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Navigation system for blind person using moving object tracking

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Abstract— Navigation is the one of the hard task for blind people in their day to day life. So as to navigate assistance for blind person a compact system with a hardware raspberry pi, camera and ultrasonic sensor is formed. This system gathers information for blind person to navigate. In navigation if there is an obstacle in the path the beep sound will be played, afterward a camera will start and using image processing system will detect whether the obstacle is moving or non moving.. Moving object detection and tracking is based on optical flow estimation together with computer vision and Image processing technique. Moving object detection involves identification of an object in consecutive frames and object tracking is used to monitor the movements with respect to the region of interest. This system is implemented in two parts, one is using optical flow in MATLAB and second part is Raspberrry pi.

***Index Terms*— Moving object detection, tracking, optical flow estimation, morphological operation, blob analysis, Raspberry pi.**

I. INTRODUCTION

The main objective of this project is to navigate the blind person. Navigation means when blind person is moving on street this project tells whether the object is coming towards him or that object is stationary in front of him. This project consists of software simulation on matlab and can be implemented as hardware on raspberry bi board. Moving object analysis and estimation is done by optical flow in MATLAB. Optical flow gives an apparent change of a moving objects location or deformation between frames. Optical flow estimation yields a two dimensional vector field i.e. motion field that represents velocities and direction of each point of an image sequence. Optical flow calculate image intensity value and estimate the velocity of object motion using either the Horn-schunck or the Lucas-kanade.the velocity estimation can be either between two images or between current frame and nth frame.

After calculating velocity we need to calculate the velocity threshold, for that calculates mean velocity value across frame and across time. After that we do a comparison of input velocity with mean velocity value, if input velocity is greater than mean velocity value it will mapped to one and zero otherwise. The output of comparison becomes threshold intensity matrix. This matrix is again passing through the median filter. Filtering process removes the noise and finally blob analysis is employed to identify object for tracking process. We only display boundary box that is greater than a certain size and the size is determined according to the object to be track. After completion of MATLAB work we convert the MATLAB coding into the raspberry pi board language.

II. FLOW OF TRACKING ALGORITHM

In the proposed algorithm we are going step-by-step to get the expected result. a video input is selected from static camera, further on that video some pre-processing operation are done i.e. convert the color video frame into grayscale video frame. Due to cameras auto white balance and the effect of sudden environment intensity changes, mean of every frame is calculated on gray scale format. After that essential part of algorithm is optical flow, optical flow is computed between current frame and nth frame back. From optical flow we can calculate the velocity of motion vectors, out of all the pixel of frame only moving pixels are moving object. During filtering operation some holes are created in frames. to fill these holes and prevent the detection mistakes morphological operation i.e. closing and erode are implemented. Now motion object are detected but many of them are not interested, blob analysis help us to cluster objects and filter out objects which are be based on blob size. Drawing bounding boxes around the object is last segment of the algorithm.

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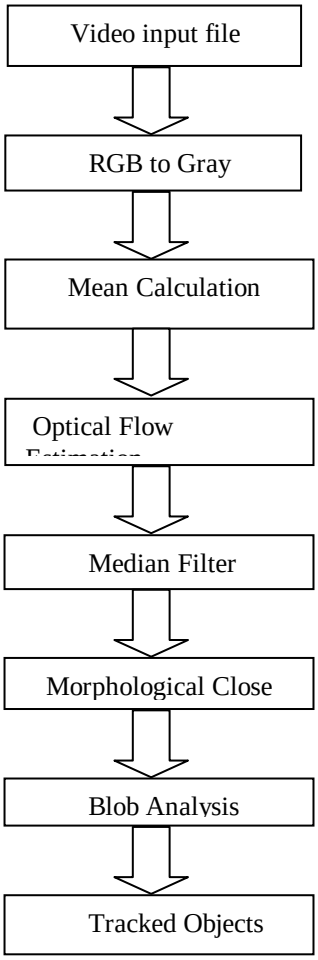

Fig.1 Flow Diagram of Proposed Algorithm

III. OPTICAL FLOW

Optical flow or optic flow is pattern of displayed motion of objects, surfaces and edges in a visual scene caused by the relative motion between observer and the scene. Optical flow techniques such as motion detection, object segmentation utilize this motion of objects, surfaces and edges. Optical flow describes the direction and time rate of pixels in a time sequence of two consequent images.

Optical flow method can be computed by using two images at time t and t+dt, since they deal with Taylor series. They also called as differential methods as they work with the spatial I(X,Y) and temporal I(t) derivatives. Assume that the image intensity of each visible scene point is unchanging over time.

$I(X, Y, Z) = I(X+ \delta t, Y+\delta t, T+\delta t)$…… (1)

Assuming that the movement is small, the image constrain at I(X, Y, T) with Taylor series can be derived to give

$I(X+\delta t, Y+\delta t, T+\delta t) = I(X,Y,Z)$

$\delta x\frac{dI}{dx} + \delta y\frac{dI}{dy} + \delta t\frac{dI}{dt}$ +higher order term….. (2)

from eq. (2), by ignoring higher order term

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$$\delta x\frac{dI}{dx} + \delta y\frac{dI}{dy} + \delta t\frac{dI}{dt} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Divide eq. (3) by δt

$$\frac{dI}{dx}\left(\frac{\delta x}{\delta t}\right) + \frac{dI}{dy}\left(\frac{\delta y}{\delta t}\right) + \frac{dI}{dt}\left(\frac{\delta t}{\delta t}\right) = 0$$
$$\frac{dI}{dx}Vx + \frac{dI}{dy}Vy + \frac{dI}{dt} = 0 \ldots\ldots\ldots\ldots\ldots (4)$$

eq. (4) is optical flow constrain equation, which express a constrain on the components Vx and Vy of the optical flow using on X axis and Y axis respectively and $\frac{dI}{dx}, \frac{dI}{dy}, \frac{dI}{dz}$ are the derivatives of image at (X,Y,T)

eq.(4) can be written as

Ix.Vx+Iy.Vy= -Tt

The optical flow algorithm are mostly based on correlation, gradient and frequency information respectively.[4][5]

