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Antenna Control System Algorithms

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ABSTRACT

In last three decades various algorithms have been designed, developed and implemented in antenna control applications. Keeping this is in mind, the algorithms such as step, electronic, monopulse tracking, P, PI, PD, PID, FLC, FPID, LQG, H∞, STR, fast genetic PID and ANN are discussed in the present communication. The advantages and disadvantages of these algorithms along with the basic principles are highlighted. The criteria for the selection of algorithms for various antenna control system applications are also elaborated. The important parameters of antenna control systems such as size, cost, power and accuracy depend on the selected algorithm.

KEYWORDS

Antenna tracking, Antenna positioning, Antenna control system, Step tracking system, Algorithm selection.

……………………………………………………………………………………………

1. INTRODUCTION

In the satellite communication system, the antenna plays an important role of the signal transmission and reception. The prime requirement of the user is a best quality and environment effect free strongest signal from the satellite. The system that will search a signal automatically as per the requirements of user is needed. Thus antenna control systems are extensively developed and studied. The systems consist of both electronic and mechanical components along with algorithm/s. The provision is made to set antenna coordinates - azimuth, elevation and polarization axes at the receiving end. The complexity of the system depends on the type of application, satellite orbital motion and implemented algorithms [1].

The important categories of antenna control systems are the ‘tracking’ and ‘positioning’ systems. In tracking, the systems continuously search the signal source [1] such as communication satellite, spacecraft, etc. In the satellite communication received signal quality depends on satellite location and antenna position [2]. In positioning, the system receives strongest signal, stops the continuous tracking and starts again when signal level goes below the threshold level [2].

The cost, size, speed, power, and accuracy are the important parameters of antenna control systems. With consideration of these, many researchers have developed antenna control systems using various control/ tracking algorithms. In this paper, various traditional algorithms and tracking methods used in various antenna systems are discussed.

2. ANTENNA CONTROL SYSTEM ALGORITHMS

In reported systems, the tracking, positioning or combination of both are used. The system parameters depend on selected components and implemented algorithm. Hence, the selected algorithm has an important role in the development of system. These algorithms are useful in various applications like tracking, positioning, adverse weather, mobile vehicles, antenna parameter measurement systems, etc. In this section, algorithms used in antenna control systems such as step tracking, electronic tracking, monopulse tracking, P (Proportional), PD (Proportional - Derivative), PI (Proportional - Integral), PID (Proportional – Integral - Derivative), STR (Self - Tunned - Regulator), FLC (Fuzzy – Logic - Controller), FPD (Fuzzy - PD), FPID (Fuzzy - PID), fast genetic PID, LQG(Linear – Quadratic - Gaussian), $H\infty$, and ANN (Artificial Neural Network) have been discussed.

2.1. Step Tracking

In step tracking algorithm, present signal strength is recorded. The antenna is then rotated in any direction by one step and the received signal strength is checked. If the received signal strength is found to be increased, the antenna is rotated in the same direction by one step, otherwise, it is rotated in the opposite direction. The execution of these steps continues until the antenna receives the maximum signal strength from the signal source. The central control unit guesses whether the antenna pointed position is as desired if received signal strength decreases in both directions (forward and reverse rotations). Otherwise, antenna is offset from the correct position. This method is useful for relatively stationary signal sources [3] like geostationary satellites and for the medium size antenna. To implement this algorithm a RF channel or signal detection is required but it has lower accuracy and dynamic lag. This problem is reduced by implementing algorithm with hill climbing technique, curve fitting or gradient methods or algorithms [4-6].

2.2. Electronically Tracking

In this method, to cover whole sky the antennas are directed in different directions to receive desired satellite signal. An electronic switch is connected between each antenna and common receiver. This switch is controlled by the central controller unit with monitoring output of the satellite receiver. The switching of another antenna depends on the satellite signal level. The controller monitors the signal level of the current connected antenna. If the received signal strength goes below a threshold signal level, the controller switches receiver input to another antenna. This switching continues until the receiver receives the signal more than a specified threshold. It is one of the simple methods of the antenna positioning. But it requires several antennas with additional electronic switch and the signal may be lost during antenna searching and switching [7].

2.3. Monopulse Tracking

The three main methods of the monopulse tracking are amplitude comparison, phase comparison and hybrid (combination of amplitude and phase). In the amplitude comparison method, beams phase center are common, i.e., target produces the voltages of different amplitude with same phase. If the received signal amplitudes become equal, it means target is on the axis and it is achieved. In phase comparison method, beams have same amplitude and different phases. In this method, the beams are parallel and identical as well as their phase centers are on the opposite sides of the axis. If the phases become equal, it means the target is on the axis.

Monopulse has different configuration viz. single channel, two channels and three channels. The selection of the configuration depends on three parameters, size, weight and power. The single channel configuration requires a single RF channel down converter link. Thus, above mentioned parameters are satisfied in the single channel. However, in this configuration design of the antenna and feed system is more complex and time consuming. These problems are ruled out in two channel configuration but it requires two RF channel down converter link [8,9]. The advantages of the monopulse are better option for the accuracy more than $1/10^{th}$ of antenna beam width, high tracking capability [10], immune to link perturbations, better sensitivity and sensing error simultaneously for both roll and pitch axes [8]. However, the phase and amplitude tolerances degrade the tracking performance of the system [11]. A system becomes large and complicated [10] with the use of more than two pairs of the antenna during tracking. RF losses in monopulse tracking are reduced by the mechanical dithering [12].

2.4. Proportional Control

In the proportional control, the output of the control system depends on the input error and proportional gain. The proportional control is useful in both the antenna positioning and tracking systems. It is useful to control the speed of the actuator used in the system. In positioning, for more positioning error, it requires to increase the speed of motor and vice versa. There are two sources of the positioning errors i) between the actual positioning angle and entered angle, and ii) between actual received signal and threshold signal level. The actuator speed is controlled by changing voltage, current and/or delay between step input. The advantages of the proportional controller are steady state error reduction and the positioning speed depends on the proportional gain as well as on error. But increased gain of proportional controller produces more overshoot and system produces oscillations. In the digital type of proportional controller implementations an error is multiplied by a constant value (proportional gain). The output of the program is applied to the actuator drive circuit.

2.5. PD

The PD controller consists with derivative terms along with proportional. The addition of the derivative terms in proportional, reduces the speed near the set point and increases the speed for large deviation from set point. This controller is beneficial whenever a sudden change of the error occurs. The output of the derivative controller depends on the rate of change of the error. Hence, the system produces less overshoot, provides a fast system response and improves the stability. The derivative controller is useful to predict the future error and to increase the system speed as the mechanical inertia occurs. Therefore, it is more suitable for the antenna mounted on the mobile vehicle. The use of the derivative controller in the system prevents the integration disturbances of system dynamics [13].

2.6. PI

In PI controller, an integral term is added in the proportional controller. Due to the Integral term a controller is reset at every interval of time. The use of integral term reduces the steady state error of the proportional controller. But it reduces speed of the response and unable to handle the sudden error. Thus, PI controller is not suitable for the antenna mounted on the mobile vehicles. The other disadvantages of PI controller are it is unsuitable for stringent pointing requirement, produces vibrations [14], worst performance for lower tracking loop gain [13] and has large overshoot and settling time compared to $H\infty$ controller [14]. This controller is useful to control sub reflector [13].

2.7. PID

The PID controller is the combination of PD and PI controllers. It is useful to improve the steady state and transient response of the system. The system developed with PID has a better stability, very small steady state error, fast response, simple structure and robust performance. For proper selection of various gain parameters, gain scheduling methods, manual tuning, ZN tuning and software method of tuning (like MATLAB) are used. The new methods developed for the tuning are fuzzy controller (FPID) and genetic algorithm-PID [15-24].

2.7.1. FPID

In FPID, fuzzy inference rules are used to tune the PID gain parameters. The FPID has more exact trajectory tracking than that with PID. It has flexibility and freedom for the gain variations [21]. Due to variable PID control gain, it has better tracking and robust performance for different environmental conditions. Thus, for uncertain environment it shows superior performance and useful in the plant parameter variation [22]. It also gives a better performance in the point of overshoot and settling time [23] and shows damped oscillations. The FPID has better performance than PID and FLC [24].

2.7.2. Fast Genetic- PID

In a control system, a genetic algorithm is used to optimize the PID parameters. The optimized PID by genetic algorithm shows better performance in terms of the steady state error, settling time and overshoot. In antenna control system, a PID controller optimized with genetic algorithm will give better performance during the rapid change of angular movement of the tracker. Thus, this algorithm is very useful in mobile vehicle mounted antenna system. However, implementation of this algorithm requires high speed large memory size control system [24-28]. The gain tuned by genetic algorithm shows better performance than the fuzzy [16].

2.8. FLC

FLC is the linguistic and rule-based controller consisting fuzzification, fuzzy inference rule and defuzzification. The crisp data set are converted into the fuzzy sets by fuzzification. In fuzzy inference rule, fuzzy set data are used to make inference by reasoning. The last block of defuzzification converts fuzzy control action into the real world form. The advantages of FLC are robust performance for non-linear systems, adaptive, useful in a load disturbance system, requires simple mathematical model to formulate algorithm, easy implementation in digital computers, no fixed design of rule base [17], requires less power than PID, better step position response time [18], useful to face the problem of mechanical configuration variations and to control fast nonlinear processes [17]. In the antenna control system, FLC is useful to reduce imprecision factor caused by sensors and environment, in fine tuning [6] and has tracking precision of control [19].

2.9. FPD

The FPD based system uses two types of variables, error and rate of change of error. The use of FPD is better for lower antenna gain but it produces overshoots during rapid changes of the target position [20].

2.10. STR

STR is used in the closed loop system to tune or adapt system with the present surrounding situations. The operating point variation range is increased by STR. It shows a better performance than conventional PID controller. But it requires a large amount of floating-point calculations during implementation. Hence it is difficult to implement [17, 24]. For antenna control system the STR is useful in unpredictable environment.

2.11. LQG

LQG is a most fundamental controller. It is designed by combining Kalman Filter and LQR. It shows the better performance for the non-linear system. It minimizes the H_2 norms. It has wide bandwidth and rate offset shows zero lagging. The acceleration limits of the antenna systems cancel its benefits. It has a large settling time, large phase margin and the low gain margin compared to that in $H\infty$ [25]. The LQG has no guarantee of the robustness [26].

2.12. $H\infty$

$H\infty$ is a robust controller. It gives the stabilized system and minimizes the impact of the perturbation of the closed loop system. It has less settling time, little overshoot, wide bandwidth, lower steady state error, low magnitude, large gain margin and low phase margin compared to LQG [4,25,27].

2.13. ANN

ANN is useful in identification and control of nonlinear dynamic systems. It requires state information or plant models. They spent extensive time for online tuning [29]. It is useful for smooth speed response and has low torque ripple distortion [30]. For a Neural Network, a large recovery time is required when sudden load disturbance occurs.

3. ALGORITHM SELECTION

The systems developed with conventional algorithms such as P, PD, PI and PID are very much sensitive to parameter variations and load disturbance. They have poor step response and are less accurate. To overcome these problems intelligent controllers with FLC, ANN, STR and genetic algorithms are developed. The systems developed using these controllers show better performance than the conventional ones. Additionally, these controllers don't require exact mathematical model but implementation of these algorithms requires high speed processors, high speed memory and large floating-point calculations. This increases the system cost. The electronic and monopulse methods require additional hardware like RF channels, antennas, etc. The ANN requires high speed and costly processor.

The 'step tracking' algorithm is the most widely used algorithm in the reported antenna control systems. It doesn't require any costly processor/control unit. Use of the 'step tracking' algorithm along with other traditional algorithms is a better option in system development.

4. CONCLUSION

In present communication, designed, developed and implemented algorithms for the antenna control systems are discussed and reviewed. The important parameters of the antenna control system - size, cost, power and accuracy, depend on the selected algorithms. Hence proper selection of an algorithm is essential in the antenna control system. To improve system performance a combination of newly developed algorithms and traditional algorithms are beneficial.

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Detection of theTomato Leaf Disease Using Image Segmentation

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ABSTRACT

The image segmentation is an important step considered in the processing of the image and therefore, a better segmentation results would make it easier to analyze in next image processing steps. In this paper, introduced the techniques for segmentation of tomato leaf disease images using Otsu thresholding algorithm and k-Means Clustering with triangle thresholding. The performance of the image segmentation is measured by different evaluation indices used for evaluating the effectiveness of the proposed method.

KEYWORDS

Image processing, Segmentation, k-means clustering, Otsu thresholding.

