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Image Processing To Transform Agricultural Scenario

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INTRODUCTION

Agricultural transformation through Image processing is a hotspot research field, with a lot of scope for advancements in coming years. There is no shortage of models and algorithms for image processing; however there is a shortage of effective, well-engineered implementations.

Every field across the globe has turned to be a beneficiary of technological advancements. It is high time for agricultural fields to reap the fruits. Specially designed low altitude Hexacopter aids the processing. Many applications are yet to be unearthed, but this paper deals with three crucial objectives namely Terrain analysis, Animal Intrusion Avoidance and Mango cutting. To analyze the terrain a new framework descending from region growing technique is employed along with thresholding. For the purpose of mango detection, HSV color detection algorithm, Edge detection and Stereo vision are combined, embedded with a robotic arm cutter to achieve the purpose. Animal intrusion avoidance can be attained through a hybrid version of region based approach and motion detection algorithm that can perfectly solve the riddle

AVAILABLE TECHNOLOGY AND SHORT-COMES

Terrain analysis

Terrain analysis falls under the category of image segmentation that defines disjoint regions of interest from a digital image. There are several techniques [1] to segment the image each with its own advantages and disadvantages. Thresholding [2] does not take into account the spatial characters of an image. This makes it sensitive to noise.

Clustering algorithms [3] do not require training data, but they might end up in ambiguity. Classifier methods are pattern recognition techniques to partition a feature space derived from the image using data with known labels. The edge-based methods [4] efficient in describing local behaviors, but not in producing results globally meaningful. Also their inefficiency can be attributed to the absence of rapid transition from one to the other region. The region splitting and merging category provides the possibility of incorporating a variety of regional features but often has difficulty in determining suitable merging and stopping criteria for a result that is neither over-segmented nor under-segmented.

Moreover rather than just relying upon the pixels of the image, we are equipped with the real time data and readings from the field. Utilizing those data, an intuitive solution combining image segmentation and thresholding thereby analyses the terrain.

Mango cutting

At the moment, mangoes are mainly hand-picked or plucked with a harvester. These methods are tiresome and involve human capital. Also mangoes can be harvested with mechanical vibrators, but they are power driven, inefficient and cause heavy loss of unripe fruits. During harvesting, the latex trickles down the fruit surface from the point of detachment imparting a shabby appearance to it upon storage. To avoid these problems a solution with a robotic arm attached hexacopter programmed using HSV color detection algorithm [5], Stereo vision [6], canny edge detection algorithm [4] with little modification can be employed to fulfil the purpose of safe and effective mango harvesting.

Animal intrusion Avoidance

Animal intrusion is troublesome in the fields where crops like sugarcane, maize, and banana are grown. The problem turns worse if these crops are situated near any agency or forest region. The loss levied by these animals is exceptionally high. To escape the loss in this regard many farmers opt for manual caring or electric fences which consume extra electricity and power cuts pose a great threat to this widely practiced solution. These practices even lead to terrible outcomes like loss of lives of both humans and rare wild animals. Also our aim is not to kill the animals but to only threaten them. To avoid these problems a solution with an effective alarm assisted hexacopter programmed using region-based Color Transfer Method [7], region based approach [10], Image differencing method and hill-climbing algorithm [12] is proposed.

PROPOSED TECHNIQUES AND MODIFICATIONS

Terrain analysis

The first objective laid before terrain analysis, is to capture the entire aerial image of the concerned field. Landscape mapping can be done once the hexacopter captures the images with a marker as a reference, which in our case can be a natural marker as cow-dung or some other part of captured

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image, so as to avoid redundancy and to ease joining the sequence of images. The images captured are joined, preserving the scale of the field. Parameters such as altitude of the copter from ground, the pace at which it moves and the time taken to navigate in between capturing account to the scale. Preserving the scale is important, as the copter needs to locate its position in the image with respect to field, in absence of GPS.

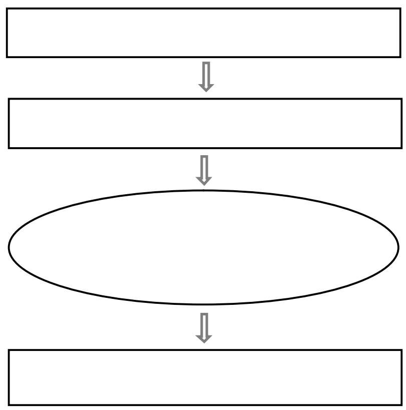

Fig 1: Block Diagram of 'Terrain Analysis'

