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Camera Surveillance System Using Motion Detection and Tracking

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Abstract – There has been a huge progress in surveillance technology since last decade. Camera is an important component of this system. In this paper we are providing a model of surveillance system which gives artificial intelligence to the camera. We have given the camera an ability to move as per the movements of an intruder. This is called object tracking which requires object detection. There is a microcontroller and a computer in the system along with the camera which operate together to serve the cause. The main idea is to track an intruder and thereby ensure that a single camera covers more geographical area. This would enable less number of cameras to cover a particular area thereby making the system cost efficient and suitable for practical applications. The paper includes image processing techniques which will be useful for the camera to detect and track the motion as well as some basics of microcontrollers. We have implemented this system in ideal conditions consisting of a single dark object in presence of a constant white background. A thorough study of this paper would help the reader to implement a prototype of a camera surveillance system using motion detection and tracking.

Keywords - Artificial Intelligence, Security, Object detection, Object tracking, centroid, ideal system, Threshold, constant background.

I. INTRODUCTION

The security and safety are one of the major concerns of any organization in present age. The countries put a lot of resources and wealth on border security and surveillance. Thus there is a need for the surveillance systems which are both cost and application efficient. The traditional method used for surveillance has been manpower. But with the need for 24 hours surveillance and security, came into existence the camera surveillance systems. These traditional camera systems lacked the intelligence of the humans and it was challenging to cover large area with these systems as it would require more number of cameras and manpower to monitor. So, there is a need to combine both the intelligence of humans and the working efficiency of camera systems to come up with “Intelligent Camera systems”. Here the camera will have an ability to track the intruder and ensure requirement of less number of cameras to cover a particular area. This paper describes such intelligent system which can be brought up into practical applications. Image processing is an important part of the entire operation. The efficiency of the algorithm used for image processing determines the efficiency of the entire system. The microcontroller also plays an important role but in this paper we will be emphasizing more on camera and image processing. The algorithm chosen to obtain the goal, the problems faced during its implementation and the possible improvements in it are discussed. We will also discuss simulation results, conclusions and the future work.

A. Motion detection

Motion detection in consequent images is nothing but the detection of the moving object in the scene. In video surveillance, motion detection refers to the capability of the surveillance system to detect motion and capture the events. Motion detection is usually a software-based monitoring algorithm which will signal the surveillance camera to begin capturing the event when it detects motions. In this, a camera fixed to its base has been placed and is set as an observer at the outdoor for surveillance. Any small movement with a level of tolerance it picks is detected as motion. There are three conventional approaches to moving object detection- Temporal differencing, Averaging and Optical flow. Temporal differencing is very adaptive to dynamic environments, but generally does a poor job of extracting all relevant feature pixels. Averaging provides the most

complete feature data, but is extremely sensitive to dynamic scene changes due to lighting and extraneous events. Optical flow can be used to detect independently moving objects in the presence of camera motion; however, most optical flow computation methods are computationally complex, and cannot be applied to full-frame video streams in real-time without specialized hardware. The Averaging approach is been utilized in this paper for motion detection.

B. Motion Tracking

The detection of the object is followed by object tracking. This function gives the intelligence to the camera. An intruder entering into cameras visual range will always be followed by the camera after detecting it. This feature is called motion tracking. This is achieved by mounting camera on motors to ensure its movement in the direction of motion of the intruder. Motion tracking depends on the efficiency of motion detection. In order to achieve real time motion tracking the motion should be detected with least possible time lag.

C. Problems Faced in Real Time Environment

Video motion detection is fundamental in many autonomous video surveillance strategies. However, in outdoor scenes where inconsistent lighting and unimportant, but distracting, background movement is present, it is a challenging problem. In real time environment where scene is not under control situation is much worse and noisy. Light may change anytime which cause system output less meaningful to deal with. Recent research has produced several background modeling techniques, based on image differencing, that exhibit real-time performance and high accuracy for certain classes of scene.Where the weather introduces unpredictable variations in both lighting and background movement.

