selling prices are fixed and production cost remains constant, the profit levels for the farmer are declined. The solution to the above problems can be (1) Using modern technological easy and productive farming (2) Reduction in water-wastage. (3) Good manure and pesticide usage in proper timings. (4) Develop smart farming techniques that are labor saving with low electricity requirement

Internet of Things is the emerging technology defined as global platform for information and communication society by ITU (International Telecommunications Union) [1]. IoT (Internet of Things) is the interconnection of objects such as constructions, automobiles, generation devices, smart Phones which are electronic, software and sensor embedded for network connectivity or exchange of data, hence it is called as Network of Networks. It uses the existing information in connecting technologies and evolving technical information to perform interoperable advanced services with high speed connectivity in both physical and virtual case of objects. The key advantage of IoT can be communication in remote and inaccessible areas with convergence of technologies with principles like analog big data, perpetual connectivity and real-time processing. Latest research estimates by 2020, there is set to be 26 billion connected devices around the world, and Internet of Things market is forecast to worth a staggering $7 trillion [2]. IoT is playing a key role in applications like management based on condition, energy based management security, and fleet management.

Digital image processing is the basic concept of processing a input image, series of images or video into simply a digital image using computer algorithms with mathematical operations and some form of signal processing practicing Fourier transforms. The input to the process is input image. It avoids problems like noise and signal distortion. It displays picture into multidimensional frameworks by defining pictures over two dimensions in digital image processing. By using this process, we would find the deficiencies in the leaf which impact the yield of the field.

Image processing can be used for multi scale signal analysis signal processing, feature extraction – To determine the class and initial features for further information, pattern recognition – To recognize the pattern of the leaf which is known or unknown and also used in projection. The various techniques used in image processing include Linear filtering, Image restoration (noisy image processing to clean image) principle component analysis (orthogonal transformation of Components) and pixilation. The output of image processing is characteristics of parameters related to the input image which in short is a digital image. As described before, both IoT and image processing are being used in the agriculture field to reduce the failure in crop and to increment the crop production. This can be achieved only when farmer is aware of the ecological conditions such as rain, water level, moisture and temperature. As to detect all these conditions sensors are used. The JPEG Camera is attached into the Arduino board to capture the crop growth at regular intervals to detect the changes or disease in the plant .This captured image is compared with the predefined image to identify morphological changes or fluctuations in the crop growth which are obtained by performing histogram analysis in MATLAB software, the above results are informed to the farmer in client side using IoT through Cloud by devices like smartphone or laptops so that early action can be taken to prevent crop growth.

The paper is so divided into five sections. The first section gives introduction of the paper with block diagram for detailed explanation, second section includes literature survey, and third section shows methodologies of the proposed model, fourth section deals with the results and discussions while the last fifth section concludes the paper.

II. LITERATURE SURVEY

Ayush Kumar and at al used IoT and image processing to find the nutrient and mineral deficiencies that affect the crop growth [1]. M.K. Gayathri and at al promote the fast development of agricultural modernization and help to realize smart solution for agriculture and efficiently solve the issues related to farmers [2]. Zhou Zhongwei and at al have proposed a method to visualize and trace agricultural products in supply chain [3]. Li Sanbo and at al focus on the hardware architecture, network architecture and software process control of the precision irrigation system [4]. Ram and atal have suggested a methodology to regulate water in agricultural fields [5]. Bo Yifan and atal have focused on the study on the application of cloud computing and the internet of things in agriculture and forestry [6]. M.V. Latte and at al have used color and pattern analysis to identify multiple deficiencies in paddy leaf images [7]. Mrs. Lathal and atal have discussed various application of image processing in agriculture [8]. Rui and at al have proposed a system framework which combines cloud computing and unified internet of things [9]. Ayush Kapoor and at al have provided the use of Internet of things in agriculture.

III.METHODOLOGIES

The main principle is the combination of both IoT and image processing along with sensor networks to provide realistic and accurate results about the agricultural field and its yielding in a smart and easy method that is economical with water and labour saving as key preference. The hardware components being used are Arduino Uno with micro controller ATMEGA 325, sensors -The moisture sensor (to detect the moisture required for healthy plant growth), LDR (Light dependent resistor- To detect the temperature and light conditions required), Rain sensor (to detect the rain drops and thus save water by turning the pump motor off), Touch sensor (to detect the presence of stranger or animal in and around the field). Water Level Indicator is used to identify the water level and pump motor is used to regulate the water supply accordingly in the field. JPEG camera is used to capture the images of the crop.

