AERIAL SURVEILLANCE AND MONITORING USING COMPUTER VISION

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Abstract: With the advent of new technologies there's a great threat to information and hence, security to a system plays a crucial role these days. Monitoring a large event, a protest, or even an individual, drones - unmanned aerial vehicles can provide the team with the overview they need to maintain control. UAV monitoring systems provide a number of benefits to users focused on public safety and civil security. This paper covers the capturing, detection and tracking the path of a drone and tracking by detection method used to track the multiple objects visual motion by detecting the objects in the frames and observing the track throughout the entire frame and with the help of deep learning(subset of machine learning) techniques. This method gives high efficient tracking and considers longer term connectivity between pairs of detections and models similarities as well as dissimilarities between the object's position, colour and visual motion. We present the Hungarian method which gives a better performance and solves the problem of occlusion occurred.

Index Terms— Hungarian Algorithm, Image processing, Kalman filters, unmanned aerial vehicle.

I. INTRODUCTION

Investigatory systems or surveillance are used to monitor the sensitive areas. Tracking multiple objects and predicting their path is a centralized problem because of the noise, changing backgrounds ,obstructions between various objects.

An **unmanned aerial vehicle** (commonly known as a **drone**) is an **aircraft** without a human **pilot** on board. UAVs are a component of an **unmanned aircraft system (UAS)** ; which include a UAV, a ground-based controller, and a system of communications between the two. These systems provide a risk free surveillance.

Specially developed, highly efficient drone motors allow for discrete-almost silent- monitoring. They provide a payload flexibility i.e., monitoring systems can use a Convolutional video camera to detect suspects in darkness or dense vegetation.

This paper aims at an approach that binds the pairs of multiple objects detected with their tracks. A framework which assigns labels for individual objects in each frame has been designed. The advantages is it provides a connecting detection pairs not only between adjacent frames but also between frames with long time interval within a temporary window and this allows us to re-label the objects which are lost by the high interruptions.

II. IMAGE PROCESSING

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. Usually **Image Processing** system includes treating images as two dimensional signals while applying already set signal processing methods to them. The digital image processing deals with developing a digital system that performs operations on a digital image.

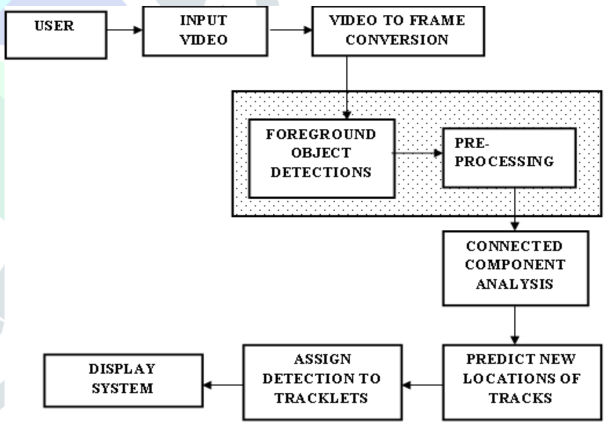
What is an image?

An image is nothing more than a two dimensional signal. It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically. The value of f(x,y) at any point gives the pixel value at that point of an image.

The dimensions of the picture is actually the dimensions of this two dimensional array. Machine vision or computer vision deals with developing a system in which the input is an image and the output is some information. For example: Developing a system that scans human face and opens any kind of lock.

III. PROPOSED TECHNIQUE

This section provides deals with the proposed technique. The technique helps us to track the multiple objects simultaneously. The approach is detailed below.



OUTLINE

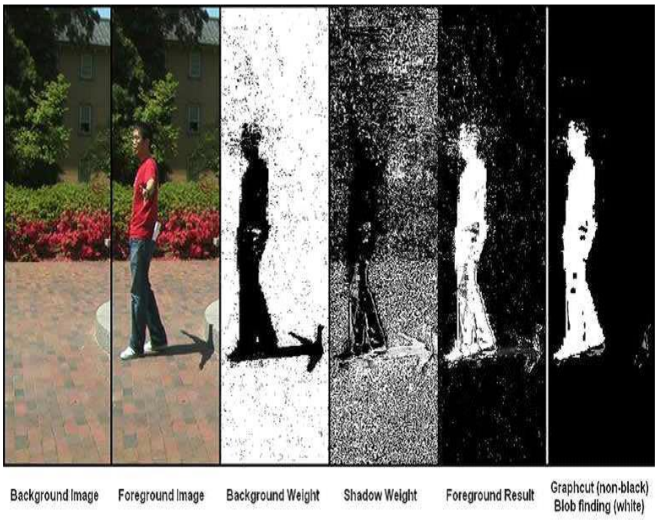
- Object Detection
- Background subtraction
- Preprocessing
- Object Tracking

Object Detection

It is the process of recognizing moving objects in an existing video or a currently running video.

