ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol.2, Special Issue 5, October 2014

Computer Vision-Based Aid for the Visually Impaired Persons- A Survey And Proposing New Framework

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ABSTRACT: Developing a tool for the visually impaired people is not a recently emerged problem. But developing a computer aided tool is a still developing area. The aim of all these systems is to help the user in navigation without the help of a second person. There are several works using computer vision techniques. But there is no existing method that help to solve the all basic needs of blind person .All existing systems are designed only for a specific purpose. In this paper, we propose new theoretical framework which combines the key aspects of some use full methods and added some extra capabilities for assisting the blind person. This new system may solve some of major problems of blind persons that are still existing. Also, we give a comparison and analysis of the current use full navigation methods, and identify some challenges which require further research and development.

KEYWORDS: Blind navigation , assistance, Computer vision, stereo vision, image processing.

1.INTRODUCTION

The World Health Organization estimates there are about 314 million vision impaired people in the world, of which about 45 million are blind. The leading causes of blindness are cataract, uncorrected refractive errors, glaucoma, and macular degeneration. Many people who are seriously vision impaired use a white cane and/or a guide dog to avoid obstacles. Moving through an unknown environment becomes a real challenge when we can't rely on our own eyes. Since dynamic obstacles usually produce noise while moving, blind people develop their sense of hearing to localize them. However they are reduced to their sense of touch when the matter is to determine where an inanimate object exactly is.

Nowadays, most of the commercial solutions for visually impaired localization and navigation assistance are based on the Global Positioning System (GPS). However, these solutions are not suitable for the visually impaired community mainly due to low accuracy, signal loss and the impossibility to work on indoor environments. Moreover, GPS cannot provide local information about the obstacles in front of or in the near surroundings of the person. Furthermore, other commercial products available in the market present limited functionalities have low scientific value and are not widely accepted by the users.

Computer vision-based approaches offer substantial advantages with respect to those systems and constitute a promising alternative to address these problems. But till now there is no existing tools that satisfies major needs of blind persons. So here we are propose a new framework for blind assisting system. Also we took a survey of some use full methods. .

II. SURVEY OF EXISTING METHODS

2.1.Stereo vision-based obstacle detection

This method[1] describes a portable vision-based obstacle detection system, intended for use by blind people. The system combines an obstacle detection system designed for AGVs with recalibration of ground position and a Kalman Filter based model of the person's walking movement. Obstacle detection is achieved through comparison of the disparity seen with that expected from the position of the ground. Recalibration of ground position is made by plane fitting in the ground region. Motion estimation using two visual methods and the use of an inclinometer is described. The results show satisfactory success in all parts of the system. The system described in [1] provides part of an obstacle avoidance capability. It will form a major part of the mobility function of a larger project, Autonomous System for Mobility, Orientation, Navigation and Communication (ASMONC) which aims to provide a full navigation and mobility capability for blind and partially sighted people. Other sensors, such as sonar, are likely to be included to improve robustness. Sonar is reliable for detecting large andhigh obstacles, but it is not suitable for detecting small obstacles standing on the ground plane, as the angular resolution is insufficient to distinguish between the ground plane and the obstacle. Therefore a major requirement for the vision system is to detect small obstacles, and this is investigated here. This system is aiming to be capable of detecting obstacles of around 10 cm in height, at a 3–5 m distance, with the vision system. The ASMONC project uses a backpack, worn by the user, to hold the system electronics and sensors. A Loughborough Sound Images color image processing module, based around the TI C40 processor, is used to perform all of the processing tasks required for vision. It is connected directly to two Sony NDP-40BY/E cameras. The two cameras are mounted on two rigid arms, which extend over either shoulder of the user from the backpack. Camera mounts were designed which allow minor adjustment of the camera orientation for camera alignment. The left camera is connected as the red input of the C40 module, and the right as the green. Camera calibration is performed. The sonar sensors are fixed on the chest and belt. The starting point of the vision system draws on the Ground Plane Obstacle Detection (GPOD) algorithm, which has been used successfully for obstacle avoidance in mobile robots. GPOD uses a pair of cameras to determine features which do not lie on the ground plane. It characterizes the ground plane by a parameterization based on measurement of disparity, rather than projection into the external world. This improves robustness to calibration errors. It includes an initial calibration stage in which the ground plane parameters are extracted. Features originally known to lie in the ground are tracked, and the ground plane re-parameterized at each iteration. This allows adaptation either to genuine changes in the plane's parameters or to changes in camera position. We show that the use of a Kalman Filter to track both the ground plane features and suspected obstacles provides sufficient stability for obstacle detection. Another major requirement is the measurement and prediction of camera motion to provide the parameters which guide ground plane recalibration. The image stabilization methods used in products such as camcorders are unacceptable, because this system need to identify all six degrees of movement of the cameras, and cannot simply use an image-based readjustment. The measurements are fed into a Kalman Filter gait model to improve the reliability of the estimates.

