Detection of Possible Obstacle Objects based on its Shape

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ABSTRACT
This study is a part of designing a system that will help to detect possible obstacles among the in-house object for visually impaired, low vision personnel by birth or accident or due to old age. The input of the system will be a scene (set of objects) and output as audio. Facility of alert is provided based on potential obstacles that gives by its shape like pointed tip, sharp edge, fragile, danger symbol etc. Different techniques are use to provide detection of objects based on shapes and alert users about the severity of the objects. The features of the object are extracted, and clusters of features are formed based on shape similarity. This avoids the exhaustive searching during testing and thus gives less computation timing. Alert service is provided to the user before the actual object is detected by considering the shape of the object. In case the object does not have a likely matching shape in any of the clusters, then it will not performed the remaining several operation that required for object detection. It declared as a new object. In such way, the overburden to the system is minimized.

General Terms
Pattern Recognition, Image Processing

Keywords
Alert facility, severity of the objects and shape

1. INTRODUCTION
A human being acquires data from the outside world mainly relying on their sights. An obstacle detection system is required to alert the target user in time. The output of such system can be directed to Bluetooth devices in the form of sound. The possible obstacle, severity level and specific description of the detected objects could be provided to alert at any time of difficulties. This will help to deal with an object that comes as hindrances in front of them. The study concentrated to provide a minimum time to raise this alert only by considering the shape of the object(s). This auditory object detection system can provide alerts to the user and nearby people about the dangerous and harmfulness of object ahead. It is aims to develop software with minimum infrastructure and cost so that it is feasible to embed into low cost devices. The shape and scale of the query image is not matching with shapes of objects in the available database (training), the remaining several operation of object detection: segmentation, cleaning, normalization, detection etc will not perform. This will save computation time.

2. RELATED STUDIES
The proposed research involves image processing and computer vision. According to WHO (World Health Organization) estimates in June 2012, there are about 285 million people are visually impaired worldwide, out of these 39 million are blind , and 246 million have low vision i.e. Severe or moderate visual impairment. About 90% of the world's blind people live in developing countries. 65% of visually impaired and 82% of blind people is over the age of 50 years, although this group comprises only 20% of the world population [1].

Many Electronic Travel Aids(ETA) devices available for such target user. For example, there are ETA devices in USA, such as LaserCane[2], NavBelt[3], PeopleSensor[4], GuideCane[5], Tyflos[6], Binaural Sonic Aid[7], v0ICe in Netherlands[8], 3-D Space Perceptor in Canada[9],NSOB in Japan[10], ESSVI in Italy[11], Navigation Assistance Visually Impaired(NAVI) in Malaysia[12], AudioMan[13] and SoundView[14].

Most of the above mentioned devices work on GPS and MAPs which is not highly possible in localities of middle class families. Most of the system has audio in English language which is difficult for rural level user. Facility of reporting the severity levels of the objects and alert systems is not provided in most of the available devices[5,15]. The full time wearable devices will have a health problem for the user. This study may provide a better health care and benefits to targeted middle class users of all ages.

3. PROPOSED WORK
A system flow diagram (SFD) of the proposed study is presented. The general flow of the process happen during training and testing is shown in the form of diagram-general flow diagram for Training process and testing process. General description of study is described.

A. Image acquisition

Images are taken as input, and then stored in the particular folder and done the other steps of processing

B. Scaling the image

Different images have different dimensions. And hence the size will vary according to the dimension. The higher the dimension, the more space will be consumed to store the image, and more time will be required to process the image. So, keeping this two factor (i.e. Time and space) in consideration the dimension of all the images will be scaled in a standard format.

C. Cleaning the image

While capturing, all the images may not be clear, some images may be blurred. Cleaning algorithm will help us to get a clear image from the blurred one, so that edge detection becomes easier. Morphological Image cleaning algorithms are considered for this study. The study uses the morphological algorithms for extracting boundaries and connected

components and the skeleton of a region. Some of the frequently used methods such as region filling, thinning, thickening, and pruning that are also applied as pre or post-processing steps. In the processing and analysis of images, it extracts the features, describe shapes and recognize patterns.