II. OVERVIEW OF SYSTEM IMPLEMENTATION

The system has various functional blocks with each block having its specific function. All these blocks together help the system to operate. We have a Camera, a motor, a computer and a controller in the system. (Fig.1) shows the system overview and the flow of data within the system

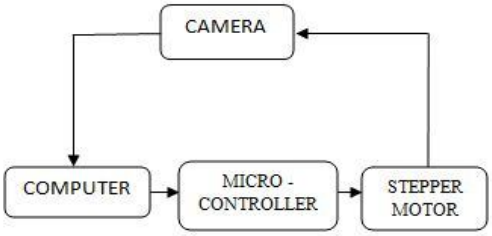

Fig. 1:- System Overview

III. PROPOSED ALGORITHM

To implement the image processing we have used a simple algorithm which is efficient for the specific system conditions. The conditions required for this algorithm are (1) Presence of a single object (2) Large contrast between object and the surroundings. (3) The background should be plane and constant (no moving components other than object). When these three conditions are satisfied then our algorithm is efficient and easy to implement. The algorithm is presented in the flowchart as below:- We capture the image with the help of camera and then these visual inputs are sent to computer for processing. The software MATLAB is used for image processing

The inputs from camera are continuous. Initially a particular time interval is defined for generating frames called as frame interval. So, instead of processing the visual inputs continuously we process these frames. The frame is nothing but an image. This image which consists of pixels is divided into two parts. Averaging is performed on both the parts and then the difference of these two averages is computed. This difference is scaled down by using a scaling factor which depends on the conditions in which system is operating. The motion of the camera is proportional to the value of this difference.
A Threshold is determined depending on the operating conditions of the system. Thus we get three conditions:-

- If difference> + threshold……. Camera rotates anticlockwise
- If difference < - threshold……Camera rotates clockwise
- If - threshold < difference < + threshold ……do not rotate

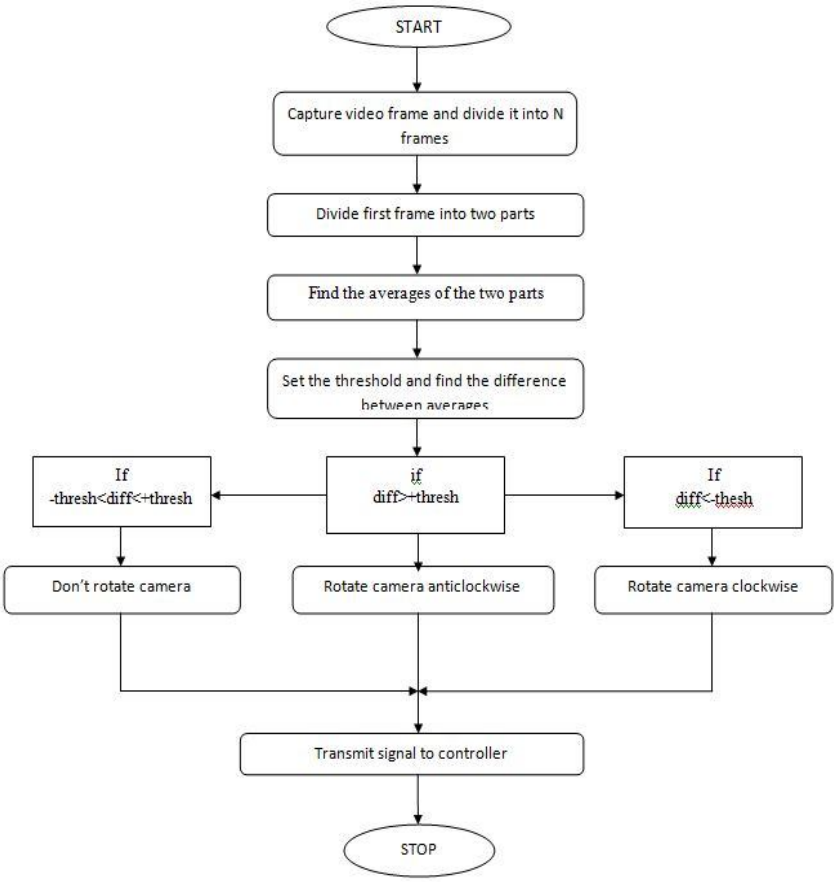

Fig. 2:- Flowchart

IV. SIMULATION RESULTS

The software implementation is done on the images of resolution 160x120. The image is divided into two parts of resolution 80x120 each. The sum of intensities of all the pixels in a particular part is called average of that part.