…………………………………………………………………………………………..

1. INTRODUCTION

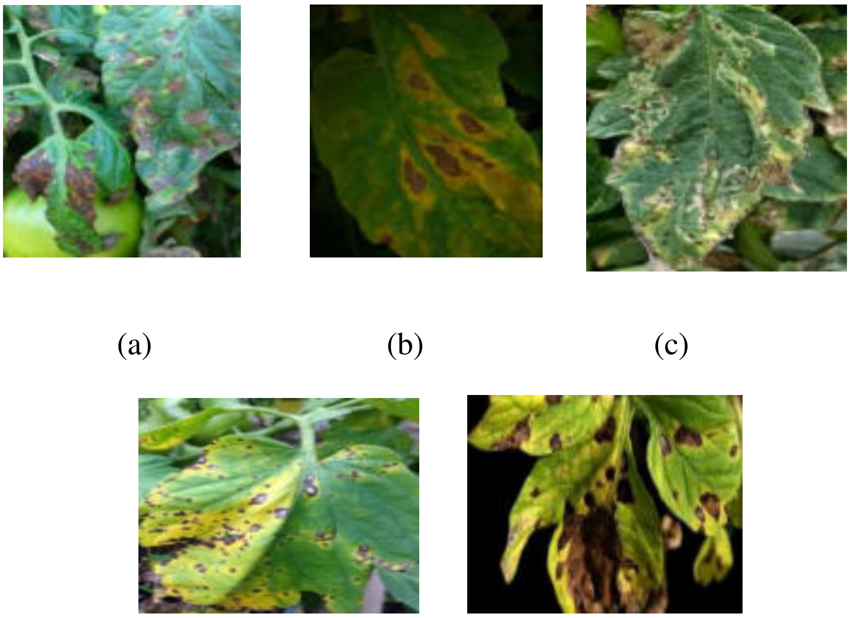
In image processing the image segmentation is a challenging and one of the most important topics in various applications including robot vision, medical image processing, object recognition and agriculture. In agriculture, the main objective of the segmentation is to segment the disease region to the background of the images. Various challenges exist for segmentation of diseased area in the image such as changes in disease color when executing the color-based segmentation process, varying the lighting situation, change in size is diseased area, texture of the diseased region, large unevenness of color make the segmentation process is difficult. These challenges effect on the disease detection accuracy and reduces the overall performance of the system. Different image segmentation methods are existing such as thresholding (mostly dependent on peaks, spatial information's are not considered which may conduct to non-information about diseased area), clustering methods, edge detection (not appropriate for a lot of edges as it incorrectly detects the edges), ANN based methods (more time expected in training of the data) etc [1]. Using this method firstly to accurately segment the region of interest from the background of the image.

This work presents the tomato diseased leaf area should be identified and segmented from the uniform background using Otsu thresholding and k-Means Clustering segmentation with triangle thresholding. The segmentation results were evaluated by using Jaccard Index, Dice index, Accuracy performance metrices for assessing the output image quality of image.

2. MARTIAL AND METHOD

2.1. Tomato Disease Leaf Images

The tomato disease leaf samples used in this study were collected from the agriculture sector in Kolhapur district of Maharashtra. Tomato image leaf samples were collected as the dataset during the entire growth cycle of tomato by a mobile phone camera (RealmeNarzo Pro), which was set to automatically correct the focal length and aperture, auto white balance, and without flash. The image resolution was 1080 x 2400 pixels. To improve the variety of data and improve the overview ability of the algorithm, the tomato images were captured regardless of environmental factors. There were 250 tomato early bright, leaf miner, Septoria leaf spot diseased images were collected for the segmentation study. Some leaf sample disease images have been shown in **Figure-1**.



(a) (b) (c)

(d) (e)

Figure-1. Sample of diseased tomato leaf images for a) & (b) early bright c) leaf miner d) septoria leaf spot.

2.2. Image Pre-Processing

After collecting the RGB image data of the tomato crop leafs the pre-processing process is followed to reduce the effect of illumination variation caused by the unpredictable lighting situation. The pre-processing is executed to reduce the background noise and enhances the image contrast of the leaf image using Brightness Preserving Dynamic Fuzzy Histogram Equalization (BPDFHE).This provides it the enhanced ability to preserve brightness and give better contrast enhancement than other pre-processing method [2]. **Figure-2** shows the pre-processing results of tomato leaf disease image.

Figure-2. Pre-processing results of tomato leaf disease image.

2.3. Image Segmentation

The goal of the image segmentation process is to separating or grouping an image into several parts. Otsu thresholding K-Means clustering segmentation with triangle thresholding method used for performing the process.

2.3.1. Otsu Segmentation

Otsu thresholding method is a global adaptive binarization threshold image segmentation algorithm [3]. In the simplest form, the algorithm processes a single intensity threshold that divides the image pixels into two classes, foreground and background. Otsu's thresholding efforts to calculate the best threshold values to separate up two parts in such a way that their inter-class intensity variance becomes maximum or equivalently by minimum inter-class variance. **Figure-3** shows the segmenting results of tomato leaf diseases using Otsu method.

Figure-3. The segmenting results of tomato leaf diseases using Otsu method.

2.3.2. K-Means Clustering with Tringle Thresholding

In the present work, k-mean clustering method for segmentation has been given the priority between all of the other methods. The better performance of k-mean clustering method is that, it works well with big data sets. Therefore, the objective functions of k-means clustering are simple, fast and is easy to implement. The accuracy of algorithm depends on the data sets. K-Means clustering algorithm is employed to segment the objects into k-number of clusters according to the set of features. The proposed segmentation algorithm works with L*a*b color space. The k value select has been done based on trial and error and method. Hence, after multiple trial runs the value of k was chosen as '5' in this case. The formations of clusters have been done based on the selection of three random points selected from the data sets. These three random points specified as centroids of every cluster. In the L*a*b color space all of the color information is in the 'a*' and 'b*' space and clustering image are pixels with 'a*' and 'b*' values [4-5]. The Image gets partitioned into five regions by reallocating each pixel to its closest clusters which reduces the sum of squared Euclidian distances and recomputing the centroids of the clusters [5]. The Euclidian distances in n-space can be can be represented in equation (1)

$$D(A,B) = D(B,A) = \sqrt{\sum_{i=1}^{n}(B_i - A_i)^2} \qquad (1)$$

Where, A ($A_1, A_2, A_3, A_4, \ldots\ldots, A_n$) and B ($B_1, B_2, B_3, B_4, \ldots\ldots, B_n$) pixel points representing a color space.

The five clusters have index values which are used to label each pixel in the image using resulting output of K-Means. Using the pixel labels, to separated objects in image by color, which will result in three images of diseased and healthy regions of the leafs. The five resulting images k-Means Clustering is shown in **Figure-5**.

After segmentation, for the further processing to properly separate the background from the leaf area and remove the unwanted or weak edges of diseased regions using triangle thresholding method can be completed accurately. **Figure-6a-d** shows the resulting output of triangle thresholding and background removal image.

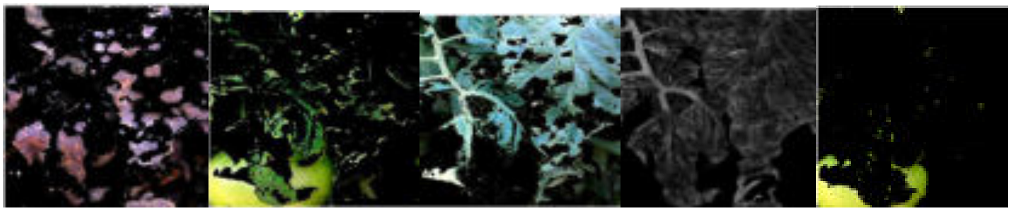
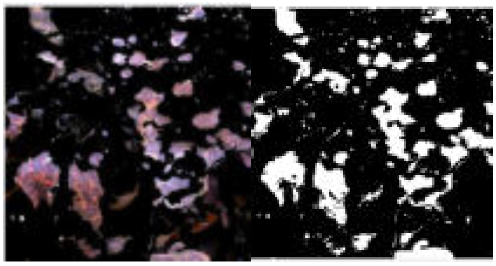


Figure-5. The Five resulting images using k-Means Clustering Method.

a) (b)



(c) (d)

Figure-6. Shows (a) background removal (b) binary conversion using triangle thresholding (c) diseased cluster (d) binary conversion using triangle thresholding.

3. PERFORMANCE EVALUATION OF IMAGE SEGMENTATION

The most commonly performance metrics are Dice score, Jaccard index and accuracy [6] are used to evaluate the efficiency of the proposed image segmentation method.

3.1. Jaccard Index

The Jaccard index, also called as the Jaccard similarity coefficient, is a statistic used for computing the similarity and variety of sample sets.The Jaccard similarity coefficient measures similarity between given two sample sets. The mathematically calculated Jaccard index is following equation (2)[7].

$J(A, B) = \left|\frac{A \cap B}{A \cup B}\right|$ (2)

3.2. Dice Index

Dice similarity coefficient (DSC) is obtained from a reliability measure called as the kappa statistic [8] and calculates the ratio of the intersection area separated by the mean sum of each individual area. Let A denote the segmented region and B denote the ground truth region. Then the Dice similarity measure is in given equation (3)

$D(A, B) = \frac{2[A \cap B]}{|A| + |B|}$ (3)

3.3. Accuracy

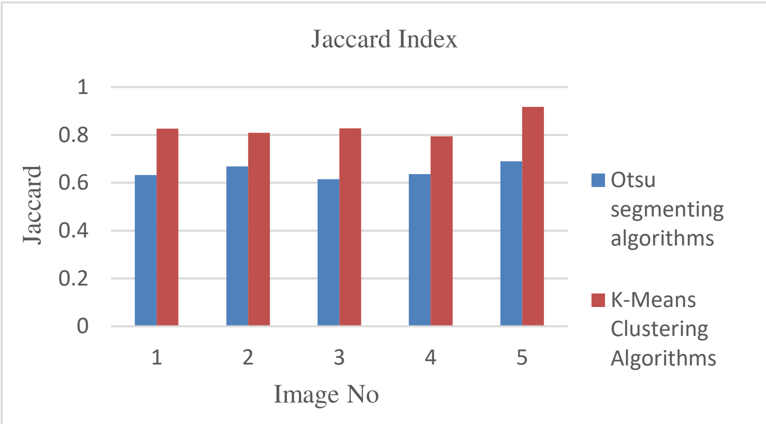
Accuracy is used calculate the effectiveness of proposed segmentation is given in equation (4)

$Accuracy = \frac{T_P + T_N}{T} * 100$ (4)

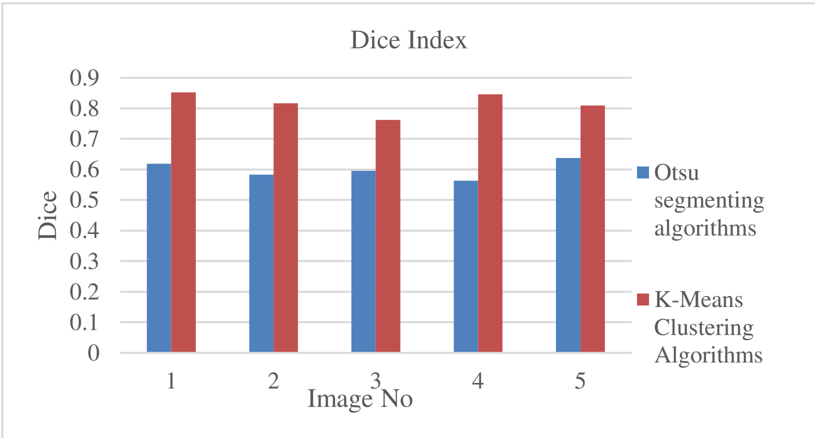
Table-1. Performance Metrices Analysis using Jaccard, Dice Coefficient and Accuracy.

