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Automated Irrigation System Using Mean Shift Based Segmentation

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Abstract: **An Automated Irrigation sensor is designed for the facilitation of farmers with the help of android Smartphone application and wireless sensor network. The sensor uses a Smartphone to capture the images of the soil and analyze the images using mean shift based segmentation algorithm and supply water to the crops nearby. The sensor is activated using an application from another Smartphone. The sensor is powered by rechargeable batteries, charged by a photovoltaic panel.**

Keywords:-- **Wireless Sensor, Smartphone, Mean Shift based Segmentation**

I. INTRODUCTION

Indian economy is basically depends on agriculture. Water resources play an important role in the development of crops. There are many types to preserve water resources and also water preservation is very much important in these days. So, the excess supply and deficient supply of water to the growing crops however destroys the crops. So, the sensor is designed in knowledge with the sufficient irrigation for the crops. Mobiles also play a major role in a human being's routine life. Everyone now owns a Smartphone which can do almost all things that aren't even impossible by humans. We designed the sensor in order to ease the work of farmers and irrigate the crops without even visiting the farm and keeping track of the crops and soil although the development of crops using an android Smartphone application. The Smartphone is connected with an illumination circuit and a power source and it is confined into the chamber and buried in the soil. The Smartphone is connected to a wifi network which transfers the images captured and analyze result to the end user with an application. The application specifies a time interval to capture images and do analysis. The system will analyze the crops in the time interval and continuously transfers the data to the user.

Related works are discussed in the section 2. Section 3 describes the problem definition of work. Section 4 concentrated on discussion of the Mean shift based segmentation. Performance analysis is carried out in the section 5. The paper is concluded in the section 6 along with future enhancement.

II. RELATED WORK

We can detect the level of water contents in the soil using many direct and indirect methods. Direct methods includes soil sampling, by taking a sample of the soil, etc., Indirect methods are such as sensing the soil using many artificial intelligence techniques. Soil moisture sensors can be placed in the field of the soil usually in a buried state or by touching the soil in close contact. Depending on the quantity of the soil measured the volumetric and tensiometric values are subject to change. For these techniques densitometers and Granular Matrix Sensors (GMS) are used. In GSM based Automated Irrigation system, irrigation will take place only in the situations whenever the soil is highly dry and immediately requires water. In other automated irrigation systems various technologies are used to accurately estimate the water level and the sensors also estimate the environmental conditions such as temperature, density, etc. Most of the soil moisture sensors are designed to estimate the soil volumetric content based on dielectric constant. The soil water content is set by the user to a particular threshold value. When the sensors detect that the water level is below that threshold value, the system comes into action and irrigate the soil. The important thing to be noted is that the irrigation system must irrigate the soil to a level that can be held by the crops. If the water level exceeds a limit, the crops will start sinking in the water. Also a single sensor can be used to detect the water contents for a large area. There are some rules and regulations to follow during the burial of the sensors below the earth level i.e. in the soil. They are listed below:

- Sensors should be buried in the zone where root of the soil is found since it is the place where crops extract water.
- Sensors should be in good contact with soil so that they can clearly estimate and give result.
- If one sensor is used to control the entire irrigation system, it should be buried in the zone which requires water first.
- Sensors should be located at a minimum of 5 feet from irrigation heads so as that sensor won't damage.
- It should not be buried in areas of high traffic.