CASE 1:- Object in the left part of the image
Consider the figure below which is the screenshot of MATLAB taken while system implementation. We see the object in the left part of the image. The averages seen in the screenshot are 8050 and 9600. The difference is -6. The threshold value considered is -4 to 4 for the presence of the object at the center.
Thus a value of -6 signifies the presence of the object in the left part of the image.

CASE 2:- Object in the right side of the image
Consider the figure below which shows a screenshot of MATLAB while system implementation. Here the object is present on the right side of the image. Now here the averages of the two blocks are 8108 and 9600 and the difference between them is 6. As per the threshold conditions discussed earlier, a positive value of difference indicates the presence of object on right. Thus the object is detected.

CASE 3:- Object in the center of the image
Consider the figure below which shows a screenshot of MATLAB while system implementation. The averages of both the blocks are observed as 8966 and 8696. The difference between them is 1. Now as per the threshold conditions we see the object is at the center.

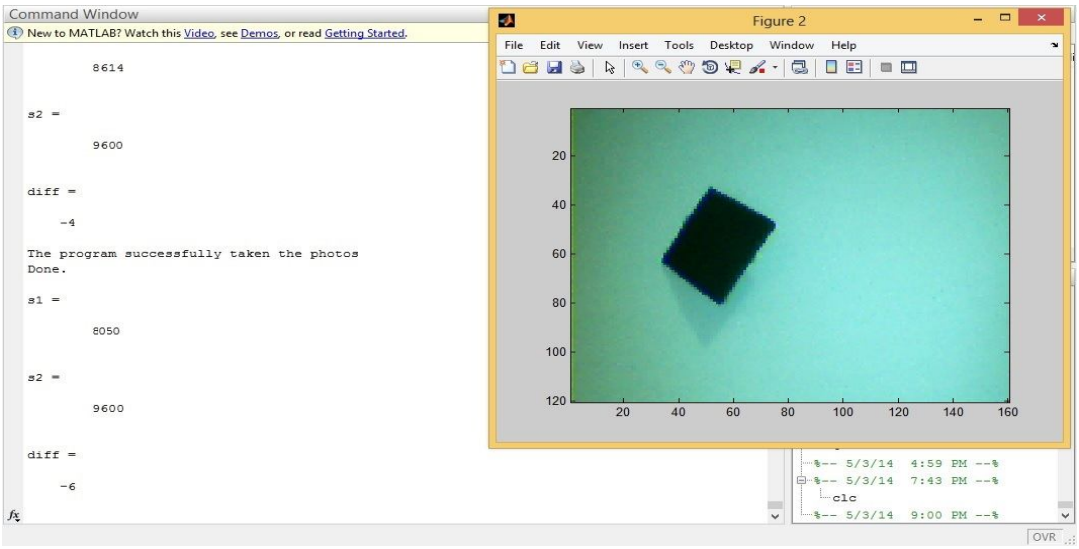

Fig. 3:- Object in the left part of the image

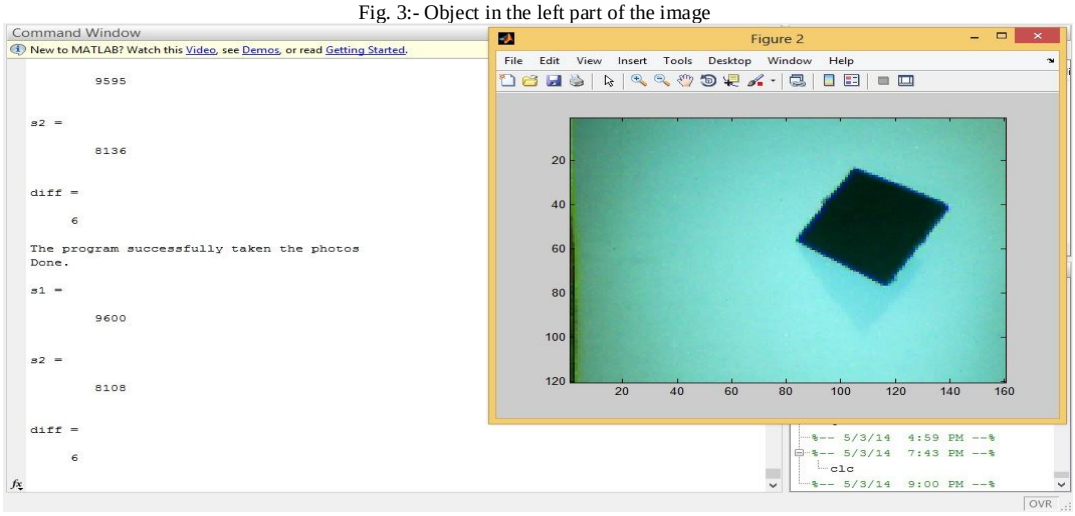

Fig. 4:- Object in the right part of the image

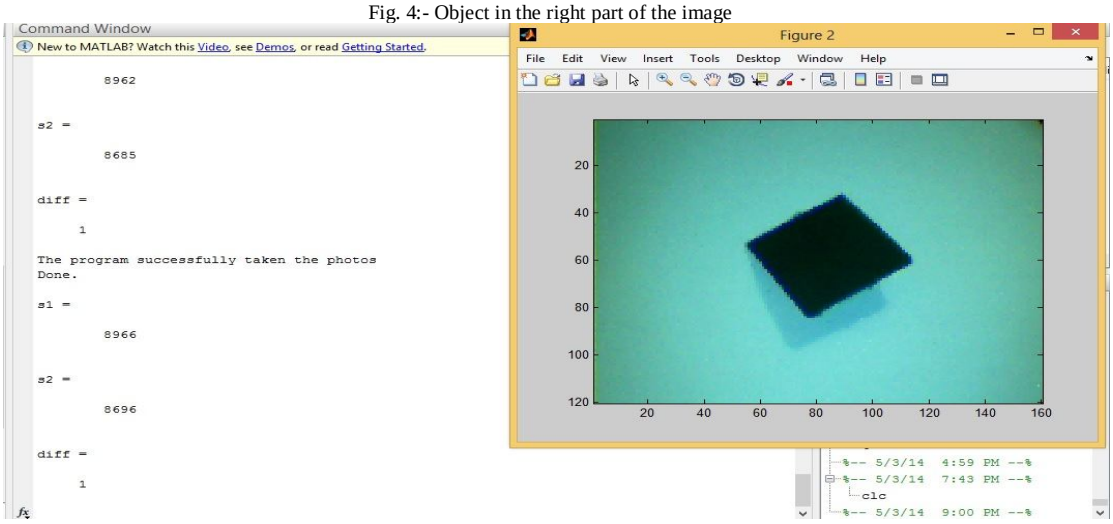

Fig. 5:- Object in the center of the image

V. CONCLUSION AND FUTURE SCOPE

We have described a camera surveillance system using motion detection and tracking, The proposed algorithm efficiently detects the intruder and tracks its motion. This algorithm integrates the motion detection and tracking task for better performance. The proposed algorithm is also supported by the simulation results obtained from practical hardware implementations.

Future Scope:-

- The system is designed to work when the background is white; but it can be modified to travel in presence of practical backgrounds.
- Tracking of person have been implemented using Averaging technique but we could use Weiner or Kalman filter to provide better implementation.
- The code could have been further modified or improved to provide better results even for low contrast images taken in low lighting conditions.

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