Image	Jaccard Index		Dice Index		Accuracy	
	Otsu segmenting algorithms	K-Means Clustering Algorithms	Otsu segmenting algorithms	K-Means Clustering Algorithms	Otsu segmenting algorithms	K-Means Clustering Algorithms
1	0.6321	0.8269	0.6186	0.8523	0.7512	0.9981
2	0.6682	0.8087	0.5826	0.8160	0.8123	0.9657
3	0.6154	0.8275	0.5956	0.7623	0.7236	0.9855
4	0.6365	0.7948	0.5626	0.8463	0.8233	0.9923
5	0.6898	0.9167	0.6376	0.8094	0.7412	0.9125

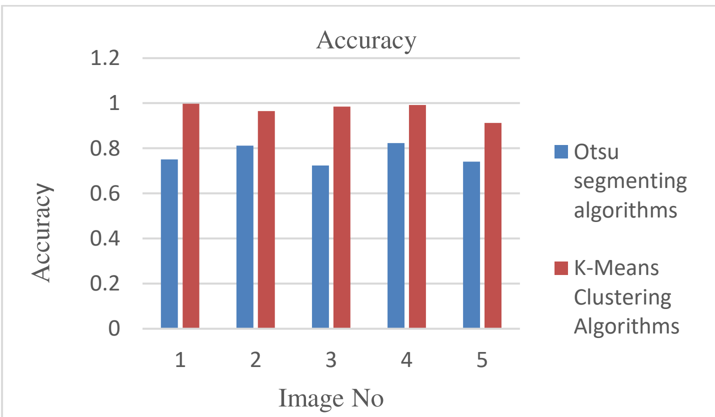
Table-1 shows the performance metrices evaluation using Jaccard Index, Dice index and Accuracy. It was observed that the Jaccard and Dice coefficient for existing Otsu algorithm comes out to be less as compared to the proposed K-Means clustering algorithm resulting in more accuracy of the proposed method and it has been examined that accuracy for proposed K-Means clustering algorithm is better as compared to Otsu algorithm. **Figure-7a-c** shows the graphical comparative analysis of Jaccard index, Dice index and Accuracy of tomato diseased leaf image.


Jaccard Index
1
0.8
0.6
0.4
0.2
0
Jaccard
1
2
3
4
5
Image No
Otsu segmenting algorithms
K-Means Clustering Algorithms

(a)


Dice Index
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Dice
1
2
3
4
5
Image No
Otsu segmenting algorithms
K-Means Clustering Algorithms

(b)


Accuracy
1.2
1
0.8
0.6
0.4
0.2
0
Accuracy
1
2
3
4
5
Image No
Otsu segmenting algorithms
K-Means Clustering Algorithms

(c)

Figure-7. Graphical comparative analysis of (a) jaccard index (b) dice index (c) accuracy.

4. CONCLUSION

The paper presented a clustering number of K-Means algorithm with triangle thresholding and Otsu thresholding algorithm for tomato leaf disease image segmentation. Diseased region areas are identified and segmented efficiently using K-Means clustering with triangle thresholding algorithm. The segmentation algorithm has evaluated by performance metrices. Comparing the results, the proposed algorithm greatly improved the segmentation accuracy of the K-Means clustering with triangle thresholding algorithm.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Comparative Study of Antenna Parameters of Rectangular Antennas Designed on Different Substrates

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ABSTRACT

The present communication explains design of rectangular microstrip patch antenna on four different substrates. The view of such design is miniaturization of microstrip patch antenna. The four different substrates with permittivity 9.8, 10.2, 12, 17.5 are used. The parameters of antenna like return loss, VSWR, smith chart, 2D and 3D radiation pattern were studied at resonance frequency 2.45GHz in ISM Band. The highest miniaturization and better simulated gain was found for antenna designed on LiTi substrate with higher dielectric constant.

KEYWORDS

Microstrip antenna, Patch antenna, Antenna design, Ansoft Designer, RT-Duroid.

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1. INTRODDUCTION

The development of microstip patch antenna technology is started from 1970. The establishment of microstrip antenna effects were studied in early 1980. Now day's researchers are interested to explore novelty in microstrip patch antenna because of its light weight, low cost, conformal size and miniaturization [1]. The antenna miniaturization in wireless communication system is became vital issue at present. The permittivity of the substrate plays crucial role in miniaturization of microstrip antenna along with frequency.

Researchers made attempts for miniaturization using different kinds of substrates. Esin Chang et al used Rogers RT duroid substrate for rectangular antenna [2], Adit Kurniwan and Salik Mukhlishin studied antenna with FR-4 epoxy substrate [3], G Srivatsun and S. Subha Rani used FR-4 substrate for wideband antenna [4]. PekkoIkonen and Sergei Tretyakov used magnetic material for substrate [5], Arik Darnell Brown et.al. Studied ferrite substrate [6], Kunal Borah and Nishi Saxena

Bhattacharyya studied antenna using magneto dielectric composites with NiFe2O4 inclusions [7]. Dheeraj Kumar and P.K.S. Paurush used Ni ferrite as a substrate [8], Kumar Mohit et al presented Nickel-Copper-Zinc ferrite as substrate [9] while Naveen Kumar Saxena et al used LiTiMg ferrite [10], LiTi ferrite [11]for microstrippacth antenna.

In present work rectangular microstrip patch antenna is designed on four different substrates with permittivity 9.8, 10.2, 12, 17.5. The performance of these antennas is studied by simulation using ANSOFT designer SV2.2 software.

2. DESIGN OF ANTENNA

The MPA is a radiating patch on one side of substrate with ground plane on the other side as depicted in **Figure-1.** The patch is mostly made up of copper. In present communication rectangular shape microstrip patch antennas are designed. For rectangular patch, the length of the patch (L) and height of the substrate (h) are about 0.5 λ_0 and 0.05 λ_0 respectively, where λ_0 is free space wavelength. The thickness t of patch is kept as $t << \lambda_0$ .is depicted in **Figure-1.**

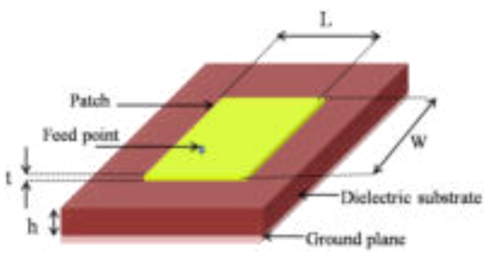


Figure-1: Geometry of Rectangular Microstrip Patch Antenna.

The models used for analysis MPAs are transmission line model [12], cavity model [13] and full wave model or method of moments [14]. To feed the antenna variety of methods are used. They are classified into two groups as contacting and non-contacting. The contacting methods are strip line and coaxial probe, while non-contacting are aperture coupling and proximity coupling [1]. In present communication coaxial probe feeding method is used as depicted in **Figure-1**.

The theoretical formulae for dimensions like width w [15], Effective dielectric constant ε_{reff} [1], Extension length ΔL [16], Length of patch L [1] of patch are given below.

$$W = \frac{c}{2f_r\sqrt{\frac{(\varepsilon_r + 1)}{2}}} \qquad (1)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2)$$

$$\Delta L = 0.412 \frac{\left(\frac{W}{h} + 0.264\right)\left(\varepsilon_{reff} + 0.3\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \qquad (3)$$

$$L = \frac{c}{2 f_r \sqrt{\varepsilon_{reff}}} - \left(2 \times \Delta L\right) \qquad (4)$$

Where, $c =$ Velocity of light in air, $f_r =$ Resonance frequency, $h =$ Height of substrate.

These dimensions obtained by using equations (1), (2) and (3) for patch antennas having various substrates with thickness 0.625mm at the design frequency of 2.45 GHz are presented in **Table-1**.

Table-1. Patch antennas having various substrates.

Sr. No.	Substrate	Permittivity ε_r	Width (W) mm	Length (L) mm
1	Substrate I	9.8	26.3468	19.5547
2	Substrate II	10.2	25.8720	19.1689
3	Substrate III	12	24.0142	17.6777
4	Substrate IV	17.5	20.2957	14.7702

3. DESIGN OF ANTENNA

Using Ansoft Designer SV2.2 software the proposed rectangular microstrip antennas on various substrates are designed; the feed point locations for coaxial feeding are optimized as depicted in **Figure-2** and the parameters like return loss, VSWR, smith chart, 2D and 3D radiation patterns are simulated

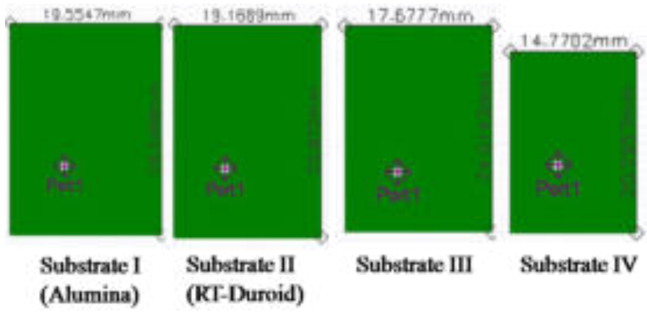


Figure-2. Rectangular microstrip patch antenna on different substrate.

The frequency range for simulation is selected between 2.3 GHz to 2.55 GHz. The variations of return loss with frequency are presented in **Figure-3**. From this Figure it can be noticed that, for the antennas except substrate IV the observed resonance frequency is 2.43 GHz. However, it is slightly reduced for patch antennas designed on substrate IV. It is of the order of 2.41GHz. The variation of VSWR with frequency for all designs is presented in **Figure-4.**

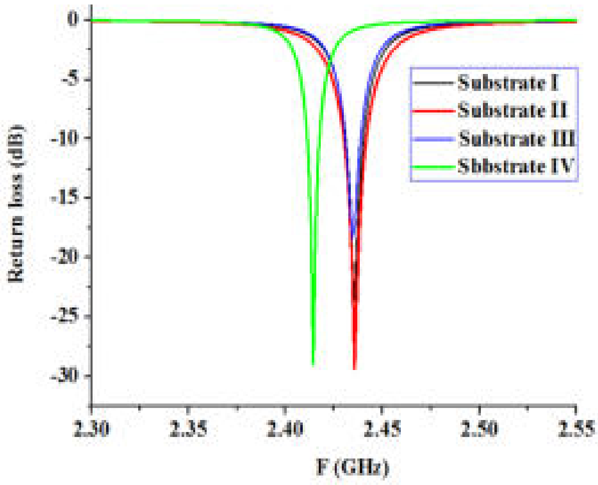


Figure-3. Variation Return loss with Frequency.

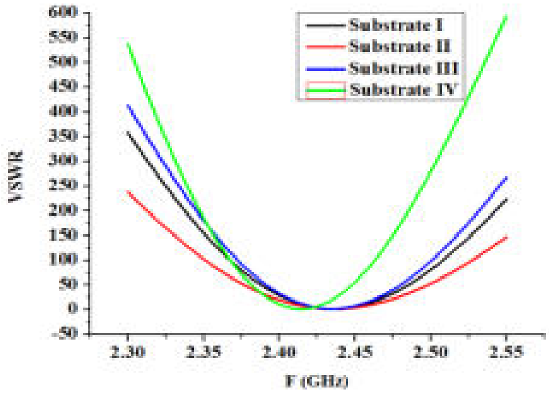


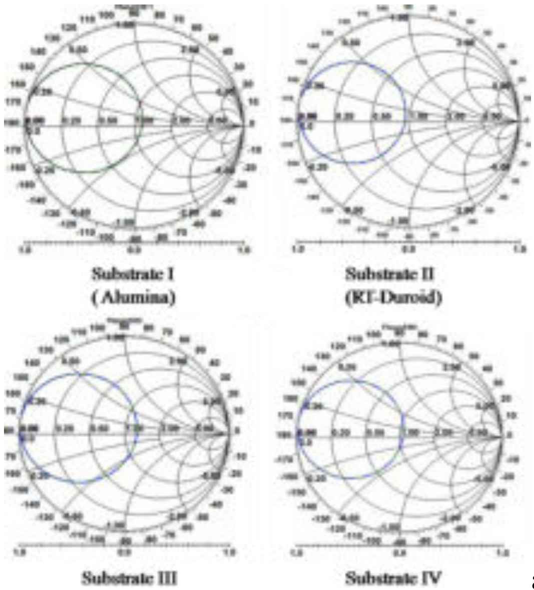
Figure-4. Variati on Return loss with Frequency.

The return loss, VSWR, maximum power transferred (P_t) to the antenna, 10 dB % bandwidth and gain are listed in **Table-2**. The return loss and VSWR on substrate II (RT-Duroid) and substrate IV have excellent impedance matching than antennas on other substrates. As can be seen form return loss to VSWR conversion table by Mari Microwave [17], the maximum power delivered in case of patch antenna on substrate II(RT-Duroid) is 99.87%, while antenna on Ni ferrite substrate shows lowest value of delivered power. The 10dB percentage bandwidth for antenna on substrate II (RT-Duroid) substrate is 4.9. It is largest as compared to antennas designed on other substrates I, III and IV.

Table-2. The return loss, VSWR, maximum power transferred (P_t) to the antenna, 10 dB % bandwidth and gain.

