SURVEY PAPER: INDOOR NAVIGATION ASSISTANCE SYSTEM METHODS AND ALGORITHMS

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Abstract—Nearly 300 million people are estimated to be visually impaired worldwide, some of them are blind while some of them have low vision. These visually impaired and also elderly people face difficulties in navigation due to obstacles in their path. GPS technology is available for outdoor navigation but it cannot be used for indoor navigation. Indoor Navigation Assistance System will assist visually impaired and elderly people to navigate safely in indoor environment. The system can detect objects in the user's path in real time while navigating and will give voice response if obstacle is detected. Various object detection and tracking algorithms can be used to solve the problem.

Keywords- Image Processing, Object tracking (Optical Flow), Object Detection , Real Time System.

I. INTRODUCTION

To design indoor navigation assistant systems there are many ways like there can be robots which can detect objects by using sensors like camera and laser range finder [3], or stereo vision system[4], and also techniques from image processing are very useful to detect objects[6].Thus there are many methods and algorithms to exactly find an obstacle coming in the way. As the system will work in real time the obstacle detection algorithms should be accurate and fast enough to compute results.

Object tracking is the problem of estimating the position of the object and other relevant information of moving object in image sequence. There are many difficulties in reliable tracking of moving object because of noise, illumination changes etc. Optical flow is a vector field and with the help of that vector field, the motion field can be analyzed under certain conditions. Optical flow can approximate projection of 3D motion vectors on image plane. In this paper, we concentrate more on optical flow object tracking algorithm and other steps to exactly how you can detect obstacle.

II. RELATED WORK

This section gives the previous research regarding navigation systems. Navigation system development using image processing technique consists of different steps such as video Capture and Framing, Vibration elimination, object detection and object tracking.

• Aji S S, Tripty Singh[3] ,in this paper it is given that how a robot can detect obstacles in the environment. This is important for any robot to avoid collision. The obstacle detection for the mobile robot is done with the help of sensor like touch-sensor, camera, sonar, laser range finder. The focus of this paper is to propose one efficient obstacle avoidance algorithm for mobile robot using image processing and laser range finder. Image processing techniques are used to identify the obstacles. Laser emitter is used to calculate the distance to obstacles.

• Arjun B Krishnan and Jayaram Kollipara [4],the paper aims at describing an approach for the building of a stereo vision system which helps the robots to avoid obstacles in indoor environment and also navigate in the environment which is cost effective. This paper discusses the techniques of stereo vision and ultrasound sensors for successful navigation through different types of complex surroundings.

• Heramb Nandkishor Joshi, Prof. J. P. Shinde[5],the aim of this paper is to design a path for autonomous robot using image processing techniques. The proposed system finds and analyses an optimal path for a robots, while detecting obstacles along the way. The environment is first captured as an image using a camera. Object detecting algorithms are then performed to detect obstacles within the unknown environment. A-Star algorithm is used to find the shortest path.

• Pankaj Jain, Dr. Mohan Awasthy[6],the paper presents an algorithm for Obstacle Detection using image processing techniques. This method is divided in parts 1. Segment the obstacle containing image 2. Find the obstacle from those images. This paper contributes for the system which aims at the path detection problems for the mobile system or robot system.

• Binsy N Rashad, NishadhaS.G [7],the paper proposes a system for detection of obstacles moving in front of a user on a walk by a camera. The system senses the object if it is present in front of the person.

• Akihisa Ohya, Kosaka and AviKak[8]the paper describes a navigation method in an indoor environment for an autonomous robot which detects and avoid obstacles. In this method, the self-localization of the robot is done with a model-based vision system. A non-stop navigation is realized by a position correction system. Static obstacles are not detected with single-camera vision system and moving obstacles are detected with ultrasonic sensors.

• Yang Song, Xiaolin Feng and PietroPerona[10],the paper discusses the problem of detecting humans from their motion pattern in image sequences, extraneous motions and occlusion may be present. The method is based on learning a probabilistic model of the joint position and velocity of different body features.

III. PROBLEM SOLUTION STEPS USING IMAGE PROCESSING

The benefit to solve this navigation problem using image processing techniques is that it would be cost efficient as there will be no hardware use such as sensors, external cameras etc. Given below Fig.1 tells you the general steps to detect an obstacle and how to make user aware of that obstacle to help the user in navigation.

Fig.1 is General Method or General Steps for navigation process using Image Processing:

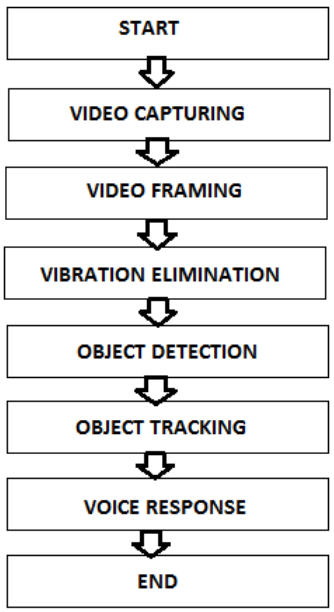

Fig.1. Steps for navigation using image processing

So these are the steps if we try to solve the problem using image processing techniques. If the system is real time then first you have to capture the video i.e the user will take help of some device or camera to record video. The framing of the video has to be done so as to calculate the distance between two objects using adjacent frames. Optical flow algorithm is used to calculate the distance between two points or pixels. Vibration elimination is used to remove any noise in the frames. Noise can occur due to camera movement. It is an important step to get accurate results. Next step is object detection and tracking. This is the final step or the important step in which you actually detect an obstacle. You have to make sure that you aware the user of the

system that the object has been detected. So the voice response step comes in which tells the user as soon as obstacle has been detected.

