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Smart plantation

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ABSTRACT

Internet of Things and Image processing have been so far applied for various applications. Their application in the field of agriculture has achieved a certain degree of success, however, the combination of both this technology so far is non-existent. This paper describes an approach to combine IoT and image processing in order to determine the environmental factor or man-made factor (pesticides/fertilizers) which is specifically restricting the growth of the plant. Using an IoT sensing network the readings of the crucial environmental factors and the image of the leaf lattice is processed under MATLAB software with the help of histogram analysis to arrive at optimal results.

Keywords— Internet of Things (loT), Image processing, Sensing network, MATLAB

1. INTRODUCTION

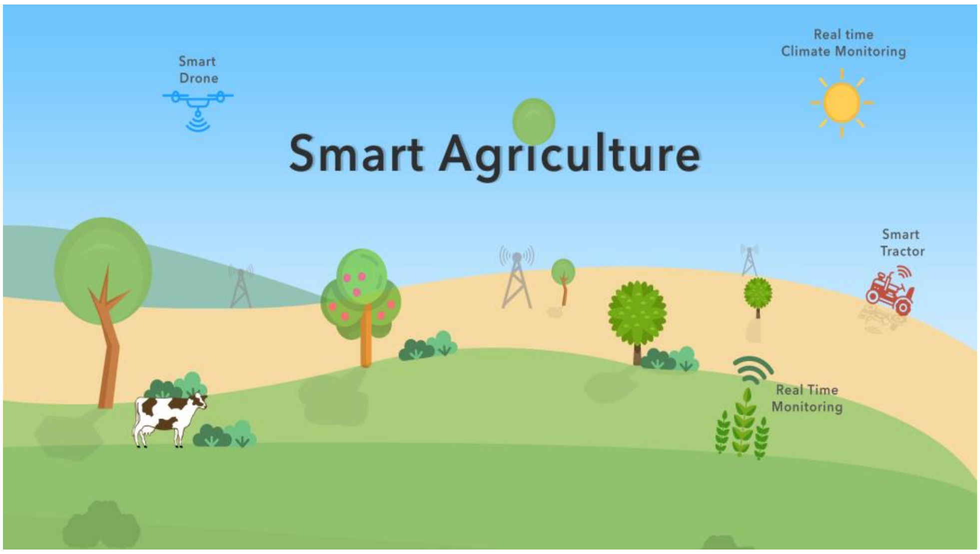


Fig. 1: smart Agriculture

India is an agricultural country. More than 70% of the population of our country depends on agriculture. Thus, our economy is majorly depended on agriculture. Thus development in this field will highly contribute to economic welfare. Technology is playing its role in bringing about change and progress in most sectors. Agriculture is one such sector, which when collaborated with technology such as the Internet of Things combined with image processing can result into cheap yet effective methods of agriculture, which in tum will give rise to higher quality produce. This approach to agriculture still stays uncharted and hence it's high time that we take a step in this direction. Building an IoT application requires the right selection and combination of sensors, networks and communication modules. The above setup then collaborates with concepts of image processing, cloud computing, etc. benefits. IoT has wide applications in the fields of transportation, lifestyle, building, agriculture, factory, health care and many more. It is often described as a network of networks. It can perform an IoT of tasks efficiently and accurately. Image processing is defined as the processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics of parameters related to the image. It usually refers to a digital image. Digital image processing makes use of various computer algorithms to perform image processing on digital images. It is widely used for classification (identifies to which class does a newly found observation belong), pattern recognition (recognize known and discover unknown patterns), feature extraction (initial information which is used to make further derivations), multi-scale signal analysis (signal processing) and projection (three dimensional objects is converted into a planar surface). As discussed earlier, IoT and Image processing can be used in the agricultural domain to have higher quality products and thus reduce crop failure. We aim at reducing crop failure by letting the farmers know what environmental conditions such as temperature, humidity, light, soil moisture is most suitable for the crop and what are the effects of the fertilizer used. This is done by constantly monitoring the crops using an IoT based circuit that includes Arduino, sensors for the different environmental factors and a camera that will capture images of the crops at regular intervals. The images captured will be processed to recognize the various morphological changes occurring due to different environmental factors. If there is any change that corresponds to the deterioration in the plant's growth, the farmer is informed. Early diagnosis will thus help in taking the necessary actions to increase productivity and reduce the failure of crops.