Sr. No.	Substrate	Return loss (dB)	VSWR	P_t %	10dB % Band width	Gain
1	Substrate I (Alumina)	-23.49	1.14	99.5	3.83	3.9
2	Substrate II (RT-Duroid)	-29.18	1.07	99.87	4.90	2.4
3	Substrate III	-18.37	1.27	98.42	3.05	2.9
4	Substrate IV	-28.97	1.07	99.84	2.70	3.0

The impepedance mathing at the feed point positions is also re-presentented in smith charts presented in **Figure-5.** It confirms a good feed point impedance matching for antennas on all substrates.



article

Figure-5. Variation Return loss with Frequency.

The 2D and 3D radiation patterns for simulated patch antennas designed on four substrates are presented in **Figure-4** and **Figure-5** respectively. The half power beam widths for antennas on alumina, RT-Duroid, Ni ferrite and Li-Ti ferrite substrates are 62^0, 56^0, 60^0 and 62^0 respectively. The microstrip antennas on alumina substrate give maximum gain.

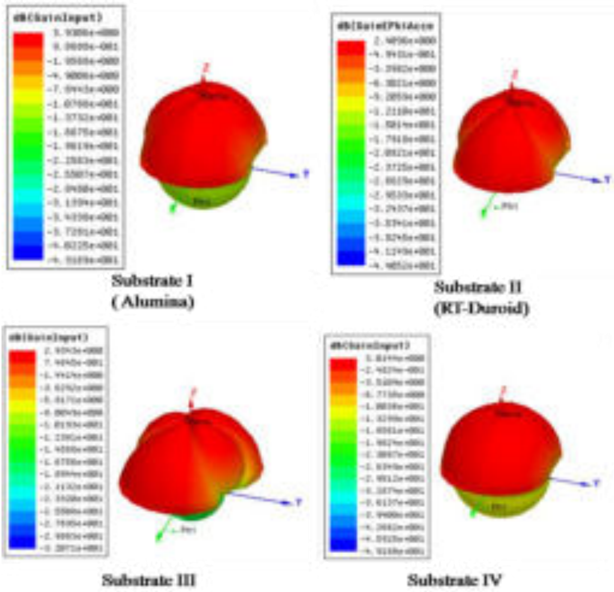


Figure-5. Simulated 2D and 3D radiation patterns.

4. CONCLUSION

The rectangular microstrip antennas on four different substrates are designed and simulated using ANSOFT SV2.2. The simulated results show LiTi substrate with higher dielectric constant has highest miniaturization and also better gain.

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Sunshine Duration Measurement WSN System for Grapes Yield and Quality Monitoring

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ABSTRACT

Crop quality and productivity are essential things in farming. Many crops have good growth because of the vigorous environment i.e. temperature, relative humidity (RH %), soil moisture, soil contents, type of soil, and light intensity. Some crops are more susceptible to these parameters; here in this research paper, we mentioned the development of a sunshine duration measurement wireless sensor network (WSN) system for grapes yield and quality monitoring. The system can monitor and measure sunshine duration from different locations of the field. It shows real-time sunshine duration on the coordinator window server and then shares data on the internet and mobile. Based on the Sunshine duration system, it is decided to provide nutrients to the crop for healthy growth or maintain good quality. The said system is developed by the integration of a microcontroller, sensor, XBee for RF communication, and power section using a rechargeable battery or solar cell. The data is accessed from different field points of crop plot on the coordinator server and shared.

KEYWORDS

WSN, Agriculture yield, Communication protocol.

1. INTRODUCTION

Agriculture acting an imperative role in India's economy. Over 58% of the rural households depend on agriculture as their major earnings of occupation. But in this field have many problems such as productivity losses and quality of crops; this is because of terrible environmental conditions, storage conditions, soil parameters, and mismanagement of farm.

All crops necessary the certain environmental conditions for good quality and more productivity. Mostly some environmental parameters are affecting the growth of plants, hence productivity losses and quality. In overall crops one crop is Grapes, It is more sensitive to ecological parameters so, we have designed and developed some wired and wireless remote sensing systems. The parameters are required for good quality is the sunshine, temperature, relative humidity, soil moisture, soil salinity, and soil nutrients [1].

In this paper, we proposed system, development of sunshine duration measurement using Wireless sensor network. Sunshine is very important parameter for plant growth, because of heat and light required by all growing plants supplied by solar radiation. As heat cannot completely replace the light, it is large amount replace byheat. The quality and quantity of sunlight are required for growing plants are both reliant upon atmospheric conditions, in addition with depends on with a season of the year. They differ from place to place and from month to month. One of the various weather conditions are essentials, the sunshine directly comes through the radiation, and indirectly through its effect on air temperatures, it in fluencies on the crops. Crops required energy for certain chemical activities in growing plants, as well as it promotes evaporation from the plants, abundant sunshine is required for most plants.

Light intensity is related to the total amount of light that plants collect in the degree of brightness plant is bare too. The strength of light can change with the time of day, season, geographic place, and weather. It regularly increases from sunrise, then the middle of the day and then gradually decreases toward sunset; it is high during summer, moderate in rainy and low during the winter season.

2. EFFECT OF SUNSHINE ON PLANT GROWTH

Light is an absolute requirement for plant growth and expansion. However, different plants have most favorable requirements and both scarce and extreme light intensities are harmful. Some physiological limits, raise of sunlight will result in an increase in the rate of photosynthesis.

The sunshine has three major characteristics that affect the growth of plant i.e. Duration, quality and quantity of sunshine. The quantity refers the concentration of sunlight and change with a season of the year. The maximum intensity present in summer and minimum in the winter season. For the better capacity of plant food produce through photosynthesis require more sunlight receive (up to peak point) by crop. As sunlight quantity decreases the photosynthesis process decreases. In green house and poly houses, sunlight intensity controlled by using shaded clothes or it can be increased by surrounding plants with white and reflective materials and supplementary lights.

Sunlight quality mention that color and wavelength reaching the surface of the plant, On raining day, raindrops act as petite prisms and break the sunlight into these colors producing a rainbow. Red and blue light have the best effect on plant growth. Green light is least efficient to plants some plants reflect green light and absorb some little. Blue light is mainly liable for vegetative growth or leaf growth. Red light while combined with blue light encourages flowering plants. The shining light is high in the blue range of light quality and is used to encourage leafy growth.

These lights are admirable for starting seedlings. The shining light is high in red or orange range but generally, produces more heat as a valuable light source. Shining lights have a combination of red and blue colors that attempts to emulate sunlight.

Light duration or photoperiod consists of the amount of time that a plant is exposed to sunlight. Photoperiod was first predictable thought that the length of time periods of light triggered flowering. The different categories of response were noted based on the light length (i.e. short-day and long-day). The capability of many plants to flowering is controlled by photoperiod.

3. SUNSHINE DURATION EFFECT

Development and growth of crops require necessary environmental conditions, sunshine or temperature is the effect on the growth of crops.

For peanut, cultivation requires suitable temperature and the sunshine during the vegetative and reproductive growth stages in the early and normal planting dates. If not proper received sunshine shortened for growth period and unsuitable growing conditions. Early planting of peanut, ranging from May 5 – 20, provided the essential 1450 and 1600°C GDD and 893 – 978 h of sunshine during the reproductive stage for peanuts grown in the Aegean region [2].

For Cotton flower and boll farming affected some climatic aspects and moisture status is considered. It's all matter such as Evaporation, relative humidity, surface soil temperature, air temperature and sunshine duration are the important climatic factors that significantly affect flower and boll production. Sunshine duration is the most effective climatic factor during preceding and succeeding periods on boll production and retention [3].

The effect of estimated daily global solar radiation on crop growth. He showed the effect of solar radiation data estimated hour based using Angstrom- Prescott formula [4]. The effect of artificial sunshine than natural sunshine with usual climate room irradiance spectra [5].

The severe differences in plant response to the Artificial Solar (AS) spectrum compared with the widely used protected cultivation light sources tested highlights the importance of a more natural spectrum, such as the AS spectrum, the aim is to produce plants representative of field conditions.

If grapes berries are in direct contact to the large duration of sunlight then produced heat energy effects severely, as the impact of this the quality of berries get reduced significantly due to an interruption in the photosynthesis process [6].

Fruit softening, berries grown without light during stages I, II, and III were lower in sugar than the control [7-9].

Here based on region northern and southern region of sunlight duration and temperature it effects on plant growth.

Region between northern and southern locations in the northern hemisphere, the light duration is longer in the northern locations from time duration of March 21 to September 21, and the day length is longer of southern locations from September 21 to March 21. For example,daylengthincreasesfrom12.7hoursto16.4hoursat10°to 50° latitude north of the equator, respectively, from June 20-22 while it decreases from 11.7 hours to 8.1 hours at 10°to 50°latitude south of the equator.

WSN make it possible to know at any time about land and crop conditions. To analyze the use of Programmable System on Chip Technology (PSoC) as part based Wireless Sensor Networks (WSN) to monitor and control various parameter of greenhouse [10]. Use of WSN technologies for agriculture and food industries [11].

Design system for a case study of greenhouse monitoring system. Such system is integrated with Bluetooth, wireless technology, Smartphone based field server (Gateway) to improve the agriculture services and precision agriculture [12].

Using WSN in cultivating potato in Egypt and importance of using WSN in precision farming. The WSN can be used to test the land to assess suitable to potato planting and it ensures that free from diseases, improve the storage of potato seed tubers and crop [13].

For precision agriculture energy efficiency essential in deployment this method finding the optimal sensor topology for reduces the implementation cost and energy consumption as well as make WSN system is new effective solution for all kinds of fields and cultivations [14].

The basic parameters are monitored i.e. temperature and moisture content of soil using WSN it control and monitoring [15].

4. ARCHITECTURE OF WSN SYSTEM ON THE FIELD

WSN emerged advancement the idea of MEMS technology, wireless communication and digital electronics. WSN devices are small size, low cost and require low power. WSN has many applications such as agriculture, medical, military, smart home and smart city. **Figure-1** shows the architecture of WSN system deployment on the vineyard. There is sensor node placed on the vineyard of all corners and middle area of plot. We have monitored sunshine duration from different field points; whenever it is necessary that at corner of plot some trees are present so, because of shadow this area has low intensity so, there is low temperature and it is harmful to the grapes growth as well as quality. There are also further chances to enter fungi diseases on grapes. WSN motes placed over the field, all sensor nodes collect data and send it to the coordinator through the router. Real-time in coming conditions based data system will send information for take precaution or apply doses to the crop.

5. LITERATURE SURVEY

Traditional agriculture is experienced by performing an exacting task, such as planting or harvesting, against predetermined schedule. Precision agriculture is by collecting real-time data on weather, soil and air quality, crop maturity, for that predictive analytics can be used to make smarter decisions. Those remote sensing systems are wired and wireless, for precision agriculture control centers collect and process data in real time to know farmers with regards of planting, fertilizing and harvesting crops. Sensors placed all over the field to measure humidity, temperature and humidity of the soil and surrounding air. Also, taken real time pictures using satellite imagery and robotic drones.

Implementation of WSN technology for tomato crop precision agriculture, this system overcomes wired communication for a large area [8].

The iFarm system proposes wireless sensor networks as a promising mechanism to agricultural resources optimization, decision making, and land monitoring [9].

Figure-1. Architecture of WSN system deployment on field.

WSN architecture shows that star topology network is deployed on the field for a small area, this topology is energy efficient. In a star topology, new nodes can be added easily without affecting rest of the network. Similarly, components can also be removed easily.

6. STRUCTURE OF WSNNODE

The WSN sensor nodes also known as Mote, WSN network capable of performing gathering sensory information, processing and communication with other connected nodes in the network. **Figure-2** shows that block diagram of WSN sensor mote comprises of light sensor, microcontroller, and RF transceiver (XBee). For power supply management is including the battery or energy harvesting system. The sensor changes resistance because of light and generates analog signals through signal conditioning system. Then ADC (Analog to Digital Converter) converts the signals. Microcontroller executes series of program to process the data. All the received data will be stored in the microcontroller memory and transmit through and integrated RF transceiver. Sensor nodes are deployed to monitor a multitude of natural and manmade phenomena.