1)Video capturing and Framing: This is kind of first step in the process to detect obstacles. In real time the camera should capture the video and do the processing on the video. The video cannot be directly processed first it has to be converted into frames. Frame is like segmentation of the video into frames. In video, per second scanned frames is known as frame rate. The higher the frame rate, we get the better sense of motion.

2)Vibration Elimination : Vibration elimination is basically removing noise from the images. The noise can be generated because of the shaking camera[19].As in indoor navigation system, the user will hold the camera in its hand while walking, there is a guarantee that noise will occur. It is important to remove such noise for good processing of the video. This paper[15] introduces a method to remove the camera shake from blurred images. The method assumes a camera blur over the image and negligible in-plane camera rotation. In order to calculate the blur from the camera shake, the user must specify a specific region in an image without saturation effects.

3)Object Detection: While navigating it is important to find out the obstacles. Obstacle detection is a very important issue in the field of path planning and robot navigation. For example in paper[3] , it is given that how a robot can detect obstacles in the environment. This is important for any robot to avoid collision. The obstacle detection for the mobile robot is done by using sensor like touch-sensor, camera, sonar, laser range finder. Image processing techniques are used to identify the obstacles. Laser emitter is used to calculate the distance to obstacles. Similarly the method given in paper [4] aims at describing an approach for the building of a stereo vision system which helps the robots to avoid obstacles in indoor environment and also navigate in the environment which is cost effective. This paper discusses the techniques of stereo vision and ultrasound sensors for successful navigation through different types of complex surroundings. For example in [5],the aim of this paper is to design a path for autonomous robot using image processing techniques. The proposed system finds and analyses an optimal path for a robots, while detecting obstacles along the way. The environment is first captured as an image using a camera. Obstacles detecting methods are then performed to detect obstacles within the unknown environment[21], A-Star algorithm is used to find the shortest path. Different algorithms for object detection include background subtraction [12][13], temporal difference[13], statistical methods[13], color histograms[14].

3.1) Background Subtraction: The background subtraction method use the difference of the current image and background image to detect moving objects[12]. After background image is obtained, background image is subtracted from the current frame. If the pixel difference is greater than the predefined threshold, that means the pixels are present in the moving object, otherwise, they are the background pixels. The moving object is detected after thresholding operation. But the drawback of background subtraction method is that it is sensitive to the changes in the environment [12].

3.2)Temporal difference: In temporal difference method the current frame is subtracted from the previous frame, and if the difference between the values for a given pixel is greater than a threshold , the pixel is considered part of the foreground. In this method, detection of moving object is not accurate. This method is the simplest form of background subtraction [13].

3.3)Color Histograms: Color histograms have been widely used for object detection and tracking due to their robustness, speed and simplicity. Color histograms are stable object features in the presence of occlusion and over changes in views, scales and shapes [14].

4)Object Tracking: Object tracking is used to track the position of the object i.e if the object is moving towards the user or away from the user, but before object tracking object detection is required. Every tracking mechanism involves a object detection methodology. The objective of tracking the obstacle is to associate target area of interest in the consecutive video frames. Tracking is done frame by frame. Different methods of object tracking are:

4.1)Optical Flow : Optical flow is the difference between the consecutive image frames of an object while it is in motion. Optical flow has a vector field where each vector is a displacement vector which shows the movement of points from first frame to second. Optical flow method is to calculate the image optical flow field, and do clustering according to the optical flow characteristics of image. Optical flow has higher accuracy of detecting multiple objects in complex scenes[18][20].As given in paper[7]Optical flow analyzes the motion vectors and decides if the detected object is moving away or towards the user. This method detects the moving object from the background, however, this method has large calculations so this is quite a complex method to detect and track the objects[7][18][19].

4.2)Point tracking: Tracking is a method of detecting objects represented by points across frames. Point tracking can be divided into two categories, i.e. Deterministic approach and Statistical approach.[16]

Given below is the comparison of few different methods and algorithms.

Methods	Accuracy	Complexity	Advantages	Dis-advantages
Background Subtraction	Moderate	Moderate	Low memory requirement	It does not cope with multimodel background.
Optical flow	Moderate	High	It gives complete information about motion.	large amount of calculation is required.
Frame Differencing	High	Low to Moderate	Easiest method. Performs well for static Background	It require a background without moving object

IV. FUTURE SCOPE AND CHALLENGES

There should be different modules to recognize different types of obstacles such as paper, water, pits etc. Such systems should detect objects accurately and give valid output. The system should detect obstacle within real time constraint and for system to perform correctly, the camera should be of larger resolution. Also while moving the camera should produce less noise in the video frames. In the environment where the camera is working, the light intensity should be constant. If we get accurate results then only the navigation system will work properly.

V. CONCLUSION

This paper surveys various navigation techniques and object detection techniques. For blind people, building a navigation system is a tough challenge. As far as, outdoor happenings are considered the blind people face difficulties in autonomous mobility, depriving them of usual societal life. As we know that the visually impaired person has difficulty to know what is going on in his/her surrounding, so we can try to help them by developing a system which will help these people navigate safely. We can develop such navigation systems using different methods given in this survey paper.

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