IV. IMAGE SEGMENTATION

Thresholding is the simplest method of image segmentation, from gray scale image thresholding can be used to create binary images. So that the objects of interest can be highlighted by fixing a threshold limit. In tracking algorithm the content of each frame is read and the background is estimated. During thresholding process individual pixels in an image are marked as 'object' pixels, if their value is greater than some threshold value i.e. background pixel. An object pixel is given a value of 1 while a background pixel is given a value of 0.finally binary image created by coloring each pixel white or black.[7]

The key parameter in the thresholding process is the choice of the threshold value. We can manually choose threshold value or threshold algorithm can compute a value automatically, simple method would be to choose the mean or median value.IN noiseless image with uniform background and object values, the mean or median will work well as the threshold. A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values. However, this may be computationally expensive, and image histograms may not have clearly defined valley points, often making the selection of an accurate threshold difficult.[1][7]

V. NOISE FILTERING

Motion digital images are often interfered by a variety of noise distributions dependent on the prevalent conditions. The observed noise can be modeled either as additive white, impulsive, signal dependent or a combination of them. Some of these noise distributions are very annoying when are involved in intensity changes in video frames. They randomly and sparsely corrupt pixels to two intensity levels: relative high or relative low, when compared to its neighboring pixels. Therefore, the need emerges for implementing smoothing techniques that are able to treat different kinds of noise. Furthermore, a noise-free version of the corrupted image or sequence required by adaptive filtering algorithms during the Training procedure is not always available. Moreover, it is well known that the main objectives of image filtering algorithms are the suppression of noise in homogeneous regions, the preservation of edges (spatial or temporal) and the removal of impulses (of constant and/or random value) .A class of filters that fulfills these requirements is the so called signal filters. Standard median (SM) is a paradigm of this class. Median filter, as its name implies, replaces the value of a pixel by the median of the gray levels in the neighborhood of that Pixel. Median filters are quite popular because, for certain types of random noise, they provide excellent noise-reduction capabilities, with considerably less blurring than linear smoothing filters of similar size.[1]

VI. MORPHOLOGICAL CLOSE

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Morphological operations are performed to extract significant features from images that are useful in the Representation and description of the shapes in the region; mostly used in image segmentation and pattern recognition. In the proposed system we used both morphological close and erode, respectively, to remove portions of the road and unwanted objects. After morphological closing operation, on condition that vehicle's appearance is not destroyed, objects including many small holes and separated pixels may be connect into one big actual vehicle shape. The following is the definition of morphological closing operation and the applied structural element B.

$P \bullet B = (P \oplus B) \oplus B$

Where,

B=

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

The matrix *P* which includes moving vehicle information is obtained through threshold segmentation. [4]

VII. BLOB ANALYSIS

In the area of computer vision blob detection refers to visual modules that are aimed at detecting points and/or regions in the images that differ in properties like brightness or color compared to surrounding Blob analysis provides complementary information about region which is not obtain from edge detectors or corners detectors. Blob detection used to obtain region of interest. Blob analysis can be used to detect any kind of 2- dimensional shapes of an image. The detection is based on spatial characteristics using certain criteria. In many applications where the computation is time consuming, one can use blob analysis to eliminate blobs that are of no interest based on certain spatial characteristics and keep only the relevant blobs for further analysis. The blobs which satisfied our system are vehicles. Other useless blobs are removed by setting limitations on the relative features in the algorithm.

VIII. EXPEIMENTAL RESULT

In this section we show the experimental results using the stationary camera and moving object. Before applying optical flow estimation on frames, the image format is converted from RGB to gray because Intensity measurements act well on gray-scale frames. Depends on tracking flow steps, the proper optical flow estimation has been applied. Then, the Median filter is performed to reduce noise corruptions.

Fig.1 original video

Fig.2 gray scale image

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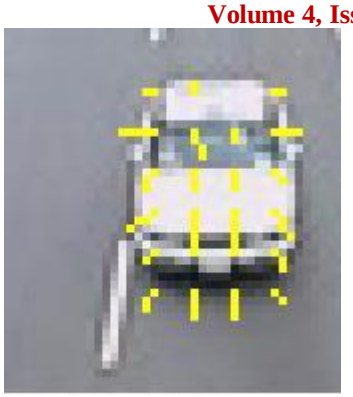

Fig.3 motion vector

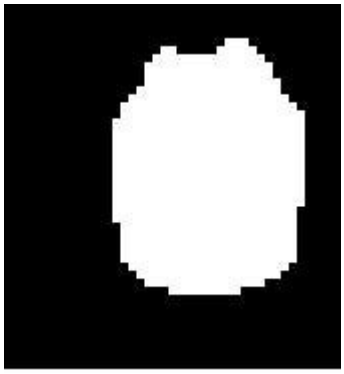

Fig.4 binary image with blob

Fig.5 tracked object

IX. CONCLUSION

We have tracked the moving object in video using optical flow algorithm. this system employs various methods to detect ,filtering, segmentation and tracking objects. We used horn-schunk method as most suitable method of optical flow estimation, to detect the moving object by intensity changes of frame. The morphological close extracted significant features of region shapes from binary images and then blob analysis introduced. The great advantage of blob analysis is the low computation cost., the system removes unwanted motion object which are not vehicles in the images. after detecting the object our matlab work is completed ,we now convert the this matlab code into raspberry board language which is nothing but in the python language.

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