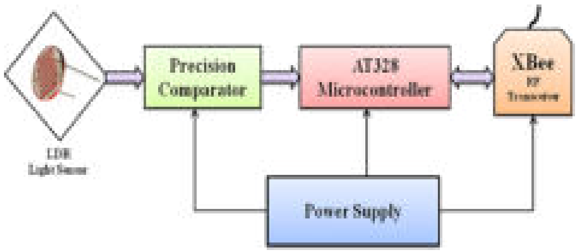
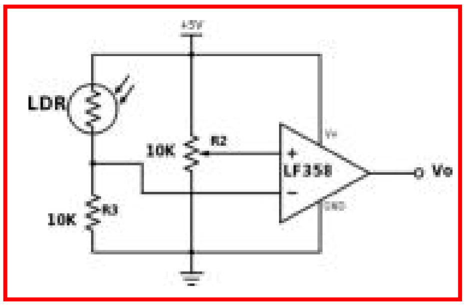


Figure-2. Block diagram of WSN Mote.

7. CIRCUIT DIAGRAM AND WORKING

The light intensity circuit is enormously useful and versatile in a wide range of renewable energy projects. In this circuit diagram LDR (Light Dependent Resistor) is used to monitor ambient level so flight. The above **Figure-3** shows schematic diagram of light sensor circuit using LF358 op amp. It is precision comparator, its output level is precisely change depends on change of intensity. The output of comparator is applied to microcontroller ADC then it is converted in to digital and sends the resultant values serially by XBee. The schematic diagram is and microcontroller circuit designed layout in Eagle PCB designing tool as shown in **Figure-1**.



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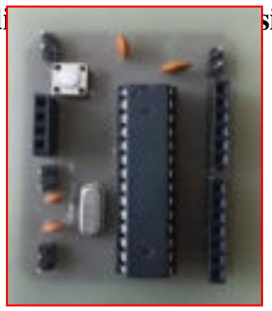

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Figure-4. Precision comparator circuit and microcontroller development board.

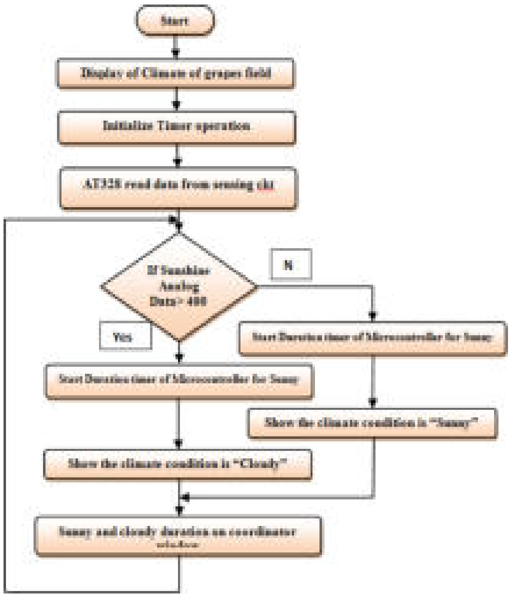

Figure-5. Program flowchart of WSN mote.

The programming logic or flowchart of WSN sensor node as shown in **Figure-5.** This program logic shows that working of WSN sensor node, to read the data from precision comparator circuit and ADC of microcontroller convert in to digital. This digital data is the converted in to analog and serially it is sent to XBee. Another end Coordinator window shows its conditions of environment and sunny climate duration based on our programming logic. Real time deployment of system on field at different places is shown in **Figure-1a-c**.

a b c

Figure-6. Sensor nodes on field at different place.

8. RESULT AND CONCLUSION

The real time sunshine condition of field is shown on coordinator window. On XTU coordinator XBee shows two climatic conditions of fields such as Sunny and Cloudy. It also shows that sunshine duration of partially cloudy and sunny environment of grapes plot as shown in **Figure-7.**

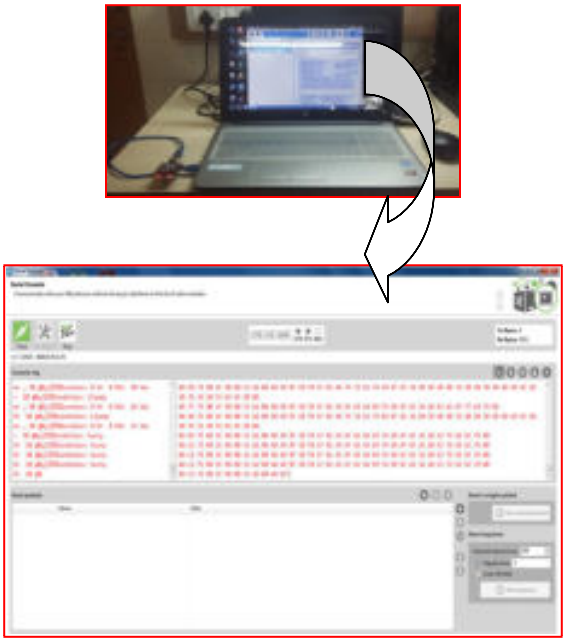

Figure-7. Coordinator window.

Table-1.SUNSHINE DURATION FROM WSN SENSOR NO DES DATED 18.8.2016.

Time	SensorNode1		SensorNode2		SensorNode3		SensorNode4	
	Conditon	**Time Duration**	**Condition**	**Time Duration**	**Condition**	**Time Duration**	**Condition**	**Time Duration**
8:00 am	Partially Cloudy	20 sec	Partially Cloudy	20 sec	Partially Cloudy	35 sec	Partially Cloudy	20 sec
9:00	Partially	1 Hr	Partially	1 Hr	Partially	1 Hr	Partially	1 Hr

am	Cloudy	20 sec	Cloudy	20 sec	Cloudy	35 sec	Cloudy	20 sec
10:00 am	Partially Cloudy	2 Hr 20 sec	Partially Cloudy	2 Hr 20 sec	Partially Cloudy	2 Hr 35 sec	Partially Cloudy	2 Hr 20 sec
11:00 am	Partially Cloudy	3 Hr 20 sec	Partially Cloudy	3 Hr 20 sec	Partially Cloudy	3 Hr 35 sec	Partially Cloudy	3 Hr 20 sec
4:00 pm	Partially Sunny	02 sec	Partially Sunny	02 sec	Partially Sunny	02 sec	Partially Sunny	02 sec
5:00 pm	Partially Sunny	1 Hr 02 sec	Partially Cloudy	1 Hr 02 sec	Partially Cloudy	1 Hr 02 sec	Partially Cloudy	1 Hr 02 sec

Table-1 shows the realtime sensor nodes data. The above system is applicable all kinds of crop those are eco-sensitive. We can apply doses and drugs to crops based on current situation of climate. And based on duration we can save our crop from sunny conditions. It is also helpful to increase the productivity and maintain the quality of grapes. The said system can build up within Indian currency Rs. 2000/node.

ACKNOWLEDGEMENT

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Performance Improvement of Self-referenced Fiber Optic Displacement Sensor using Multilayer Configuration

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ABSTRACT
A multilayer configuration based self-referenced fiber optic displacement sensor (SFODS) is reported for the simultaneous improvement of linear displacement range and sensitivity. Simulation and experimental studies of multilayer configuration based SFODS have been conducted. An analytical model based on the Gaussian beam approach is used for the simulation study. In comparison to linear array based SFODS, the multilayer configuration based SFODS gave 2.36 times more sensitivity without degrading the improvement in the linear displacement range.

KEYWORDS
Optical fiber, Displacement sensor, Linear array, Multilayer, Simple ratio, Weighted ratio.

…………………………………………………………………………………………

1. INTRODUCTION

Fiber optic sensors based on light intensity modulation are simple in structure, non-contact type, immune to EMI and inexpensive. The measurement of various physical and chemical parameters like displacement, strain, pressure, temperature, refractive index, etc. is possible with the use of fiber optic sensors [1-5]. Fiber optic displacement sensors (FODS) can measure position, surface roughness, thickness, vibrations, etc. FODS having a large linear displacement range and sensitivity is required for the measurement of various parameters. Therefore, researchers have been reporting various configurations of FODS for the improvement of linear displacement range and sensitivity [5-13]. A linear array based self-referenced fiber optic displacement sensor (SFODS) offered a significant improvement in linear displacement range as compared to other reported configurations of FODS. But the further improvement in sensitivity is limited due to their linear array configuration [13].

In this paper, a multilayer configuration based SFODS is proposed for the simultaneous improvement of linear displacement range and sensitivity. The proposed sensor consists of three layers, i.e., layer 1, layer 2 and layer 3. The effect of the addition of receiving fibers in layer 3 on sensor performance is being studied.

2. ANALYTICAL MODELLING

The multilayer configuration based SFODS is shown in **Figure-1**. This sensor consists of a transmitting fiber and two receiver groups.

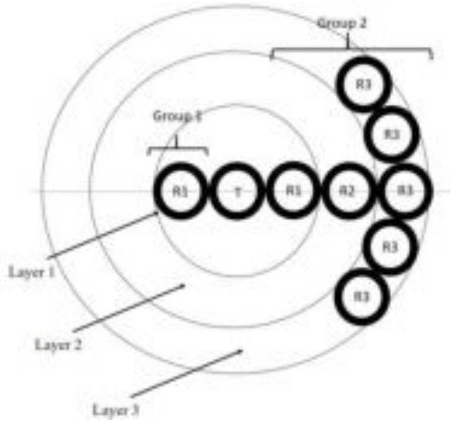

Figure-1. Multilayer configuration based SFODS.

The first receiver group has only one receiving fiber, i.e., in layer 1. The second receiver group has multiple receiving fibers and these receiving fibers are placed in layers 1, 2, and 3. The output of the second receiver group is taken as a summation of the outputs of all the receiving fibers present in the second receiver group. According to the Gaussian beam approach [7], the light intensity emitted from the transmitting fiber depends on the emitted power, P_E, the radial coordinate, *r*, the longitudinal coordinate from the light origin, *z*, and the beam waist radius, *w(z)*.

$$I(r,z) = \frac{2P_E}{\pi w^2(z)} exp\left(\frac{2r^2}{w^2(z)}\right)$$

The received power is evaluated by integrating the intensity of light (*I*) over the fiber end surface area (S_a).

$$P(z) = \int_{S_a} I(r,z) dS_a$$

The ratio of outputs from the second receiver group to the first receiver group is the output of multilayer configuration based SFODS. The sensor output, i.e., the ratio function (R), is given by

$$R = \frac{G_2}{G_1} = \frac{\sum_{i=1}^{n} P_{Ri}(z)}{P_{R1}(z)}$$

3. SIMULATIONS AND EXPERIMENTATIONS

The plastic optical fibers having a core diameter/outer diameter of 1 mm/2 mm and a numerical aperture of 0.34 are used to form a multilayer configuration of SFODS. These optical fibers are used for the transmission and reception of light. The simulations of multilayer configuration based SFODS are carried out using the MATLAB tool. The simulation study showed that the performance improvement of SFODS is possible with the use of the addition of optical fibers in layer 3. The experimental study of the multilayer configuration based SFODS was carried out to validate the simulation results. The fiber optic probe, i.e., the multilayer configuration of SFODS, is fixed at one end of the micro-scale arrangement. A flat mirror reflector is attached to the movable part of the micro-scale arrangement. The resolution of the micro-scale arrangement is 0.1 micrometers.

A light emitting diode (LED) is used as a light source. The intensity of the LED is kept constant by driving it using a constant current source. An optical fiber is coupled to an LED for the transmission of light. Multiple optical fibers are used for the reception of light. These optical fibers are termed as receiving fibers. These receiving fibers are coupled to the phototransistors for the conversion of the received optical signal into an electrical signal. The LED driver and phototransistor circuit operate on a +5V power supply. The output of the phototransistor circuit is available between 0 and 5 volts. A data acquisition system based on an 8-bit Atmel ATmega2560 microcontroller has been developed. The developed data acquisition system acquires a voltage signal from the phototransistor circuit for each step of displacement. The ATmega2560 microcontroller has 10 bits of analog-to-digital converter (ADC). The voltage received from the phototransistor circuit is mapped into integer values between 0 and 1023 in 100 microseconds. For each step of displacement, the receiver outputs from layer 1, layer 2, and layer 3 are added for the second receiver group. Then the sensor output is taken as a ratio of the output of the second receiver group to the first receiver group. The sensor outputs are sent to a serial port on the computer. The data on a serial port is transferred to Microsoft Excel for post-processing. The experiments were carried out for varying displacements from 0 mm to 20 mm.

4. RESULTS AND DISCUSSION

Simulated and experimental responses of receiving fibers present in layer 1, layer 2 and layer 3 of multilayer configuration based SFODS are shown in **Figure-2**. The receiver response is a function of the distance between the fiber optic probe and the reflector.