The server side is given with 5V DC power supply using step down transformers. The sensors output is given to the Arduino that is programmed and interfaced with microcontroller. The output from the controller is given to the relay which drives the pump motor to regulate the water supply in required circumstances as indicated by the sensors, thus saving the water. Overhead tank is also being used to store water during adequate rainfall. This stored water is supplied through pump motor to the field when required or whenever the plant is dry this water can be served. The whole process is explained in detail in the figure (1) below.

Block Diagram:

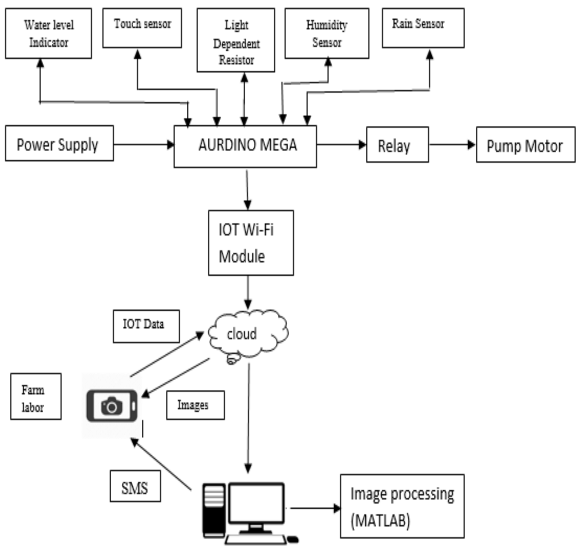

Figure 1

The sensors are programmed with few computer algorithms for their functioning. The algorithm used are explained below

A. Algorithm for Moisture Sensor

Step (i) : Intialize the serial communication to transmitt data from sensor at 9600 bps(Baudrate per second)

*Step(ii):*Read the Moisture sensor Level values from Analog pin which is alloted to it
Step(iii):Print the Sensor value accordingly
Step (iv): if (sensor value <800)

Print"High"

else (sensor value >800)

print "low"

*Step (v):*Given Delay for next loop is 3600seconds

Step(iv): Termination and Re-Initialization of Sensor
Test data: delay at 500ms

B . Algorithm for LDR(Light Dependent Resistor)

Step (i): Initialize the serial communication to transmit data from sensor at 9600bpd (Baud Rate Per Second)
Step (ii): Start Reading the LDR Light level values from Analog pin allotted to it
Step (iii): if (Sensor Value > 900)
Print High"
Else (sensor value < 900)
Print" Low"
Step (iv): Given Delay for Next Loop is 3600seconds
Step (v): Termination and Re-Initialization of sensor
Test data: delay at 500ms

C. Algorithm for Rain Sensor

Step (i): Initialize the Serial Communication to transmit data from sensor at 9600bps (Baud Rate per Second)
Step (ii): Start Reading the Rain conditions value from Analog pin allotted to it
Step (iii): if (sensor value > 600)
Print" High"
Else (Sensor Value < 600)
Print" Low"
Step (iv): Given Delay for Next Loop is 3600seconds
Step (v) Termination and Re-Initialization of Sensor
Test data: delay at 500ms

D. Algorithm for Touch Sensor

Step (i): Initialize the Serial Communication to transmit data from sensor at 9600bps (Baud Rate per Second)
Step (ii): Start Reading the sensor values from Analog pin allotted to it
Step (iii): if (sensor value >300)
Print" Yes"
Else (Sensor values < 300)
Print "No"
Step (iv): Given Delay for loopback is 3600seconds
Step (v): Termination and Re-Initialization of sensor
Test data: delay at 500ms

Algorithm for Water Level Indicator

Step (i): Initialize the Digital Display
Step (ii): Declare the Red_ Led pin as an Output
Step (iii): Read the water level value from Analog pin of Sensor allotted to it
Step (iv): if (Sensor value > 400)
Handle_ led" ON"
Else (Sensor < 400)
Handle_ led" OFF"
Step (v): Delay Given is 3600seconds for next loop
Step(vi): Termination and Re-Initialization of Water Level Indicator
Test data: delay at 200ms

The sensor algorithms use the threshold value (constant value) changes in the value above or below threshold are sensed by sensors and are indicated to pump motor through microcontroller for water supply in necessary conditions and prevents water-wastage automatically thus saving water and labor in the field. In addition to the sensors used above, camera that monitors the crop is also considered as visual sensor as it helps in visualization of crop miles away from field using IoT and cloud by wireless transmission of data.