III. PROBLEM DEFINITION

In some of the irrigation system irrigation scheduling is achieved by monitoring soil, water status with tension meters under drip irrigation by the automation controller system in sandy soil. It is very important for the farmer to maintain the content in the field. In this design of a Micro-controller based drip irrigation mechanism is proposed, which is a real time feedback control system for monitoring and controlling all the activities of drip irrigation system more efficiently. Irrigation system controls valves by using automated controller allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labor to turn valves. Some irrigation systems are used to implement efficient irrigation scheme for the field having different crops. The system can be further enhanced by using fuzzy logic controller. The fuzzy logic scheme is used to increase the accuracy of the measured value and assists in decision making. The green house based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniformity at all the places in the farmhouse manually. For this GSM is used to report the detailed about irrigation. The report from the GSM is sent through the android mobile. The software and hardware combine together provide a very advanced control over the currently implemented manual system. The implementation involves use of internet for remote monitoring as well as control of Drip Irrigation system. This system uses sensors like humidity, soil moisture. These sensors send values to micro-controller. Micro-controller sends values to PC using serial communication. According to real time sensors values continuous graph is display on PC and Android Based mobile using Internet and Android application. Here threshold value is keep, if sensor values cross the threshold value then Drip Irrigation components can be controlled automatically by micro controller. So, we define an automated system which uses android technology and wireless sensor networks to analyze water contents. It can be practically used in large farm bases.

IV. DISCUSSION

The irrigation sensor is based on the concepts of wireless sensor networks and means of an android application. The whole setup is buried into the soil at the root level of the crops. The setup contains a light tight waterproof chamber, a route node and illumination circuit and the LED bulb.

At first, the user sets the time interval to monitor the water level in the soil. When the timer ticks zero, the Smartphone is woke up from standby mode with some parapets such as LCD brightness. Then the built-in camera is activated to take a picture of the soil through an anti-reflective glass present in the chamber. The LED bulb is illuminated using Illumination circuit ignorer to take the picture in a dark environment. After the image is taken, the LED is turned off. This is done with the help of a micro controller. Then the image is analyzed using mean shift based segmentation algorithm in order to pixel differentiate the image to estimate wet-dry contents of the soil. The image is then transferred to a router node which in turn transfers the data to the gateway that receives the data from many router nodes. The gateway decides the amount of water required to the crops of different area and supplies the required amount of water.

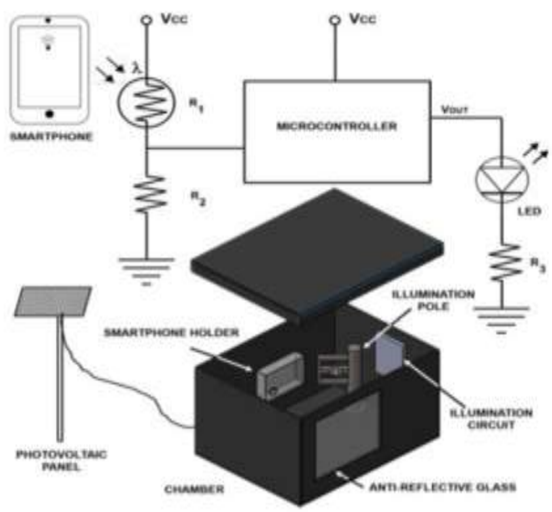

Figure 1: Smartphone irrigation sensor

Mean Shift Based Segmentation Algorithm

We chose the mean shift algorithm, proposed in [16], over other segmentation methods, such as level set and graph cut based algorithms, for several reasons. First, the mean shift algorithm takes into consideration the spatial continuity inside the image by expanding the original 3D colour range space to 5D space, including two spatial components, since direct classification on the pixels proved to be inefficient. Secondly, a number of acceleration algorithms are available. Thirdly, for both mean shift filtering and region merge methods, the quality of the segmentation is easily controlled by the spatial and colour range resolution parameters. Hence, the segmentation algorithm can be adjustable to different degrees of skin colour smoothness by changing the resolution parameters. Finally, the mean shift filtering algorithm is suitable for parallel implementation since the basic processing unit is the pixel. In this case, the high computational efficiency of GPUs can be exploited.

$$\nabla f(x) = \frac{2c_{k,d}}{nh^{d+2}}\left[\sum_{i=1}^{n} g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)\right]\cdot m(x)$$

$$m(x) = \frac{\sum_{i=1}^{n} x_i g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)}{\sum_{i=1}^{n} g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)} - x$$