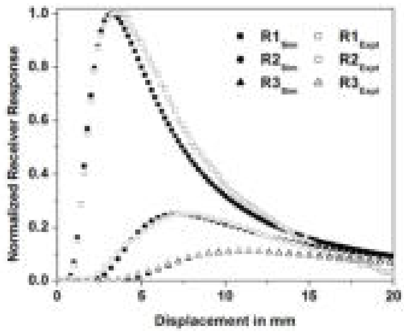

Figure-2. Normalized response of individual receiving fiber.

The simple ratio output of the multilayer configuration based SFODS is shown in **Figure-3**. In this configuration, one receiving fiber is placed in each of layers 1, 2, and 3. This sensor configuration is known as linear array based SFODS. The output of the second receiver group is taken by the sum of the outputs of all the receiving fibers present in the second receiver group. The output of SFODS has been taken as a ratio of the output of the second receiver group to the first receiver group. As the number of receiving fibers in the second receiver group increases, the output of the sensor also increases. A receiving fiber placed in layer 1 of the first receiver group is for self-referencing purposes. The light intensity received by receiving fiber present in layer 1 is greater as compared to receiving fibers present in layer 2. Similarly, the light intensity received from receiving fibers present in layer 2 is greater as compared to receiving fibers present in layer 3. In a sensor output, the contributions of receiving fibers close to transmitting fiber are greater as compared to those receiving fibers which are far from transmitting fiber. Therefore, this linear array based SFODS provides a significant improvement in linear displacement range, but the improvement in sensitivity is limited.

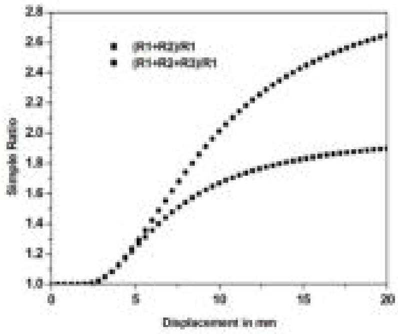

Figure-3. Simple Ratio of SFODS.

The response of the weighted ratio of the multilayer configuration of SFODS is shown in **Figure-4**. This configuration includes one receiving fiber in layers 1 and 2, and multiple receiving fibers in layer 3 of the second receiver group.

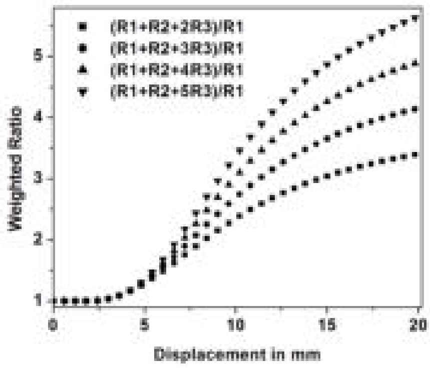

Figure-4. Weighted Ratio of SFODS.

The analysis of multilayer configuration based SFODS is shown in **Table-1**. The contribution of layer 3 to the output of the second receiver group is increased by adding several receiving fibers in layer 3. As the number of receiving fibers in layer 3 increases, the linear displacement range and sensitivity of the sensor are increased. But if the number of receiving fibers in layer 3 increases beyond a certain number, i.e., 4, then the contribution of layer 3 in the output of the second receiver group becomes greater as compared to layer 2. It helps to increase sensitivity, but the linear displacement range decreases.

Table-1: Analysis of SFODS.

Ratio output	Linear displacement range (mm)	Sensitivity (mm^{-1})
(R1+R2)/R1	3.7	0.10
(R1+R2+R3)/R1	5.8	0.14
(R1+R2+2R3)/R1	6	0.20
(R1+R2+3R3)/R1	6	0.27
(R1+R2+4R3)/R1	6.1	0.33
(R1+R2+5R3)/R1	6	0.4

The weighted ratio of multilayer configuration based SFODS having an output (R1+R2+4R3)/R1 gave the best results in terms of linear displacement range and sensitivity. Both the linear displacement range and the sensitivity are increased with this sensor configuration. Sensitivity is seen to be increased 2.36 times and the linear displacement range is 1.05 times as compared to a simple ratio of multilayer configuration based SFODS, i.e., linear array based SFODS. In this self-referenced FODS, the sensor output is only a function of the distance between sensor probe and reflector. The sensor output is insensitive to the variation of source light intensity and reflectivity of the reflector. The self-referencing is also used to increase the linear displacement range and the sensitivity of FODS.

5. CONCLUSION

Simulations and experiments are carried out for the simple ratio and the weighted ratio of multilayer configuration based SFODS. The effect of introducing several receiving fibers into a second receiver group, i.e., layer 3, of a multilayer configuration based SFODS is investigated. The sensor output, taken as (R1+R2+4R3)/R1, helped to increase both the linear displacement range and sensitivity.

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Design and Implementation of Low-Cost Smart Home Automation System using CC3200

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ABSTRACT

The last decade has witnessed the buzz created by Internet of Things (IoT) in the domestic products. IoT has been increasingly deployed to sense and control the devices remotely using the ubiquitously spread internet. Present paper reports IoT based system to control and monitor home appliances leading to a holistic home automation setup. The striking features of the said setup are energy efficiency, ease of operation and single board assembly leading to robustness and increased reliability. The reported system senses the operational status of the home appliances and measures the physical parameters through the sensors and sends the same to the cloud based on Ubidots server. It was built around the TI's CC3200-LAUNCHXL SimpleLink Wi-Fi CC3200 LaunchPad. The smartness of the system is attributed to the programmability of the CC3200 chipset centers around ARM cortex-M4 applications Microcontroller, Wi-Fi certified chip and Power-Management Subsystems.

KEYWORDS

Internet of things, Home automation, Smart home, Ubidots cloud.

…………………………………………………………………………………………

1. INTRODDUCTION

The past decade has seen the rapid developments in the field of IoT with dramatic increase in niche applications such as security systems, disaster monitoring, remote electrical metering, smart cities, connected health, connected cars, smart retail, smart farming and supply chain management [1-5]. Amongst all the smart IoT application domains, smart homes clearly stands out as the most popular area wherein significant investment is bring done and is also pursued by corporate sector and good number of startups. IoT and its recent derivatives such as Industrial IoT (IIoT), Artificial Internet of Things (AIoT), Subsea Internet of Things (SIoT) have paved way towards many interesting possibilities with the synergy and advances in networking technologies, embedded systems, Big Data, Artificial Intelligence and Social Networking. A considerable amount of literature has been published on IoT with special reference to its application in home automation which is the focal point of the present paper. Most of the literature refers inculcation of IoT in home automation as smart home or intelligent home. Marijon Pano [6-9] put forth the issue of power consumption as the home appliances in standby mode consumes 8% power of total consumption. Risteska Stojkoska and

Trivodaliev [9] discuss the other challenges such as reliability, ease of operation and so on which are addressed in the present development. The notion of the smartness comes from the intended automation and control with insight gained through the intelligence gained through soft computing techniques such as Artificial Intelligence, Deep Learning and Convolutional Neural Networks with the devices gathering information and sharing it amongst the other devices popularly termed as M2M communication. The other concerns of storage, preprocessing and filtering issues are being addressed in the reported system by resorting to cloud servers. The other prominent features of the system are its increased reliability owing to single board setup and ease of operation for the elderly people.

Having introduced the theme, the paper will now move on to discuss the other sections viz. prior art, system architecture, results and conclusion.

2. LITERATURE REVIEW

International Data Corporation (IDC) in their seminal report [1] concluded that the worldwide IoT market will boost up to 1.7 trillion in 2020 up from 655.8 billion USD in 2014 with a compound annual growth rate of 16.9%. The devices alone are ex-pected to contribute 31.8% of the total worldwide IoT market in 2020 [1]. In their thorough study Mehmood et.al. reported recent trends and advancements in IoT enabled smart cities paradigm. The taxonomy devised therein resorts to communication protocols, major service providers, network types, standard bodies and major service requirements for the understanding of the fellow researchers. They conclude that smart city applications relying on several wireless technologies such as IEEE 802.11p, WAVE, SIGFOX, 6LoWPAN and LTE/LTE-A [2]. Mohamed Moubarak in his impressive investigation reports an approach for smart home automation using Internet of Things (IoT) integration with computer vision, web services and cross-platform mobile services [3]. This approach focuses on: sending data and receiving instructions by sensors, cameras and servo motors, to and from the end user, through embedding intelligence to the mentioned gadgets using Raspberry Pi tiny computer; assisting interaction of end users and home devices through cross-platform mobile application developed using Ionic Framework; connecting the two client sides, the end user and devices, through publish/subscribe model using PubNub Data Stream Network; data representation and exchange efficiently using JSON data format. Riaz et.al. established a economically made home automation system from low-cost easily available components and used it to control various home appliances ranging from the security lamps, the television to the air conditioning system and even the entire house lighting system [4]. Finally, their study reveals the possible implementation using Bluetooth, Infrared and WAP connectivity without much alteration in the design and yet handling the diversified home appliances. Raji [5] reports implementation of a low cost android based home automation system with control facilitated by Android phone. The concerns expressed in the literature such as power consumption, reliability and ease of operation have been handled in the present design.

3. PROPOSED SYSTEM ARCHITECTURE:

The proposed system was built around cc3200 embedded board as shown in **Figure-1**. The heart of the system is CC3200 microcontroller. The firmware developed for the said system works on the standalone boards to which the sensor hub and relay switch board is connected. The system works on manual as well as semiautomatic mode. In manual mode the user has to turn the devices on and OFF using an exclusive designed mobile App and web-based interface. While in automatic mode the system takes its own decision based on the sensor inputs. In the automatic mode the system is configured to perform the following operations.

- Automatic Light on/Off according to the motion sensor, and light intensity sensor.
- Automatic Fan on/Off according to temperature sensor
- Alarm settings for SMOKE, fire detections

CC3200 consist of 27 Individually Programmable, Multiplexed GPIOs, 4-Channel 12-Bit Analog-to-Digital Converters. The electrical appliances are controlled using a switch board comprises of relay and relay driver. The different sensors like temperature, humidity, gas sensor have been interfaced to cc3200 using the ADCs available on microcontroller board. The energia is used for software development of the proposed system. Energia is an open-source platform available freely and used for Texas Instruments MCU [7]. The Ubidots cloud server [8] is used to control and monitor the device status and different physical parameters in the home viz- temperature, gas, etc.

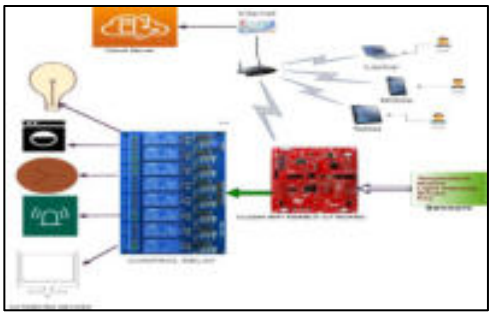

Figure-1. Proposed Architecture for Smart home automation system using IoT.

In the automatic mode of operation PIR sensor detect any manual activity at the door of the room and accordingly lights the room. On the similar lines, temperature sensor sense the temperature of room and accordingly turns FAN ON or OFF to maintain the temperature. The light intensity sensor automatically adjusts the brightness of the lamp using Pulse Width Modulation (PWM) technique. Smoke and fire sensor detect smoke or flame inside the room and automatically energizes the alarm as well as sends the alert through registered email through cloud database.

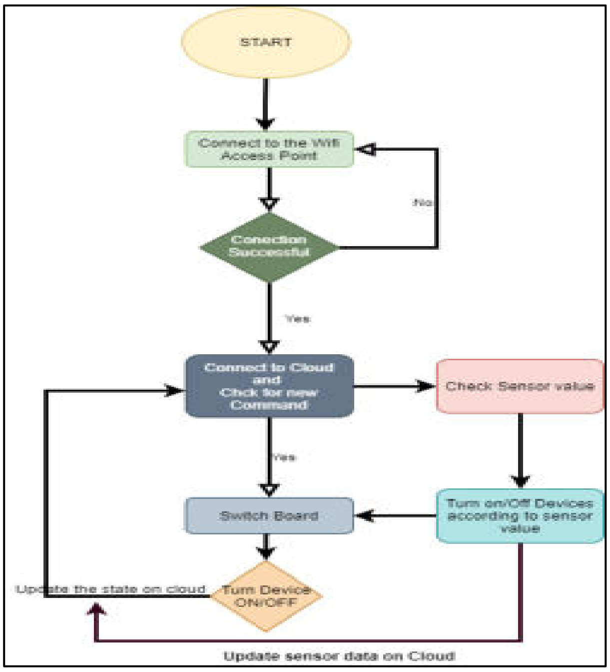

Figure-2. Software algorithm for home automation.