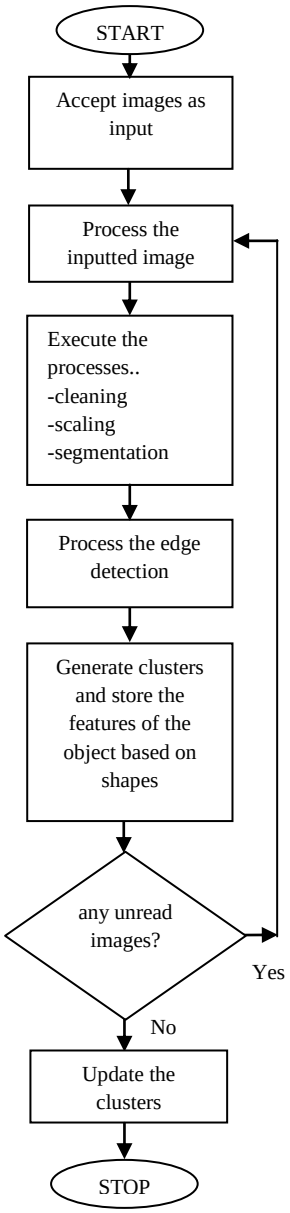

Fig1: System flow diagram for the training process

D. Segmentation

Image segmentation normally is a process of partitioning or subdividing an image into multiple meaningful regions etc giving a set of segments that collectively cover the entire image.

E. Edge Detection Technique

Edge detection is a fundamental tool in image processing, and it identifies the points in a digital image at which the image brightness changes sharply or otherwise and also sees discontinuities. There are three steps in edge detection technique.

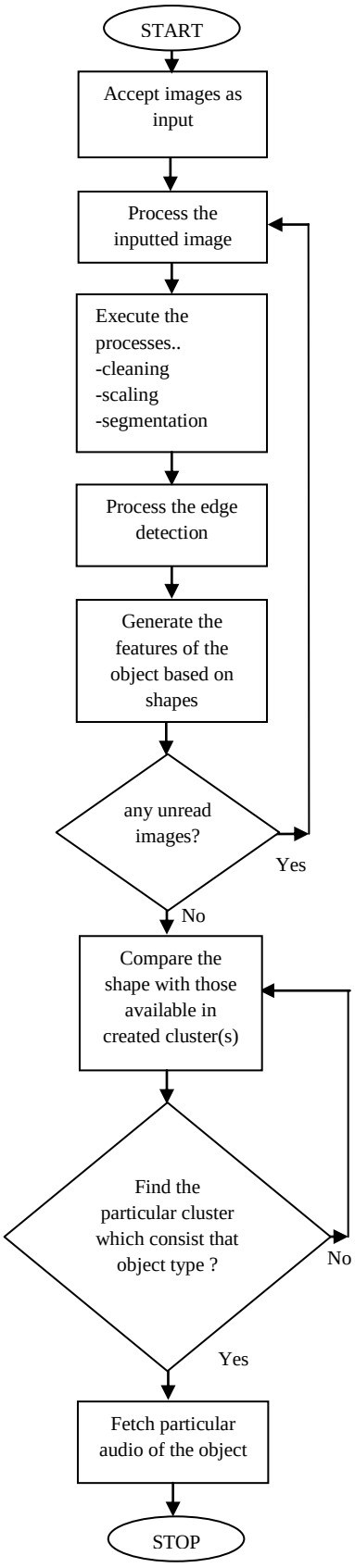

Fig2: System flow diagram for the testing process

F. Filtering and Enhancement

Any raw images are corrupted by noise; such noise can be clean before the next process. Enhancement process is performed to improvement of digital image quality.