The mean shift algorithm belongs to the density estimation based non-parametric clustering methods, in which the feature space can be considered as the empirical probability density function of the represented parameter. This type of algorithms adequately analyses the image feature space (colour space, spatial space or the combination of the two spaces) to cluster and can provide a reliable solution for many vision tasks. In general, the mean shift algorithm models the feature vectors associated with each pixel (e.g., colour and position in the image grid) as samples from an unknown probability density function f (x) and then finds clusters in this distribution.

$$f_{h,K}(x) = \frac{c_{k,d}}{nh^d}\sum_{i=1}^{n} k\left(\left\|\frac{x-x_i}{h}\right\|^2\right)$$

$$y_{k+1} = y_k + m(y_k) \qquad (4)$$

$$K_{hs,hr}(x) = \frac{C}{h_s^2 h_r^3} k\left(\left\|\frac{x^s}{h_s}\right\|^2\right) k\left(\left\|\frac{x^r}{h_r}\right\|^2\right)$$

V. PERFORMANCE ANALYSIS

To estimate this differentiation a set of images were taken and their histograms were analyzed in the gray scale from 0 to 255, using Mat lab R2014a, between an image when the soil is completely dry and other when is saturated with 300 ml of water These two images represent the limits of the dynamic range of the system, which depends of the physical characteristics of the soil: sand, loam, and clay percentages. Other images were acquired adding 60, 120, 180 and 240 ml of water respectively. To implement the irrigation sensor, the basic Smartphone ZTE-V791 was selected, which integrates an ARM Cortex- A9 processor with 512 MB of RAM and 4 GB of internal memory, runs at 1GHz on Android 2.3.6 Gingerbread with application programming interface level 10. A touch screen of 3.5” is provided, with 320 x 480 pixels, with a standard Li-Ion battery of 1200 m Ah. Other features include GSM/GPRS and EDGE bands, Wi-Fi 802.11 b/g/n, Hotspot, WAP 2.0 and a 3.0 megapixel rear-facing camera with 2048 x 1536 pixels. As can be seen the number of wet pixels is increased directly proportional to the added water. Therefore, the RWS is calculated as the ratio between the number of wet and total pixels.

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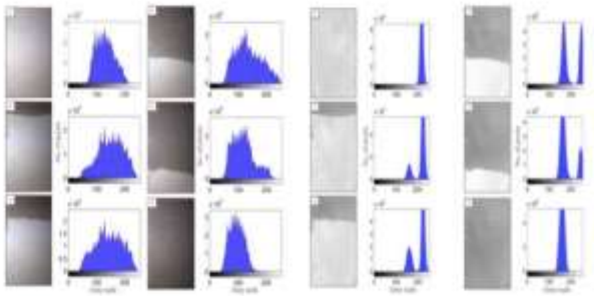

Figure 2: Analysis different water level in the soil

VI. CONCLUSION

Due to rapid growth of Smartphone appliances at affordable prices, this App represented a simple and practical implementation. The sensor installation in the field can be done simultaneously with the preparation of the cultivation beds and irrigation tubes, so there is no significant additional labor, nevertheless compared with traditional sensors; the installation in the field requires more effort and time. The irrigation sensor has an inherent advantage over other kind of soil moisture sensors for irrigation purposes. The outcome of others depends of soil characteristics like: density, compaction, gravimetric or mixture of their components among others. The irrigation sensor is of non-contact type, requiring only an in calibration to acquire the dynamic range for any soil type. This is performed using a dry soil image and water saturated. This procedure may represent a disadvantage respect to other kind of sensors. The sensor can be used creating networks for large fields or for uneven cultivation terrains, in such a way that several places have to be monitored for different RWS values. Also if needed there are other communication capabilities such as Bluetooth or directly through a SIM card via SMS linked directly to a URL site or other Smartphone, integrating several versatile possible applications. If a gateway is not required, the irrigation sensor can be used alone to trigger remotely an irrigation pump. This work will be extended in Fertilizer Irrigation process in future.

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