Figure-2 shows the software flow diagram of home automation system. The smart switchboard consists of a relay driver and a relays which controls through the AC mains of the appliances and hence the energy consumption in standby mode is set to minimum.

4. RESULTS

The reported system controls the devices using the ubidots App of web browser-based framework. The Screen Shot of the Dashboard used to control and display the difference sensor values are given in **Figure-3**. The actual values transmitted by using dashboard and received at the client level at CC3200 boards are shown in **Figure-4**. This evidences successful controlling of the devices using IoT platform. **Figure-5** shows actual system prototype controlling the devices using Ubidots based dashboard on a smartphone.

Figure-3. A control dashboard for a remote user using cloud server to control and monitor home Appliances.

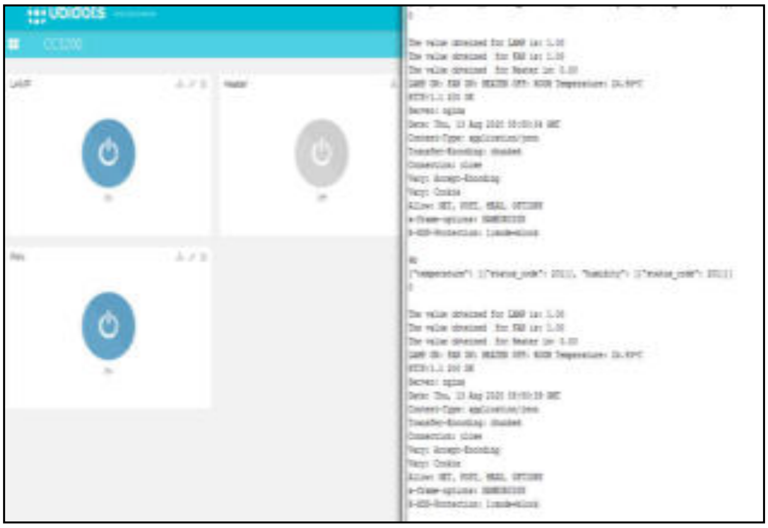

Figure-4. The values received at the client displayed on serial terminal to control the devices.

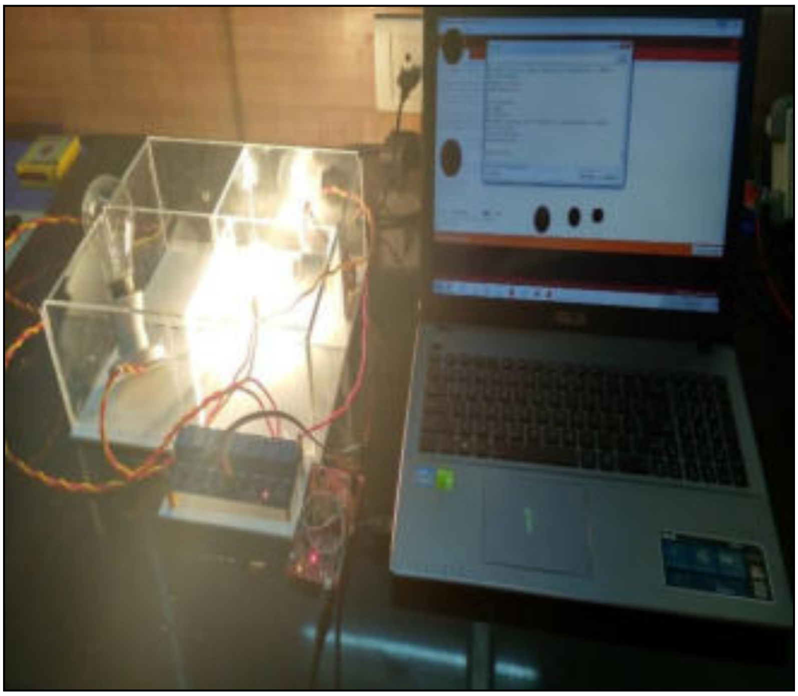

Figure-5. prototype of the IoT based Home Automation system.

5. CONCLUSION:

The paper reports successful design and development of the home automationsystem using IoT configured through the CC3200 MCU. The system has been deployed in a typical home and found to work satisfactorily for controlling appliances connected to it remotely through internet. The user interface isintuitive and eases the operation even for the senior citizens besides saving electricity, time and money.

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Use of Machine Learning for Soil Analysis: A Scoping Review

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ABSTRACT

This paper provides an overview of methods for analyzing, and evaluating soil properties from digital images of soil samples using digital image processing techniques. Researchers and businesses around the world are developing proximal soil analysis techniques to more precisely estimate agriculturally suitable soil qualities. An automated monitoring system will help to farm. This review was developed to review the currently available soil analysis techniques that may be integrated for use in the handling of Indian grain-growing soil, and evaluate the feasibility of conducting research, development, and commercialization on sensors, that are likely to benefit Indian grain growers. Farmers can benefit from accurate geographical and temporal information on soil characteristics. Water, SOM, nutrients, pH, organic carbon, bulk density, texture, salinity, and moisture are the soil characteristics of greatest interest. Each of these characteristics varies spatially between sites and with depth, as well as seasonally or annually. It takes a lot of time and effort to analyse the pH, EC, soil texture, particle size, and colour of agricultural soil samples using traditional laboratory techniques. Inclusive Proximal soil sensing systems with powerful data analytics can be used to measure chemical, physical, and biological soil properties that have an impact on crop production more accurately and efficiently than traditional laboratory analysis. Sensors can measure quickly and may be less expensive to buy and use than traditional laboratory techniques. The data will effectively characterize the spatial and temporal variability of soil properties because many more measurements can be quickly and inexpensively made with sensors across farms, at depth, and over time. In this rapidly changing era, digital image processing is playing an increasingly important role in finding smart solutions to many problems of soil analysis. The data gathered from the images of soil is used to analyze and illustrate the potential of image processing in the field of digitalizing agriculture. The deep Convolutional neural method could effectively replace expensive and time-consuming laboratory methods by rapidly and precisely predicting the type of soil characteristics on large-scale farms.

KEYWORDS

CNN, Deep learning, Image processing, Proximal soil analysis, Soiltexture, SOM.

1. INTRODUCTION

In order to address the difficulties associated with agricultural production in terms of productivity, environmental impact, food security, and sustainability, smart farming is crucial [1,2]. Given that the world's population has been steadily growing [3], there needs to be a significant increase in food production [4], while simultaneously maintaining availability and high nutritional quality everywhere and safeguarding the natural ecosystems by using sustainable farming practices.

It is necessary to continuously monitor, measure, and analyze various physical aspects and phenomena in order to better understand the complex, multivariate, and unpredictable agricultural ecosystems in order to address these challenges [5].This calls for the analysis of large-scale agricultural data , as well as the use of new information and communication technologies [6], enhancing the management and decision-making processes currently in place through context, situation, and location awareness. Remote sensing, carried out by satellites, aircraft, and unmanned aerial vehicles, or drones, enables larger-scale observation and provides wide-view snapshots of the agricultural environments [7]. Being a well-known, non-destructive method to gather information about Earth's features and the ability to get data automatically over vast geographic areas give it several advantages when used in agriculture.

Images make up a sizable portion of the amount of data gathered by remote sensing. Images often provide a complete picture of the agricultural environments and can help with a number of problems [8,9]. As a result, digital image analysis is a crucial area for research in the agriculture field, and intellectual data processing methods are employed in a wide range of agriculture uses for image recognition, object tracking, etc. Machine learning (ML), artificial neural networks (ANN), wavelet-based filtering, linear polarization, and regression analysis are the most widely used methods for image analysis [10-12].

The extraction of soil sample-specific image features and image classification nowadays are simple tasks thanks to advances in digital image processing, machine vision, and deep learning (DL). Today, a wide range of technologies, including web browsing, image extraction for image classification, face recognition with cameras and smart mobile devices, as well as object tracking in images, use machine learning and computer systems more and more. The achievement of these techniques has recently times improved through the use of DL algorithms [13-15]. They have been able to solve pattern recognition problems and perform high-performance classifications thanks to their aptitude for learning complex problems [16].

Currently, two artificial intelligence techniques are used to classify soil based on deep-layer outputs. The first technique employs image processing techniques, which involve the steps of image preparation, image segmentation, feature extraction (shape, color, and texture), sampling of common and significant features, and characterization of soil sample images according to the extracted features.

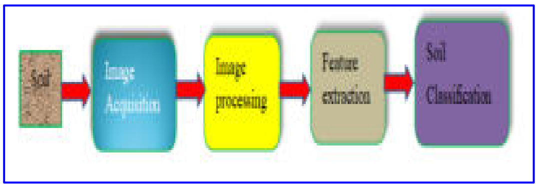

Figure-1. Steps of Image Processing techniques for Soil analysis.

Figure-2. **Steps of Deep Learning for Soil analysis.**

In contrast to the conventional methodology for image processing, DL methods combine image extraction and feature classification concurrently, reducing the time and volume of processing operations on the input images. **Figure-1** and **Figure-2.** Summarized the Image processing technique and Deep learning methods. It shows the steps for soil analysis method using both technique.The reason for conducting this survey is that the Digital image processing technique in agriculture is a relatively new, cutting-edge, and promising technique that is gaining recognition while developments and applications of Digital image processing in other fields suggest that it has significant potential.

2. LITERATURE REVIEW

Considering that soil offers a favorable environment for plant growth, seedling, and biomass production, it is one of the primary sources of agricultural production. Thus, accurate identification and investigation into this natural organic characteristic are necessary for its proper management [17,18].For the best planning and long-term use of farmlands, soil sample is required[19].

For the prediction and classification of soil images, soil texture and colour are already well-established parameters. New methods for analysing particle size using gamma radiation [20], X-ray [21], laser [22], and infrared spectroscopy [23] have been reported in the literature as a result of the development of advanced technologies.

Computational models with multiple processing layers can learn representations of data at various levels of abstraction thanks to deep learning. The state-of-the-art in many other fields, including drug discovery and genomics, object detection, visual object recognition, and speech recognition has been significantly improved by these techniques [24].

For boosting agricultural output, the classification of soils based on the nutrients found in the soil as well as its physical characteristics, such as pH, organic carbon, and electric conductivity, is very helpful. The four algorithms—NB, K-NN, DT, and RF—and consider and compare. The K-NN classification algorithm performs better than the other four, correctly classifying all of the instances. KNN is a potential suggestion for predicting soil features. Additionally, earlier research was connected to the conclusions proposed for soil classification [25].

To deal with the large amount of data, many data analysis techniques have been created, including KNN, ANN, SVM, LDA, PSO, Fuzzy, QDA, and EDT [26-32]. Since DL is a powerful machine learning algorithm, it has been extensively researched and is now gaining interest from a variety of industries, including speech recognition, remote sensing, precise agriculture, medical science, robotics, and health care.One of the most widely used DL algorithms has been CNN [33].In the majority of the articles surveyed, CNN and its highly speculative algorithms have been acknowledged as the key techniques that can recognize patterns and deep feature information of input digital data resulting in classification or regression tasks. CNN is able to process the enormous amount of information that the tools for assessing soil texture have collected [34].

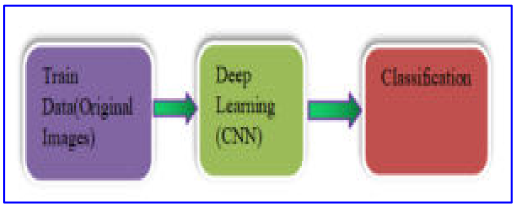

Figure-3. The algorithmic phenomenon of using deep learning for soil classification.

The CNN algorithm receives an input image and identifies the classification of Soil. In the researcher's study, the soil aggregates obtained from plowing were classified using a deep convolution neural network with several different architectures (Inception-v4, VggNet16, and ResNet50).

The researcher has made a machine vision system and an enhanced CNN algorithm to predict soil samples based on images of their texture. The goal was to develop a deep-learning, learning model to classify images of soil texture and classification of soil aggregate sizes using images taken at different heights. The complexity of traditional methods was eliminated by using the suggested CNN model. The two separate convolution and classifier blocks made up the proposed model. The classifier block was comprised of an SVM classifier, two fully connected layers, a flattened layer, and a max-pooling layer. With an overall accuracy of 99.89% and its best performance for soil images captured at a height of 20 cm, the CNN model has a lot of potential for predicting soil texture [35,36].

The result showed that the mentioned CNN model, which is based on gated pooling, has a 99.36% accuracy rate for categorizing turmeric images for judging turmeric powder's quality and spot fraud.CNN and image processing are quick and reliable methods for spotting spice fraud [37].