The second objective is image segmentation, for which a solution descending from the region growing technique is proposed. Initially, the image is divided into an N x N grid, let each cell be denoted by n_{ij}. The properties of each cell that corresponds to a piece of field in real sense are studied using a probe or sensor, depending on the parameter we are interested in. Unlike the traditional region growing region, in which the seed point needs to be selected manually, in this method, any arbitrary seed point can be selected. From the seed point, copter navigates to the surrounding cells to check if the neighbor's properties match with that of seed point. Matching can be ensured if the difference in parameters between the two cells, doesn't cross a given threshold value. If difference is less than the threshold value, matching is ensured and the cell is appended to a label, say A. If the difference is greater than the threshold value, the cell is appended to other region. The copter moves further and if properties are matched with A, it appends to the label, else it creates a new label B, and appends the cell. The copter keeps track of the label and its properties as long as it hovers around. Once a new cell is appended to the region, their mean is selected and is used for the thresholding. The mean calculation can be done from simple arithmetic formula with the values or property in investigation, thereby ensuring appropriate segmentation of the terrain.

Mean (Cells in region) - Value (Cell in investigation) < Threshold, Append the cell
(1)

Mean (Cells in region) - Value (Cell in investigation) > Threshold, Create a new region
(2)

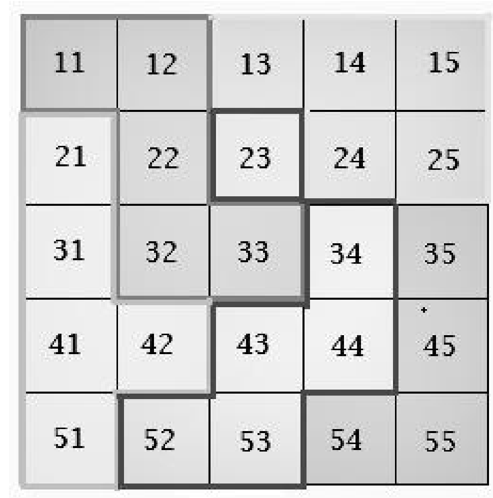

Fig 2: Grid represented segmented field

Let the field be divided into 5x5 grid as shown in Fig1. The cells of the grid are numbered in a general fashion resembling the elements of a matrix. Let the property based on which the segmentation be done is x, which may include a wide range of properties varying from nutrient availability to moisture content. Assuming that the copter begins the task with the cell 'n11' and appends to a label A (Here-after n11 and its value '11' are used synonymously). It then hovers to n12, n21, n22 and compares 12, 21 and 22 with 11. If the difference falls below the threshold, they are appended to A else new label B is created. In the next move, the mean of 11, 12 and 22 is used to represent A.

A: 11, 12, 22, 33, 32
B: 21, 31, 42, 41, 51
C: 23, 34, 44, 43, 53, 52
D: 13, 14, 24, 15, 25
E: 35, 45, 55, 54

This process iterates over and over, until the entire image is segmented into regions. Copter needs to be programmed in such a way that it doesn't visit the same cell more than once. Once the image is segmented into regions, centroid of the arbitrary region is calculated and sowing of crops, watering the soil can be done.

Mango cutting

The position of mangoes in the image can be tracked by converting the image into a grayscale image, which is then enhanced and converted into binary image. If the luminescence of pixel in grayscale is greater than the threshold which in our case is adaptive to the lighting, then pixel is replaced by 1 else 0. Thereby we could get a binary image with white concentration at the mango and black in the background.

Color detection algorithm is used to check whether the fruit is ripened or not. Depending on the threshold value

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adaptive to the illumination, image is converted into HSV format. HSV color detection algorithm can be employed to detect ripen mango.

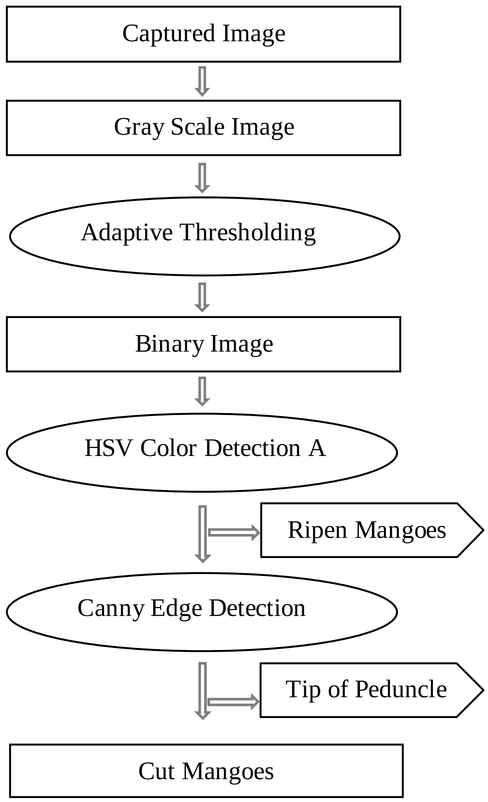

Fig 3: Block Diagram of 'Mango Cutting'

Stereo vision improves approach by adding the third dimension depth, to attain a more accurate localization of objects within the sensed scene. Once the mango is detected, the tip of the peduncle is detected and a robot arm attached to copter cuts the peduncle. To find the tip and pole, canny edge detection algorithm is used. This algorithm determines which edge pixels should be discarded as noise and which should be retained. The edges can be considered as the outline of the fruit. This information can be used to determine the cutting point. Cutting point is set along the axis and a few centimeters above the tip.