2.2. NAVI

The NAVI[2] system comprises of 3-part functioning units namely a digital video camera, a single board computer and a headphone. The single camera limitation in providing the depth information, which is critical for navigation purposes, has prompted the extension into a stereovision system by using two cameras. This stereovision system also uses the fuzzy-based segmentation procedure as an image pre-processing package that was developed for the single camera NAVI but with an additional adaptive loop. The segmented images undergo a rule-based stereo matching procedure. From the matching features, the disparity is computed. The disparity in combination with information of focal length as well as the space between two cameras provides the information on the distance between cameras and object. This distance information is incorporated into the final processed image as four gray levels such as white, light gray, dark gray and black. The size and location of object in the visual plane is then conveyed to the blind individual by means of a structured coded sound. The distance information is represented by means of verbal sound.

BEGIN
↓
Adaptive Fuzzy-based Segmentation
↓
Rule-based Stereo Matching
↓
Computing Disparity
↓
Computing Distance
↓

Generate Structured Stereo Sound for Identifying the Size of Object

↓

Generate the Verbal Sound to Indicate Four-level Distance

Figure 1: Flow chart of methodology

2.3. Wearable navigation assistance

This method [3] describes the system architecture for a navigation tool for visually impaired persons. The major parts are: a multi-sensory system (comprising stereo vision, acoustic range finding and movement sensors), a mapper, a warning system and a tactile human-machine interface. It consists of a sensory system controlled by the user. The primary data needed for local navigation is range data. . The mapper converts the range data into map data. The local map is the input to a warning system that transforms the map data into a form that is suitable for communication. They use three sensor types: stereovision, optical flow, and sonar. Stereovision and optical flow are accomplished by an optical imaging system consisting of a dual camera system mounted in the two legs of a pair of spectacles. This allows easy control on the focus of attention. The camera system must be provided by an IMU that registers the movements of the head.

2.4. A Stereo Image Processing System for Visually Impaired

This method [4] proposes an approach for visual rehabilitation using stereo vision technology. The proposed system utilizes stereo vision, image processing methodology and a sonification procedure to support blind navigation. The developed system includes a wearable computer, stereo cameras as vision sensor and stereo earphones, all moulded in a helmet.In order to incorporate the distance information, stereo cameras are used.Use of stereo vision sensors has been of research interest mainly for extraction of 3D models of objects and for perception of depth. The captured image's edge is calculated. After the noise removal process, the broken edges are filled and excess edges are removed. And the closed edges are filled. These binary images are mapped with the resized gray scale images to derive new gray scale intensity images with only objects. As a next step, the depth is calculated and though disparity. Then the object preference is calculated using a fuzzy inference system. And it is transformed to acoustic form when the object appears to the blind people.

2.5. Vision System for the Blind that Helps Find Lost Things

This method[5] present a computer vision system that helps blind people find lost objects. To this end, they combined color- and SIFT-based object detection with sonification to guide the hand of the user towards potential target object locations. They used SIFT to detect known objects. To this end, the system provides a simple training interface, which makes it possible to train new objects by holding them in front of the camera and triggering snapshots. Trained objects can then be searched for in the environment using common SIFT feature matching and classification methods. When using local features such as SIFT and SURF, it is only possible to detect specific, known objects (i.e., existent in the database) with a distinctive texture. As a complementary approach, they used visual attributes to help find things in a broader range of scenarios. To this end, this prototype implementation used probabilistic models of the 11 basic English color terms, which can also be used to name the color of an object in front of the camera. The sound properties pitch and pan are used to map the information about the object's location that is received from the vision module.