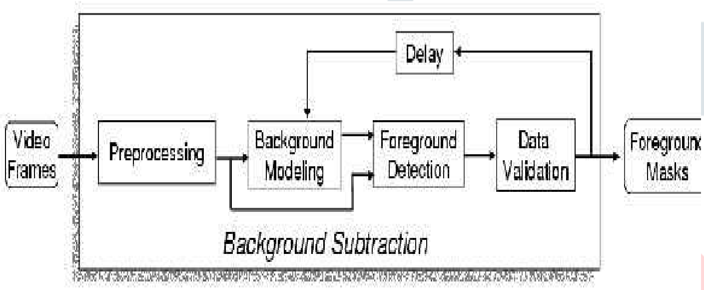
Background Subtraction

As the name suggests, background subtraction is the process of separating out foreground objects from the background in a sequence of video frames.

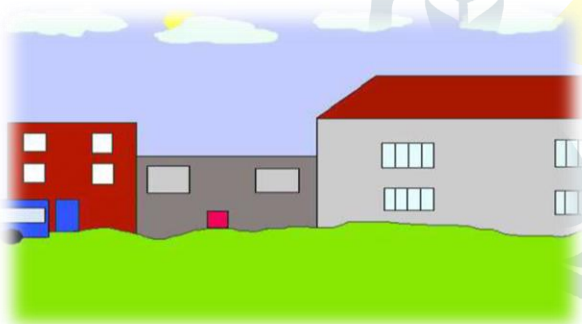


Fundamental Logic

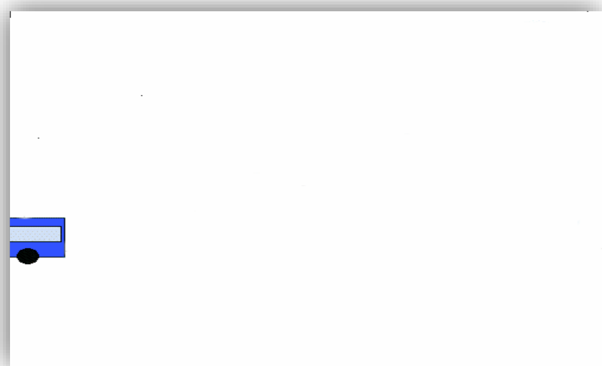
• Fundamental logic for detecting moving objects is from the difference between the current frame and a reference frame, called "**background image**" and this method is known as "**FRAME DIFFERENCE METHOD**".

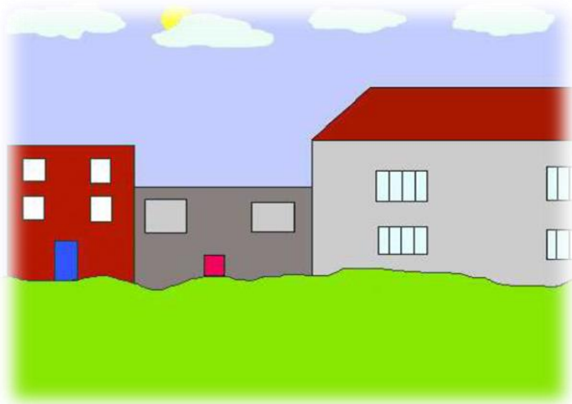


Background Modelling



Background Model
After Background Filtering…





Background Subtraction Principles:

• Background subtraction should segment objects of interest when they first appear or reappear in a scene.

• An appropriate pixel level stationery criterion should be defined. Pixels that satisfy this criterion are classified as background and ignored.

• The background model must adapt to sudden and gradual changes in background.

• Background model should take into account changes at differing spatial scales.