After being cut, mangoes are collected over a net attached to the tree trunk having some blotting material like powdered husk or blotting paper that can absorb the oozing substances from the plucked mango. This process is iterated over a series of times, as copter rotates about the tree. This system can guarantee unwounded mangoes and even grading can be done through image processing.

Animal Intrusion Avoidance:

So as to avert the intrusion of animals into the agricultural field especially during night times, firstly the image needs to be processed from night vision image (low-light image and infrared image) into a visible color image. Primary interest in obtaining a colored image stems from the necessity to make the system independent of day and night phenomena. Next the colored NV image is to be processed further to detect the animal and then alarm the farmer or threaten the animal. For this objective to be fulfilled, a hybrid algorithm that combines region-based Color Transfer Method and any general algorithm that detects motion can be developed.

Of the four categories: pixel-based search [8], statistical approach [9], region based approach[10] and pattern recognition based approach[11], the region based color transfer methods have gained momentum in recent years, as it offers better scene perception and interpretation. By using a combined framework consisting of hill-climbing algorithm [12] for color based segmentation, non-linear diffusion, region recognition and image fusion techniques, we arrive at a colored night vision image as an outcome of selective color transfer from the natural target color image. The hill-climbing algorithm optimizes the performance of the region feature based image fusion method and color transfer method, thus generating an optimized colored night vision image.

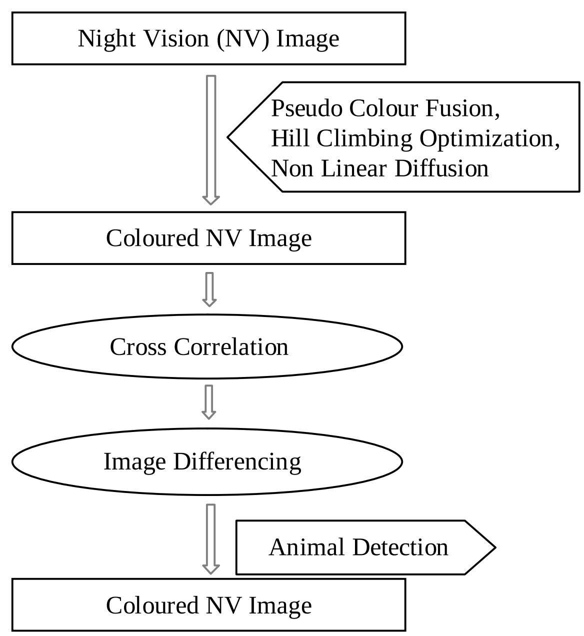

Fig 4: Block Diagram of 'Animal Intrusion Avoidance'

Over a sequence of colored night vision images, motion is detected using image differencing method. Since the interval between successive images (including that of region based fusion method) is relatively long, techniques such as feature correspondence or optical flow doesn't fit here. Moreover, the hexacopter cannot be static as it has to monitor the entire field and so is the camera fixed to it. This poses threat to the traditional image differencing method. To prevent this, individual images in the sequence are aligned with respect to the first frame, taking into consideration a marker. Cross correlation is performed in the horizontal and vertical directions, using a pair of lines, intersecting at the marker,

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which are correlated with equivalent lines of first or reference or base image. This correction procedure can correct the shift between images, leaving a sequence of images containing a stationary background but a dynamic foreground which in our case happens to be animal intruding. Care must be taken so as to differentiate the case when field is dynamic, but animal is static. If necessary, moving blobs can be extracted over the sequence so as to aid the process.

Power consumption might be the primary demerit to be named, due to the unavailability of solar power, and heavy processing required. Also at first hand it might seem impossible for the hexacopter to monitor the entire field. An alternative can be suggested that, vibration sensors are placed at the boundaries of the field. When intruded by an animal, they activate otherwise semi-active hexacopter which then moves to the location of vibrated sensor, and then resumes its image processing techniques. It detects and decides if it's a false alarm or that of a human or animal. If and only if it is an animal, an alarm alerting the farmer or threating the animal is done.

CONCLUSION

In comparison to prevailing technologies in the market and need of the farmer, it can be concluded that the above proposed techniques can be used in small farm areas with reasonable expenditure. If aided by solar or wind power the copter with Image techniques will fetch great results for farmers and there by the country's economy. On field efficiency and unexpected hurdles is still unexplored area of research.

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