G. Conversion to a standard format

The JPEG format consumes large memory space the memory needs to be reduced and the necessary information. The binary image takes only 0 and 1 describe the image, and it also keeps the necessary information. So image will be converted to the binary format.

H. Grouping

If all the inputs need to be checked from the database in a serial order it the high computation time. Grouping makes the process easier. Grouping is mainly done by differentiating the images according to their geometrical shapes.

I. Identify the type of objects

The objects will be identified according to which group it falls. They are primarily identified using the shape detection method and it will give us the type of object.

J. Comparing the test data

This is the second phase of this study. When an object is discovered in the surrounding, in front of a visually impaired person, the image must be identified, and actions to be taken must be announced to the visually impaired person. But before that knowing the type of the object is important. So to identify the object, comparison of the objects are done with features those are already available in the database. So, to do the comparing of images there are three techniques.

K. Histogram Method

It builds feature histograms for each image, and chooses the image with the histogram closest to the input image's histogram which is potentially faster.

4. BOUNDARY STRUCTURE SEGMENTATION

The study uses the Boundary Structure Segmentation model (BoSS) to retrieve the shapes of the objects during the training and testing phases. BoSS provides a detection score for the particular object Model[14]. The study collects the features of the objects and stores in clusters categories based on shape of objects. A simple formula for BoSS is given.

BoSS (s) = Detection(s, m) + Cluster (s) …..(1)

Where s is segment indicator vector for an image that has N pixels. To define a model (given below), consider all possible pairs of boundary edges of a segmented object capturing the geometric configuration of two boundary edges, and their distribution to describe the global shape. Boundary Structure Matching is used to compares the edge of the model and image segmented.

The distances measures of shape described with point set, can be described by the clusters into which it falls using a predefined clustering based on acceptance and rejection schemes.

5. THE EXPERIMENTS AND THE RESULTS

5.1 Representation of the Detected objects using an Audio

The detail descriptions of the detected objects are represented in the form of audio. For example, the detected object is 'pointed pin' the description and severity level, action to taken is suggested by the system to the targeted user.

Fig3. A lizard auditory system Wireless speaker

5.2 Object models based on 'shape'

The study uses some predefine obstacle object model. The features of all participating models are stored. The shapes of training image and testing images were compared by means of graph comparison method. The graph matching problem, which evaluates the structural similarity between the graphs that represents the object (normal or broken state). The shapes like sharp edge objects (knife, pin) and broken glass is detected and alerted to the user. The model having the predefine shapes are also used to determine the status of the object such as broken cup or not.

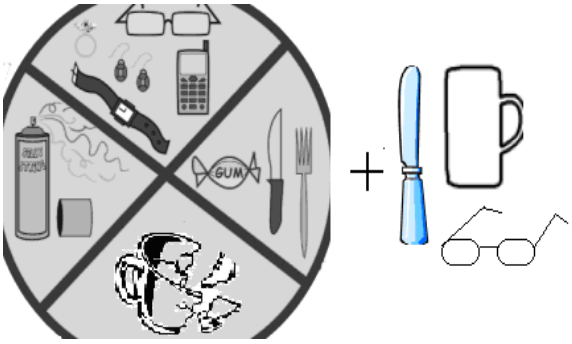

Fig3. Scene object model for detection

5.3 Computation Time based on 'shape'

The given graph shows the processing time taken during an exhausted search and search time using the 'shape based' approach. Generally the time taken during the non-shaped based (exhausted search) took thrice the original time. By introducing such study on the object detection based on the shaped give speedy processing time. It can save time during the testing process one (or more) objects.