Frame Differencing

• Background is estimated to be the previous Frame . Background subtraction equation then becomes:

$B(x, y, t) = I(x, y, t-1)$

$I(x, y, t) - I(x, y, t-1) > Th$

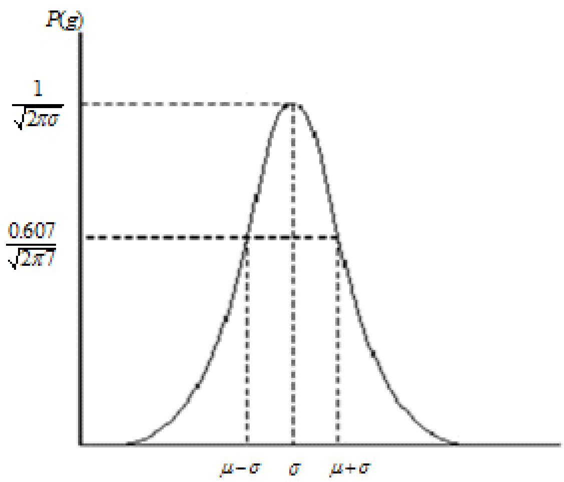
Preprocessing

NOISE:

In a very general sense, "noise" is an unwanted contribution to a measured signal.We are especially interested in image noise or video noise. Noise is here typically a high-frequency random perturbation of measured pixel values, caused by electronic noise of participating sensors (such as camera or scanner), or by transmission or digitization processes. For example, the Bayer pattern may introduce a noisy color mapping.

Gaussian Noise Model

It is also called as electronic noise because it arises in amplifiers or detectors. Gaussian noise caused by natural sources such as thermal vibration of atoms and discrete nature of radiation of warm objects [5]. Gaussian noise generally disturbs the gray values in digital images. That is why Gaussian noise model essentially designed and characteristics by its PDF or normalizes histogram with respect to gray value.



White Noise

Noise is essentially identified by the noise power. Noise power spectrum is constant in white noise. This noise power is equivalent to power spectral density function. The statement "Gaussian noise is often white noise" is incorrect [4]. However neither Gaussian property implies the white sense. The range of total noise power is $-\infty$ to $+\infty$ available in white noise in frequency domain. That means ideally noise power is infinite in white noise. This fact is fully true because the light emits from the sun has all the frequency components. In white noise, correlation is not possible because of every pixel values are different from their neighbours. That is why autocorrelation is zero. So that image pixel values are normally disturb positively due to white noise.

Morphological operations

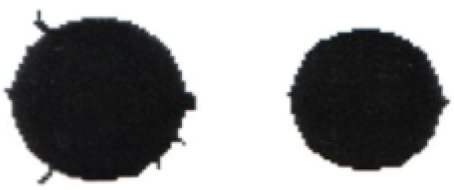
Morphological operations such as erosion and dilation are used to remove noise from the pixels.

For sets A and B in Z^2 (Binary Image), erosion of A by B is denoted by **A⊖B**

$$A \ominus B = \{z \mid (B)_z \subseteq A\}$$

It is a set of all points Z such that B, shifted or translated by Z, is contained in A.

Erosion removes irrelevant size details from a binary image, shrinks and thins the image. It also strips away extrusions and strips apart joined objects.

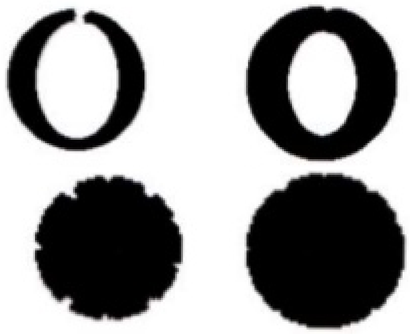


For sets A and B in Z^2 (Binary Image), dilation of A by B is denoted by **A⊕B**

$$A \oplus B = \left\{z \mid (\hat{B})_z \cap A \neq \phi\right\}$$

In Dilation, first B is reflected about its origin by a straight angle and then translated by Z.

Dialation enalrges and bridges gaps of character by thickening and reparing breaking and intrusions.



Blob Analysis

In the terminology of image processing, a blob is a region of connected pixels. After detecting foreground moving objects and applying preprocessing operations, the filtered pixels are grouped into a connected regions and are uniquely labeled.

To solve this problem we use a simple two pass algorithm.

On the first pass:

1. Iterate through each element of the data by row, then by column.
2. If the element is not the background
3. Get the neighboring elements of the current element
4. If there are no neighbors, uniquely label the current element and continue
5. Otherwise, find the neighbor with the smallest label and assign it to the current element
6. Store the equivalence between neighboring labels

On the second pass:

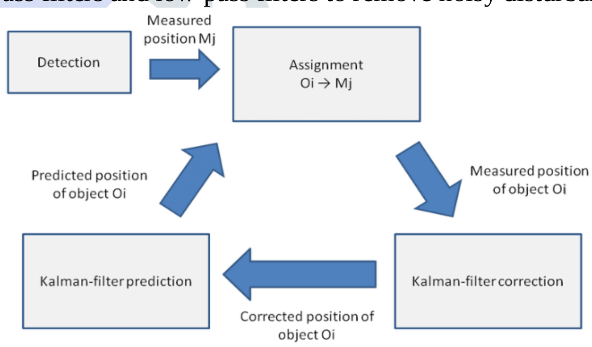
1. Iterate through each element of the data by column, then by row
2. If the element is not the background ;Re-label the element with the lowest equivalent label

2. Object Tracking

This deals with the prediction and assignment to prediction process.