2. LITERATURE SURVEY

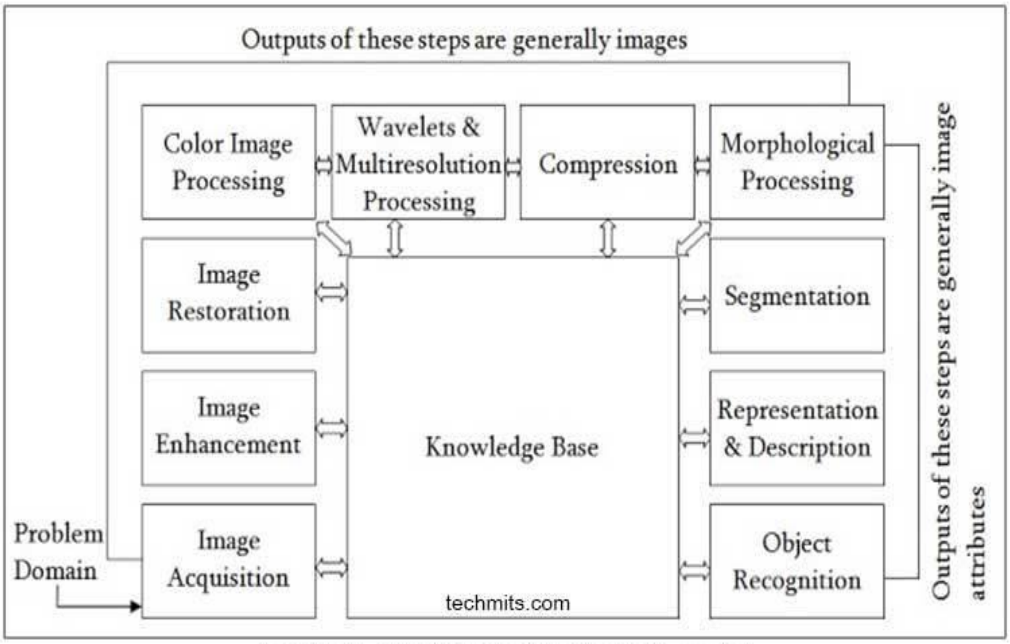
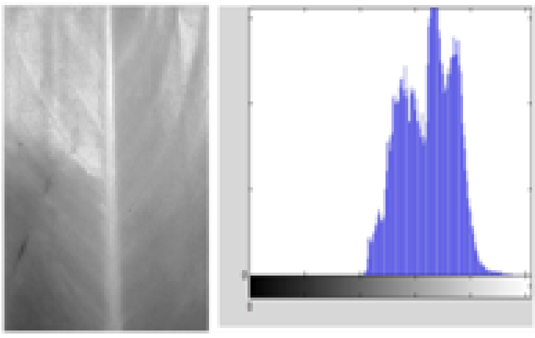


Fig. 2: Fundamental steps in Digital Image Processing

Authors in have used color and pattern analysis to identify multiple deficiencies in paddy leaf images. Authors in have proposed a system framework which combines cloud computing and the unified internet of things. In authors have suggested a methodology to regulate water in agricultural fields. In authors promote the fast development of agricultural modernization and help to realize the smart solution for agriculture and efficiently solve the issues related to farmers. In authors have provided the use of Internet of things in agriculture. Authors in have discussed the various application of image processing in agriculture. In authors have proposed a method to visualize and trace agricultural products in the supply chain. Authors in focus on the hardware architecture, network architecture and software process control of the precision irrigation system. In authors have focused on the study on the application of cloud computing and the internet of things in agriculture and forestry.