While the other half of the project deals with image processing for external monitoring of crop which is done by capturing the images of the crop at periodic intervals to identify the morphological changes that effect the crop. The JPEG Camera subsequently captures the crop /plant images, these images endure image processing and are compared with the predefined pictures of the plant in MATLAB software that is histogram analysis is performed by capturing images to detect the changes in the plant. The few conditions are health of the plant (infected/good), growth (fully grown/failed), dry/wet plant. Thus, these conditions of crop are stored in a cloud and shared via IoT (Internet of Things) to client's smart devices like mobile or laptop. Thus, transforming manual methodologies of agriculture into smart and remote methods and making agriculture automated. The simple illustration of image process is shown in Fig 2.

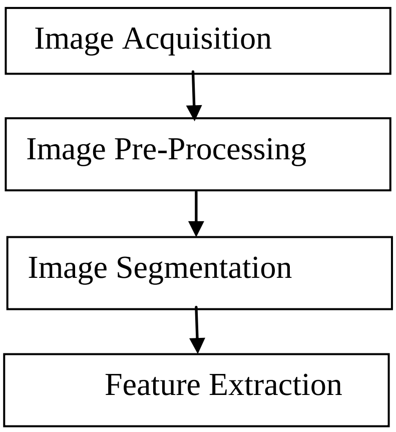

Figure 2

Image Acquisition:

It captures image through camera and processes the image in MATLAB via Graphical User Interface (GUI) which automate the calculation of plant properties.

Image pre-processing:

To remove noise in image using several techniques such as image smoothing utilizing image smoothing filter.

The RGB images are converted to grey images using equation

(1) $f(x)=0.2989*R+0.5870*G+0.114*B$

Image Segmentation:

It is the key step involved in image processing area perimeter and surface continuity are found by segmenting the image different parts.

Feature Extraction:

To compare the sample image with the pre-defined image to extract the feature and conclude the results.

The major part of the project is monitoring the crop to perform early diagnosis when it is affected, which is done by using JPEG camera that is connected to the Arduino. This camera scans and captures the images of the crop at regular intervals as said above, and these pictures undergo histogram analysis that is comparison with the pre-defined image of the crop using the technical process called digital image processing that requires mathematical operations such as Fourier transforms, and computer algorithms.

The plant we used for the illustration purpose is *Cassia Fistula.*

The various inputs given are Dry, Wet, Good and Diseased leaves. The whole process involves

Step 1. Captures the image using JPEG camera module which is given for input image analysis this can be done by following computer algorithm:

(a): Start the camera module.

(b): Acquire the frames in number

while (vid. frames acquired<=10).

(c): Get the snapshot according to the frames acquired.

(d): Stop, End and flush the data finally.

Step 2: Involves the conversion of the pixels of the image using the below algorithm:

Img resize (org, [256,256]).

Step 3: Conversion of RGB image to grey scale image:

Rgb2gray (Img resize (org, [256,256])

where 256x256 is no. of pixels of the image.

Step 4: Find the area and diameter of the leaves so as to determine the continuity of the pixels in the image:

AR=Region props (L,'AREA').

Step 5: Comparing the grey image with real image to find the conditions by performing histogram analysis and to obtain at the accurate results using the algorithms.

Input image of healthy leaf *Cassia Fistula* and its conversion to grey scale is shown in Fig 3.

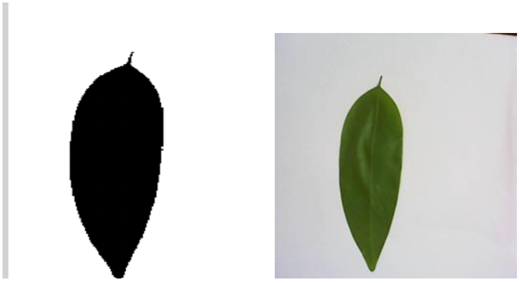

Figure 3

Input image of diseased leaf *Cassia Fistula* and its conversion to grey scale in fig 4.

Figure 4

Input image of wet leaf *Cassia Fistula* and its grey scale conversion is shown in fig 5.

Figure 5

Input image of dry leaf *Cassia fistula* and its grey scale conversion is shown in fig 6.

Figure 6

These inputs which are converted are compared with the pre-defined images in the MATLAB software. The pixel size of the grey scale converted images is 256x256.