2.6.Computer Vision-Based Door Detection

In this method[6] ,they presents a robust image-based door detection algorithm based on doors' general and stable features (edges and corners) instead of appearance features (color, texture, etc.). A generic geometric door model is built to detect doors by combining edges and corners. Furthermore, additional geometric information is employed to distinguish doors from other objects with similar size and shape (e.g. bookshelf, cabinet, etc.). The robustness and generalizability of the proposed detection algorithm are evaluated against a challenging database of doors collected from a variety of environments over a wide range of colors, textures, occlusions, illuminations, scale, and views.

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International Journal of Innovative Research in Computer and Communication Engineering

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Vol.2, Special Issue 5, October 2014

The developers developed an image-based door detection algorithm by establishing a general geometric door model that utilizes the general and stable features of doors (i.e. edges and corners) without a training process. Furthermore, integrated with geometric information of lateral at similar horizontal coordinate, the proposed algorithm is able to distinguish doors from other objects with door-like shape and size. The detection results demonstrate that this door detection method is generic and robust to different environments with variations of color, texture, occlusions, illumination, scales, and viewpoints.

2.7. Acoustic Perception Based On Real Time Video Acquisition

A smart navigation system (an Electronic Travel Aid) based on an object detection mechanism has been designed in [7] to detect the presence of obstacles that immediately impede the path, by means of real time video processing. In this paper this is discussed, keeping in mind the navigation of the visually impaired. A video camera feeds images of the surroundings frame by frame. The processor carries out image processing techniques whose result contains information about the object in terms of image pixels. The algorithm aims to select the object which, among all others, poses maximum threat to the navigation. A database containing a total of three sounds is constructed. Hence, each image translates to a beep, where every beep informs the navigator of the obstacles directly in front of him.

The proposed algorithm contains the steps video acquisition, image extraction from the video, RGB component extraction from the image, edge detection, edge combining using logical OR, preprocessing steps like dilation, fill, erosion to form objects from edges. Then object preference is set by dividing the frames into parts. And high pitch sound is produced when the object appears in the frame which is near to the user.

2.8.An embedded system for aiding navigation of visually impaired persons

The work by Amit Kumar[8]presents a methods in order to help blind people navigate safely and quickly, an obstacle detection system using ultrasonic sensors and USB camera-based visual navigation has been considered. The proposed system detects obstacles up to 300 cm via sonar and sends audio feedback to inform the person about their location. In addition, a USB webcam is connected with eBox 2300 Embedded System for capturing the field-of-view of the user, for finding the properties of the obstacle in particular, in the context of this work, locating a human being. Identification of human presence is based on face detection and cloth texture analysis. The major constraints for these algorithms to run on the Embedded System are small image frame (160 × 120) having reduced faces, limited memory and very less processing time available
to achieve real-time image-processing requirements. Prototype of an electronic travel aid device has been developed and experimentally verified on blind-folded persons to analyse the device performance in a laboratory set-up.

III. DISCUSSIONS

Based on the above evaluation, this section makes a comparison and analysis of the current methods discussed above .

Method	Techniques used	Devices used	Uses	Remarks
2.1	**AGV , Kalman filter based model**	**Sensors, camera**	**Obstacle detection and navigation**	**Not simple. and costly**
2.2	**Stereo sound and image processing**	1.Digital video camera fixed on headgear 2-Stereo earphones 3-SBPS with chassis 4-NAVI Vest.	**Obstacle detection and navigation**	**No distance calculation**
2.3	**Stereo vision, mapping**	Sensors, acoustic device, stereo vision camera, mapper	**Obstacle detection**	**Need mapper, no accurate distance calculation**
2.4	**Stereo vision,**	wearable computer,	**Obstacle detection**	**Distance is measured.**

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	image processing, fuzzy inference	stereo cameras as vision sensor and stereo earphones		**Good performance**
2.5	**SIFT, neural network**	Video camera, sound systems	**Object recognition, finding objects**	**But no obstacle detection**
2.6	**edge detection, corner detection**	Video camera	**Door detection**	**no obstacle detection on the way of door**
2.7	**Basic Image processing techniques**	Video camera, sound systems	**Obstacle detection**	**Not accurate distance measure**
2.8	**Both sensing and image processing**	Ultra sonic sensor and USB camera	**Obstacle detection and obstacle identification**	**Detection distance is limited..No distance measure**

Table 1: Comparison table of different methods explained in the survey

3.1.Challenges:

While many tools have been introduced to help address these problems using computer vision and other sensors (talking OCR, GPS, radar canes, etc.)], their capabilities are dictated as much by the state-of-the-art in technology as they are by real human problems. From this survey we find that there is no system that have multiple capabilities .All previous methods are designed for specific function. The following problems could not solve with existing methods.