3. METHODOLOGIES



The idea is to combine the concepts of the Internet of things along with the techniques used in image processing to arrive at accurate results. It is known that temperature, humidity, soil moisture, and light intensity lead to subtle to drastic changes in the health of the plant. The morphological changes that a plant undergoes is captured and analyzed on the MATLAB software using the algorithms to arrive at the result. The whole process of capturing the image along with the requisite environmental factors are done at once using the IoT sensing network and the data is fed onto the SD Card for further analysis. The specific components that are used in the IoT sensing network are Soil Moisture sensor, DHTII (Temperature and Humidity sensor), Serial JPEG camera module (To capture an image at regular intervals) and SD Card Shield using an 8 GB SD card. The set of sensors and the image processing camera assembled on an Arduino UNO. The program is written in the Arduino language which first activates the sensors namely the soil moisture and the DHTll sensor and subsequently captures a snapshot of the plant and stores in the SD Card. This brings into the attention type of the plant that is used in the experimental analysis. For the sake of the experiment, it needed such a plant that showed moderate to drastic changes on subtle changes in the vicinity. And at the same needed low maintenance. Keeping these things in mind, owing to the rationale behind the selection of the right plant, Philodendron (an indoor ornamental plant) was selected. It shows moderate to drastic morphological changes in the short span of time enough to be processed by the MA TLAB algorithms. Once the test image is taken by the camera module, it tested and run against a set of pre-defined database of images already taken keeping the environmental constraints as well as general artificial crop catalyst in mind namely N, P and K. The algorithm thus analyses the given image and arrives at the conclusion which refers to the specific problem that affected the given plant. Figure 2 shows a flow diagram that illustrates the whole process.

3.1 Algorithm for DHTll (Temperature and Humidity)

Step 1: Initialize the sensor to send data at 9600 baud rate
Step 2: You need to start reading humidity and temperature values from the assigned analog pin
Step 3: Print to in /\C and Humidity in % on the serial monitor
Step 4: Read data at a delay of 2000ms
Step 5: De-initialize the sensor and terminate

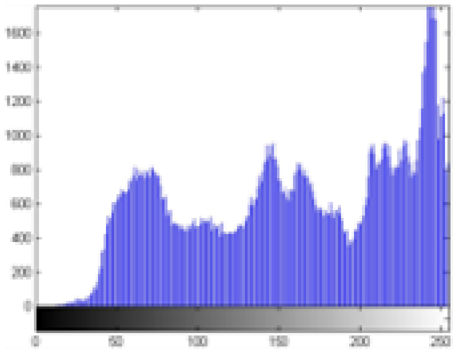
3.2 Algorithm for Soil Moisture sensor

Step 1: Initialize the sensor to send data at 9600 baud rate
Step 2: Start reading moisture level value from the assigned analog pin.
Step 3: if moisture level >900
Print "Low"
Else if moisture level<900 && moisture level>500
Print "Medium"
Else
Print "High"
Step 4: Continue to read data at a delay of 2000ms
Step 5: De-initialize the sensor and terminate