RESULTS AND DISCUSSIONS

The Objective of the project was to implement the modern technologies in required fields like agriculture. Usage of IoT concept makes the whole process of cropping easy. Here some level of automation is achieved in terms of capturing images in regular intervals and image processing helps in monitoring the crop and analyzing its various conditions like health and growth using the data obtained from wireless sensor networks. The advantages as mentioned like water-saving and labor-saving are required the most in current agricultural scenario. hence it is proved using the sensor networks again making smart irrigation. The data from IoT is sent to the client using Cloud. Thus, any variations in the crop can be identified easily and early diagnosis is done as such. The images are compared with the grey scale images as shown below to find the characteristics of the crop using few algorithms. The example for each set uses pixels, area and diameter of the leaf in order to determine the conditions of the leaf, that are healthy, dry, infected, small leaves.

Test Picture :1

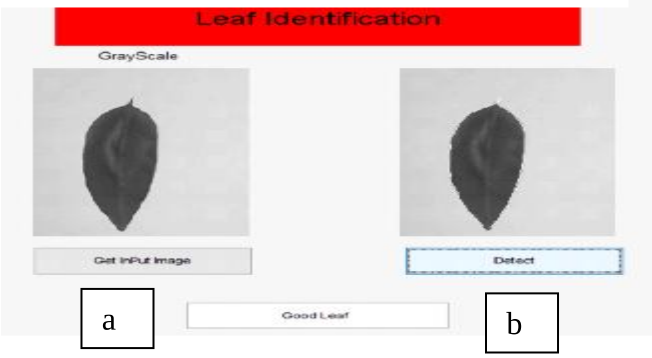

Figure 7

In fig. 7 the image (b) is compared with the grey scale image (a) of *Cassia Fistula*. If the area and surface continuity 256 x 256 are equal (horizontally and vertically). we conclude the leaf as healthy and perfect.

The algorithm to identify healthy leaf:

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if(ARE>=(ARE(1)-250))&&(ccomp1<(ccomp(5)-4))
Set (handles, edit1,'string','Good Leaf')
```

Test picture: 2

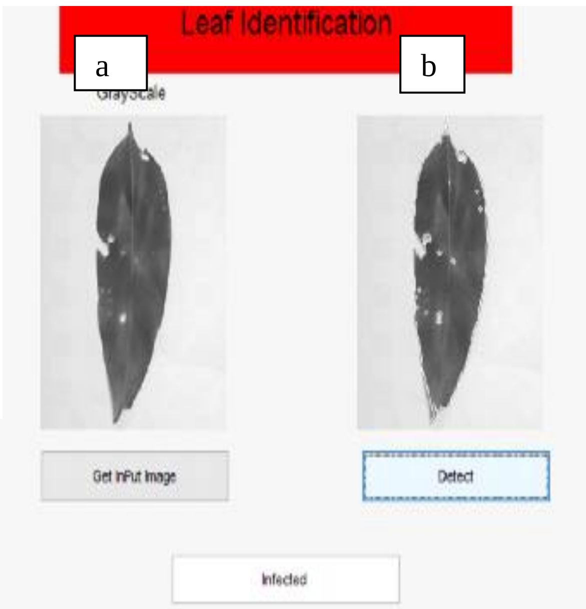

Figure 8

In fig. 8 the image (b) is compared with the grey scale image (a) of *Cassia Fistula*. If there is no area and surface continuity then its concluded as the diseased leaf, as the leaf shows spots in outer appearance.

Its algorithm is as follows:

Else if (Are1 >= (Are (5)-250)) && (ccomp1 > (ccomp(5)-4)

Set (handles, edit1,'string','Infected')

IV. CONCLUSION AND FUTURE WORK

Thus, the paper proposes an idea of combining the latest technology into the agricultural field to turn the traditional methods of irrigation to modern methods thus making easy productive, and economical cropping. Some extent of automation is introduced enabling the concept of monitoring the field and the crop conditions within some long-distance ranges using cloud services. The advantages like water-saving and labor-saving are initiated using sensors that work automatically as they are programmed. This concept of modernization of agriculture is simple, affordable and operable.

(i) Later, it can be interfered with HYDROPHONICS which is hydro-irrigation method (requires no soil) for complete transformation of phase of Irrigation.

(ii)Every other person can monitor condition of the filed by working at their own places without being present in the field, thus encouraging agriculture.

(iii)The camera module can be placed on a drone to capture huge number of fields at once by flying in the air both horizontally and vertically such that every look and corner of the plant is visible.

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