One of the research survey pretending that, a grapes recognition system that accurately classifies bunches of red and white grapes in colour images taken in natural settings with 97% and 91% correct classification rates, respectively. As built-in image processing methods, the system makes use of colour mapping, morphological dilation, stem and black areas detection. Terasawa et al. observations focus on how well imaging systems are able to track plant growth [38].

Citrus fruits were separated using image information gathered from a study by Li et al. Using color image segmentation. Although the techniques were successful, white noise in the image data could not be eliminated [39].

In this work the pictures were taken with a high-resolution cell phone camera. Utilizing image processing methods, the captured image is transformed. The predicted results on soil properties are displayed after a comparison between the processed soil image data and the readily accessible laboratory analysed standard data. Can learn more about the soil and be better equipped to decide in the shortest amount of time. Thus, the proposed system's capacity for quick and affordable SOM and moisture analysis is amply demonstrated [40,41].In this study tested analysis confirmed that portable mid-IR and dual-type vis-NIR spectrophotometers were both comparably useful to predict soil texture[42-44].

3. SUMMARY AND DISCUSSION

The literature on machine learning and deep learning applications in agriculture has been thoroughly reviewed in this paper. Various cutting-edge machine learning and deep learning models were examined for various agricultural processes. Deep learning technology is continuously developing. This study demonstrates how widely CNN is used in agriculture and the outstanding results it produces. The learning capacity and accuracy of the CNN are significantly increased by taking advantage of depth, additional structure, and hardware support. The creation of data sets, the length of time needed for testing and training, hardware support, the deployment of large models on mobile devices like Android phones.

This paper outlined the basic principles of the image processing methods, for evaluating soil moisture detecting, evaluating, and classifying soil analysis techniques from digital images of soil using digital image processing techniques,and provides a brief state of the available information retrieval, especially segmentation, revealed that these methods can help agricultural investigators.

4. CONCLUSION

The deep learning approach, a branch of machine learning, is becoming more and more prominent. It uses neural networks to enhance computer vision, automatic speech recognition, and natural language processing applications, according to Bengio [45]. The most common applications for the machine learning technique include crop identification, disease detection, image segmentation/clustering, cloud detection, practise classification, remote sensing, nutrient deficiency detection, and environment classification.

There is an acute need for soil texture prediction in order to manage and utilize agricultural lands sustainable. The current methods involve a number of steps that are extremely expensive, time-consuming, tedious, bad for the environment, and demand specialized operators. As a result, the current study was carried out to forecast different soil textures. This study was carried out in stages, including the creation of the imaging box, sampling, referencing in the lab, imaging of sample data, designing the suggested CNN model, and creating the graphical user interface. The complexity of traditional methods was eliminated by using the proposed CNN model. These deep networks performed exceptionally well in the classification of aggregates, with overall accuracy of 95.83%, 97.12%, and 98.72%, respectively. This study offers a very precise method for categorize aggregate size classes.

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Camonea umbellata (Convolvulaceae) - A New Record for Indian Mainland

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ABSTRACT

Camonea umbellata (Convolvulaceae) previously known as *Merremia umbellata* ssp. umbellata which is occurs in America from Mexico to Paraguay in the West Indies and tropical East Africa. In India it was previously reported from Andaman Islands. The species is distinct from other species of the genus in having more robust habit, larger leaves, longer peduncle, larger flowers and number is also more, corolla always yellow and capsule is subglobose instead of ovoid to conical with seeds villous and slightly longer hairs only at margin.

KEYWORDS

Camonea umbellata, Convolvulaceae, Indian mainland, Maharashtra, New Record.

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1. INTRODUCTION

On the basis of morphological characters and molecular evidences recently Simose and Staples [1] have raised a new genus *Camonea* Raf. From *Merremia* Dennst. The newly formed genus is characterized by having simple or angular leaves, with a pair of auricles at the base of petiole; corolla with a tuft of hairs at the apex of the mid-petaline bands; anthers longitudinally dehiscing, pollens hexazonocolpate and fruit a chartaceous four-valved capsule. Hallier and Ooststroom [7] pointed out two distinct populations of the genus *Merremia*. A population from tropical America was recorded as *M. umbellata* subsp. umbellata which have yellow flowers. While the population from tropical East Africa, India, Ceylon, China and Malaysia that have white flowers that belong to *M. umbellata* subsp. orientalis (Hal. f.) Ooststr.

The present study pointed out the fact that in the main land of India, only the white flowered population (subsp. *orientalis*) could be observed. But certain populations in Andaman Islands with yellow flowers, subglobose fruits and pubescent seeds could also be observed. Recently Simose & Staple [9] raised the var. *occidentalis* at species level as *Camonea umbellata* (L.) Simose & Staple and var. *orientalis* raised at the species level as a *Camonea pilosa* (Houttuyn) Simose & Staple. According to Biju [3] in the mainland of India only white flowered populations i.e., *Camonea pilosa* is recorded. At present the genus *Camonea* is represented by five species in the world and distributed in tropical Asia and tropical America and Africa [9] while in India it is represented by three species viz., *C. kingii* (Prain) Simose & Staples; *C. pilosa* (Houttuyn) Simose & Staples and *C. umbellata* (L.) Simose & Staples is present in Andaman Island only.

While revising the tribe Merremieae for India, few specimens of genus *Camonea* were collected from Bhandara district of Maharashtra state, after critical studies and consultation of relevant literature [2-11]. In present communication it is reported first time for mainland of India from Bhandara district of Maharashtra state. The species is previously reported from Andaman and Nicobar Islands of India [6,8]. A detailed morphological description along with illustrations and photographs of the species are provided in the present communication for easy recognition of the species in field.

2. TAXONOMIC TREATMENT

Camonea umbellata (L.) A. R. Simose and Staples, Bot. J. Linn. Soc.183 (4):583. 2017. *Convolvulus umbellatus* L., Sp. Pl. 1:155. 1753. *Merremia umbellata* ssp. *umbellata* Ooststr., Fl. Males.1, 4:449, f 24, a-b. 1953**[Plate 1 A-E; Fig. 1]**

Plate 1. Camonea umbellata. A. Flowering twig; B. Single dissected flower; C. Immature fruit; D. Matured fruit; E. Seeds.

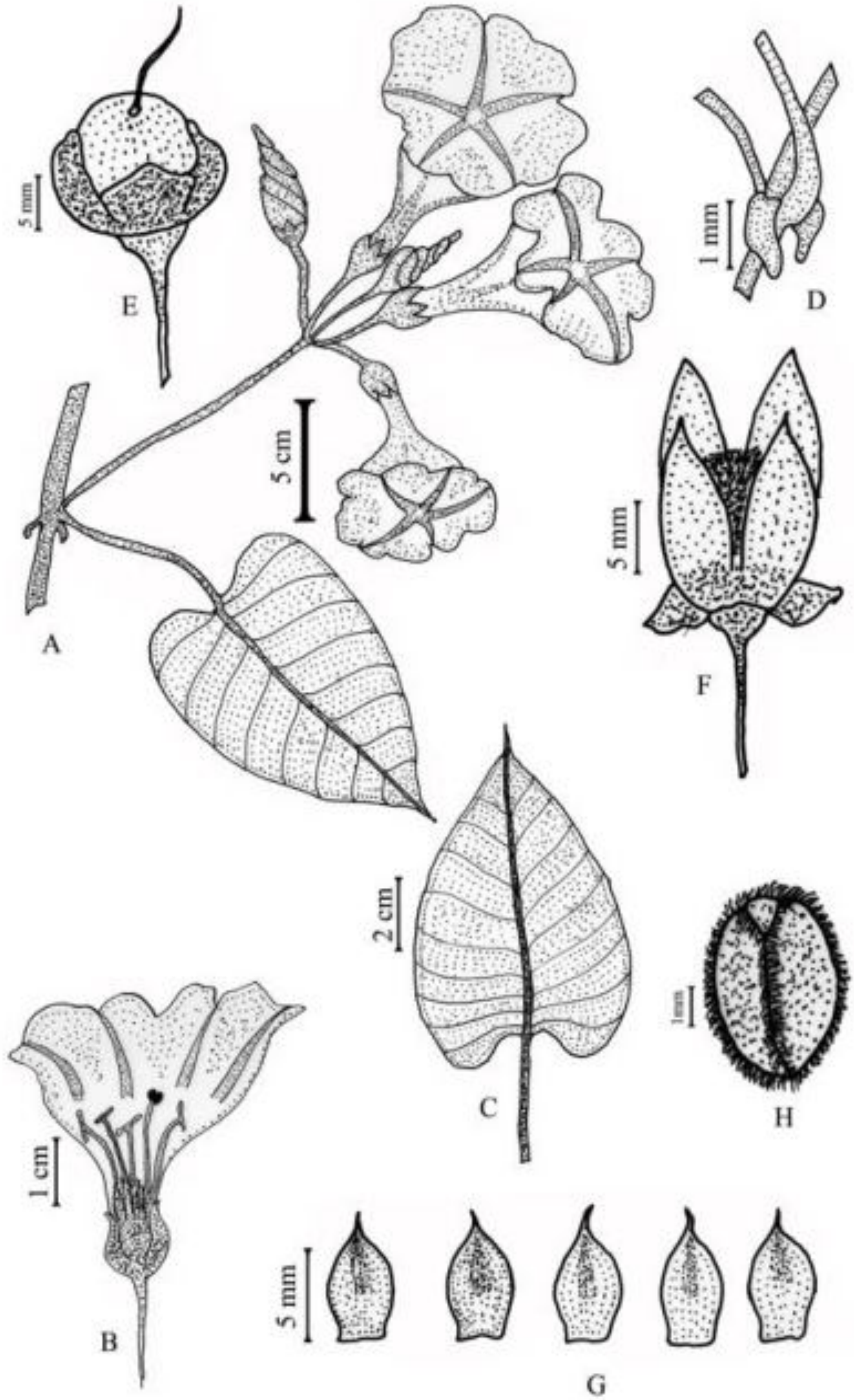

Figure-1. Camonea umbellata. A. Flowering twig; B. Single dissected flower; C. Single leaf; D. zoomed stem portion showing stipules; E. Immature fruit; F. Matured fruit; G. Sepals; H. Seed.

Perennial twiner; young stem herbaceous, older woody, slender with milky sap, 1 – 3 m in length; young stem terete or striate, softly pubescent to glabrescent. *Leaves* simple, variable in size, 4 – 8 x 3 – 6 cm, more or less cordate at the base, basal lobes rounded to angular, rarely hastate, acute at the apex, mucronulate, margin entire; abaxially sparsely to densely hairy; hairs soft whitish, hairy or glabrescent adaxially; lateral nerves 5 – 8 on either side of midrib; tertiary nerves many; petiole 6 – 8 cm, glabrous or pubescent, a pair of auricles present at base of petiole. *Peduncles* axillary, 10 – 12 cm in length, longer than petiole, cymes 8 – 10 flowered, umbelliform. *Pedicel* 1 – 1.5 cm in length; bracts minute1-2 mm, lanceolate, early caducous, *Sepals* 0.6 – 1 x 0.3 – 0.4 cm, strongly concave, sub–equal, orbicular, strongly mucronulate. *Corolla* funnel shaped, dark yellow, 3 – 4 cm long, *ca* 2.5 – 3 cm in breadth. *Stamens* 5, included, attached to the base corolla tube; anthers dehiscent longitudinal, pollen grains hexazonocolpate; filament hairy at the base. *Gynoecium* bicarpellary; stigma biglobose; style and ovary glabrous. *Capsule* sub-globose, *ca* 1.5 x 1.2cm in diameter, with ovate valves, brown colored at maturity. *Seeds* 4 per capsule, 0.5 – 0.6 x 0.3 – 0.4cm, trigonous, with pubescent to puberulous all over, margins with longer brownish hairs.

Flowering and Fruiting: December – February.

Specimen examined: INDIA, Maharashtra, Bhandara district, Pauni Tehsil, Ruyad village, 10.01.2020, *Sujit Patil* 15 (NCK – The New College Herbarium).

Habitat: Grows along roadsides especially at wet places.

Distribution: **In world**: Bangladesh, China, Sri Lanka, Nepal, Myanmar, Thailand, Malaysia, Cambodia, Vietnam, Singapore, Indonesia, Tropical Africa, Americas. **In India**: Indian Ocean Islands – Andaman & Nicobar and now from Mainland of India.

Note: During present investigation the species was collected from three populations and about 20 individuals were observed. The species is worth of cultivation as it possesses bright yellow attractive flowers.

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