3.3 Algorithm for Image Capturing using serial JPEG camera module and storing it on the SD Card

For this, the requisite header files are included namely softserial.h and SDFat.h. The buffer of the SD Card is cleared and initialized. The chip select pin is assigned on the Arduino. The camera is initialized for transferring the stream of bytes. The function SendCmdpicO is run which takes pictures at a delay of 300ms. Subsequently, each picture is titled serially SendReadDataCmdO command is run to get the picture from the camera buffer and stored onto the file. The process of reading and writing dines at adequate delay so as to not lose intermediate buffer. The above algorithms are utilized to capture an image for morphological analysis and at the same time utilized to read the present weather conditions that are currently influencing the plant under normal conditions without any human intervention. The data so collected is fed into the system for computational purposes to narrow the specific factors which have led to the plant's deteriorated state. Before proceeding with the test image to find out the specific environmental factor and mineral factor that has affected the plant's present, a database is prepared for the histogram analysis. The images are converted to a monotone to obtain accurate results. Four sets of the same plant are taken for the same plant; Philodendron Ceylon, in this case, is subjected to specific variations of the environment. The healthy conditions for this plant are moist conditions with low to moderate sunlight requirement for its metabolic activities to be able to function normally. Set of the plant is kept under normal healthy conditions. Set 2 of the plant is kept under extreme sunlight conditions with moist conditions being maintained. Set 3 is kept under low to moderate sunlight with little to no water being given to it. Set 4 is treated with an excess of N, P, and K fertilizer under normal environmental conditions. For each of these sets, visible morphological differences were seen. These visible morphological differences give way for histogram analysis for each plant. Each histogram p IoT for each set will before proceeding with the test image to find out the specific environmental factor and mineral factor that has affected the plant's present, a database is prepared. Before proceeding with the test image to find out the specific environmental factor and mineral factor that has affected the plant's present, a database is prepared for the histogram analysis. The images are converted to a monotone to obtain accurate results. Four sets of the same plant are taken for the same plant; Philodendron Ceylon, in this case, is subjected to specific variations of the environment. The healthy conditions for this plant are moist conditions with low to moderate sunlight requirement for its metabolic activities to function normally. Set of the plant is kept under normal healthy conditions. Set 2 of the plant is kept under extreme sunlight conditions with moist conditions being maintained. Set 3 is kept under low to moderate sunlight with little to no water being given to it. Set 4 is treated with an excess of N, P, and K fertilizer under normal environmental conditions. For each of these sets, visible morphological differences were seen. These visible morphological differences give way for histogram analysis for each plant. Each histogram p IoT for each set will be variably different.

4. RESULTS AND DISCUSSIONS



The aim of the experiment from its inception was to show how image processing techniques can be used to assess and analyze the health of the plant. Including the concepts of the Internet of Things makes the whole process automated and more consolidated data is obtained using the sensing network. Using the IoT network, we assess the exact variations the plant undergoes during the course of time allowing to pinpoint the specific deficiencies that the plant faces in terms of mineral requirement or environmental adjustments. The images are obtainable from the SD Card that has been installed on the IoT Sensing network and fed onto the system. By corroborating the histograms for all the sets, it can be analyzed to conclude the deficiency that is currently affecting the plant. Therefore, using the IoT Sensing network that contains the exact temperature, soil moisture, humidity data, the information is collaborated to validate the findings by the image processing results so obtained. Thus, allowing for validation of the image processing technique used in the setup. The pattern for each set will be similar in nature. The images are captured by the IoT sensing network and at the same time, the data is noted down.

Temperature from DHTll Sensor: 26*C
Humidity from DHTll Sensor: 25%

Soil Moisture Level from Soil Moisture Sensor: Medium observation, remedial measures can be taken. The rovers can have the specific amount of pesticides, fertilizers on board. The levels of the minerals in it the soil is computed using the techniques so described. Based on these readings, the requisite amount of minerals can be put on the soil. The database so collected and variation in the morphological features of the plant can be extrapolated to corroborate a one-to-one relationship between them. The cloud database so created can be used to formulate the specific remedial measures that should be taken for them. For each condition and variation, the altering levels of the minerals in the soil combined with the morphological alterations, the remedial measures can be formed as the IoT opens such possibilities. As IoT explores the interconnecting of devices, cloud computing concepts can be established with them for a complete consolidated system which can be used as a platform for further advancement.

5. CONCLUSION AND FUTURE WORK

It is seen how Internet Of Things and Image Processing can be combined and implanted in the field of agriculture and how exactly they need to be combined in order to get magnificent results. Some level of automation is achieved in terms of capturing images at regular intervals. Also, the status of the environment is regularly checked and updated. This gives rise to the possibility of constant monitoring of the fields and the environmental factors. The IoT sensing network so established can easily be mounted on a rover or even a drone to monitor and collect data of the field on a regular basis. This will immensely help the farmers as they cannot be on their field 24*7. The information so collected can be communicated to the farmers using CDMA-GSM protocol.

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