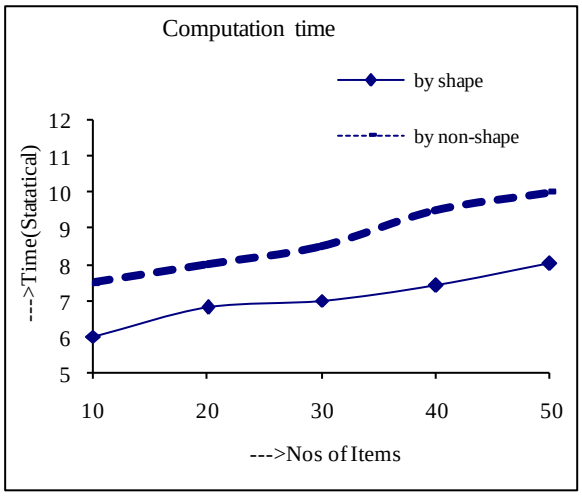

Fig4. Computation time

5.4 Computation Time based on 'cluster'

As the features of the objects are stored as per the different clusters for each different shape, the searching time also reduce to half to this search that took without have this clustering facility. Similar performance graph s available for this study varying the timing graph.

5.5 Groups of possible obstacle objects based on shapes

There could be objects having possibly harmful for a user, like breakable or broken items with a pointed or sharp edge. The objects having such shapes will be alerted immediately before the system processes for identifying the actual object.

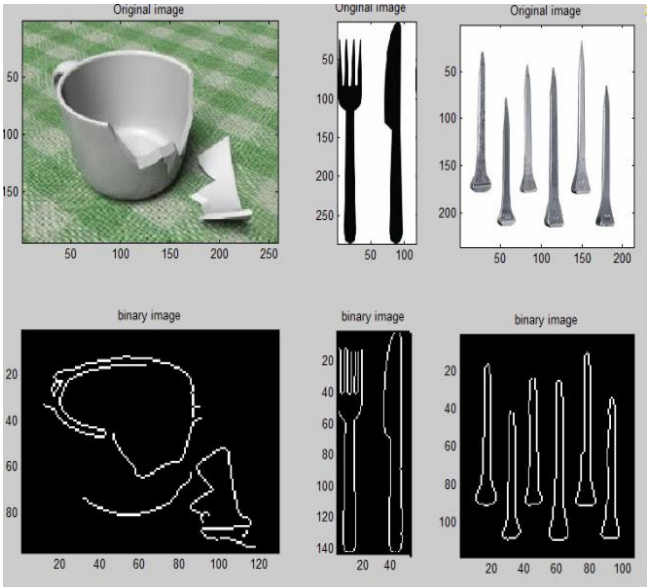

Fig5 a. Samples of clusters based on (a)breakable and pointed edge and

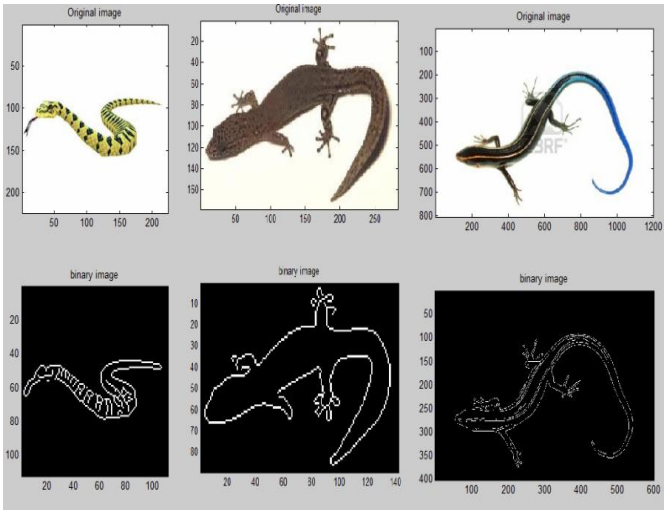

Fig5. Samples of clusters based on (b) poisonous objects

5.6 Alert facility based on the 'shape of the object'

The implemented system can provide an early alert to the target user based on detected shaped of the object. For example-there could be groups of breakable items, pointed edges, snake types, water etc.