Kalman Filter

After the objects are detected the very next step is to associate detected object with it's track. The Kalman filter is used to predict the new detection in the consecutive frames and to associate those predictions to the location of a track in each frame. Kalman filter uses prediction and correction method to do so and sometimes they are also used as high-pass filters and low-pass filters to remove noisy disturbance.



Kalman filter algorithm

•The Kalman filter estimates a process by using a form of feedback control: the filter estimates the process state at some time and then obtains feedback in the form of (noisy) measurements.

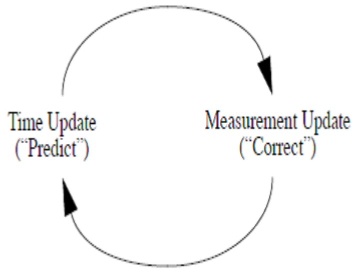
•As such, the equations for the Kalman filter fall into two groups: *time update* equations and m*easurement update* equations.

•The time update equations are responsible for projecting forward (in time) the current state and error covariance estimates to obtain the *a priori* estimates for the next time step.

The measurement update equations are responsible for the feedback—i.e. for incorporating a new measurement into the *a priori* estimate to obtain an improved *a posteriori* estimate.

•The time update equations can also be thought of as *predictor* equations, while the measurement update equations can be thought of as *corrector* equations.

•The final estimation algorithm resembles that of a *predictor-corrector* algorithm.



The ongoing discrete Kalman filter cycle.

The *time update* projects the current state estimate ahead in time. The *measurement update* adjusts the projected estimate by an actual measurement at that time.

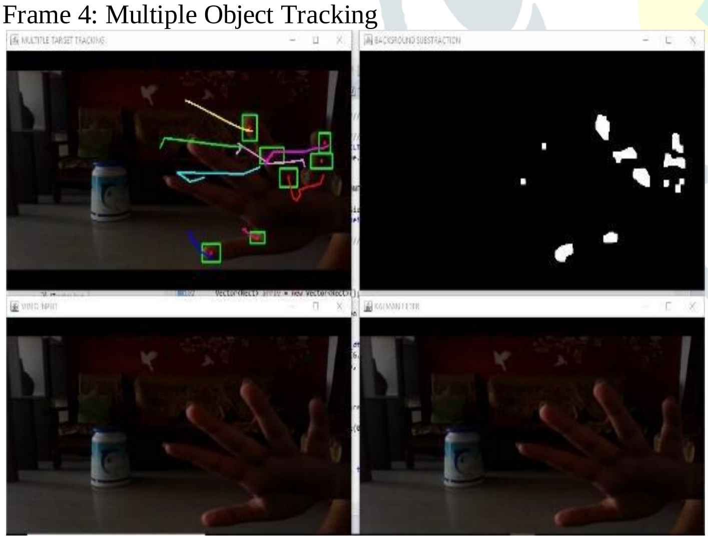
Hungarian Algorithm

The process of assigning directions to the tracks is the responsibility of Hungarian assignment algorithm developed by James Munkers's . This determines which tracks were missing and which object should be given a new track. This method returns the indices of assigned tracks.

Based on indices of assigned tracks the cost matrix decides the cost of the track. If the cost is less, then the assignment is more and if the cost is more the assignment is less. In terms of mathematics the Euclidean metric is the distance between the two points in Euclidean space. Where the distance is smaller, then the assignment is more. Finally the tracks are displayed to the end user.

IV. EXPERIMENTAL RESULTS

The experimental results have been shown below:
They consist of:
Frame 1: Motion Tracking
Frame 2: Background Subtraction
Frame 3: Original Frame
Frame 4: Multiple Object Tracking



CONCLUSION

The proposed method is best suited for video surveillance contexts . The desired outcome of this paper is to track multiple objects in the video which is inputted by the user or the video being captured and predict their paths to an extent which would be very much helpful for the defence systems. This system recognizes the multiple moving objects and tracking algorithm successfully tracks objects in consecutive frames. This approach lays down the long term connectivity between pairs of detections which were captured.This helps connect objects in different frames on the basis of similarities and dissimilarities defined at detection level, based on position, colour. The model also incorporates a label for each and every object detected which makes occlusion free. Hence,this would be an efficient solution for the investigatory systems or surveillance to monitor the sensitive areas.

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