1.There is no existing tools that combining some important needs of blind persons.
Each system is developed for specific purpose.
2. Identification –(No Context).The user has asked what an object is, with no additional information about the object provided.
3.Identification – (Contextual).The user knows the general type of the object, but wants to know the specific brand or exact name
4. Identification of Currency
5.Structure,design and color of objects
6.Description of current state(Example on or off)
7.Description content(eg:computer screen content)

3.2.Proposed framework:

For solving some important problems we propose a new method as follows:

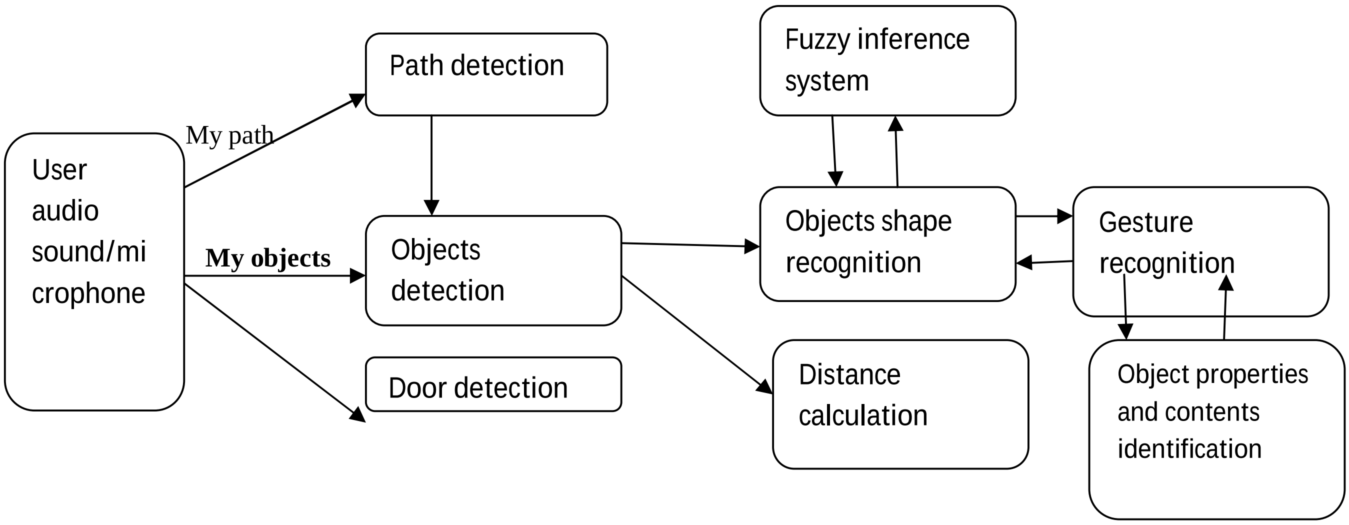

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Figure 2: Different units of a proposed system,

This approach will solve major problems that faces by blind peoples. Because it is comprises some important units in to a single system. The proposed scheme can have the following capabilities.

Obstacle detection, object identification, path and door detection, object features identification(eg: color, design etc) and reading content of objects(eg: Computer screen ,TV etc). The proposed system will use image processing technique, gesture recognition , and some of the existing techniques .

IV. CONCLUSIONS

In this paper, firstly we conducted a evaluation and comparison of some use full existing systems. It is found that image processing plays an important role in obstacle detection for the navigation of blind. By using experiments and theoretical evaluation, we found that some of the assisting systems are good for some purpose. From this survey we realize that there is no system that can help to assist all basic needs of blind persons. Also we discussed with some blind persons, and they also not satisfy with existing systems. They still faces some problems and they need a better system that have multiple capabilities. Because all existing systems are used for individual purpose. So a new framework that combines navigation and other basic aid for visually impaired are proposed. The works are continued to overcome the problems encountered ,while assisting blind persons. This new system may help to solve major problems faced by blind persons.

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