5.7 Early detection of objects

Every time, the query objects may not available in the feature dataset. In case of exhausted search, the availability or non-availability of the object(s) will be reported after completion of the exhausted search, after consuming a long time. However by using the shape based, if the shape type of the object is not available, an alert will be issued without wasting much time.

6. CONCLUSION

The main goal of this application is to introduce an innovative virtual reality system in order to provide an interface that is accessible to visually impaired users. The application allows the visually impaired people to understand the object(s) present in an environment. The development of this application will be extremely helpful for the community of visually impaired people. This application will help them to protect themselves from danger and may save their life. It will also help them to be independent and do their things by their own and lead a safe life.

Computation based on shape shows the processing time taken during the non-shaped based (exhausted search) takes thrice the original time. By introducing such study on the object detection based on the shape gives speedy processing time. It can save time during the testing process any objects. As the features of the objects are stored as per the different clusters for each different shape, the searching time also reduce to half to those searches that take without having this clustering facility. The objects having similar shapes of possible obstacle can be alerted immediately before the system processes for identifying the actual object. The availability or non-availability of the objects will be reported after completion of the exhausted search, after consuming a long time. However

by using the shape based, if the shape type of the object is not available, an alert will be issued without wasting much time.

7. ACKNOWLEDGMENTS

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8. REFERENCES

[1] Blindness and Visual Impairment: global Facts. "http://www.vision2020.org. Archived on 28June2013

[2] Global initiative for the elimination of avoidable blindness action plan, Report of WHO-2011, 2006–2011

[3] Shalu Gupt, Y. Jayanta Singh, A Survey on Indoor Object Detection System, International Journal on Advanced Computer Theory and Engineering (IJACTE), Volume1, Issue1, 2012,

[4] C. Capelle, C. Trullemans, P. Arno, and C. Veraart, "A Real-Time Experimental Prototype for Enhancement of Vision Rehabilitation Using Auditory Substitution," IEEE Trans. Biomed. Eng., Vol. 45, pp. 1279-1293, Oct. 1998.

[5] Shoval S. Auditory guidance with the Navbelt: a computerized travel aid for the blind. IEEE transactions on SMC, Part C, 28(3): 459-467, 1998

[6] Ram S, etal. The PeopleSensor: A Mobility Aid for the visually Impaired. IEEE Second International Symposium Wearable Computers,166-167, 1998

[7] Ulrich I, Borenstein J. The GuideCane – applying mobile robot technologies to assist the visually impaired. IEEE Transactions on Systems, Man and Cybernetics, 31(2):131-136, 2001

[8] Bourbakis NG, Kavraki D. An intelligent assistant for navigation of visually impaired people[A]. Proceedings of the IEEE 2nd International Symposium on Bioinformatics and Bioengineering Conference. 230-235, 2001

[9] Kuc R, Binaural Sonar Electronic Travel Aid Provides Vibrotactile Cues for Landmark, Reflector Motion and Surface Texture Classification. IEEE Transactions on Biomedical Engineering, 49(10): 1173-1180, 2002

[10] Meijer P, An experimental system for auditory image representations. IEEE Transactions on Biomedical Engineering, 112-121,1992

[11] Milios E, Kapralos B, Kopinska A, Stergiopoulos S. Sonification of range information for 3-D space perception. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 11(4): 416 – 421,2003

[12] K Sawa, K Magatani, K Yanashima. Development of a navigation system for visually impaired persons by using optical beacons. Proceedings of second joint EMBS/BMES conference, 2426-2427, 2002

[13] Ando. Electronic Sensory Systems for the Visually Impaired. IEEE Instrumentation & Measurement Magazine. 62-67, 2003

[14] Toshev, Alexander, Ben Taskar, and Kostas Daniilidis. "Object detection via boundary structure segmentation." Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on. IEEE, 2010.

[15] Chen, Kuang-Hsiung, and Wen-Hsiang Tsai. "Vision-based obstacle detection and avoidance for autonomous land vehicle navigation in outdoor roads." Automation in construction 10.1, 1-25,2000