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# Vicariously Self-Adaptive Re: Sight for the Visually Impaired Using Spatial Data Mining

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*ABSTRACT---* ***Visually challenged mostly depends on the Braille language for reading textual documents and on canes for travel from place to place. They require much guidance in their daily activities thus preventing them from living independently. By providing them with virtual visibility of the environment, the proposed system allows them to "see" vicariously and live an independent lifestyle. The system applies Artificial Intelligence (AI) by implementing concepts of Learning and Computer Vision through latest trends in technology such as Clustering Large Applications based on RANdomized Search (CLARANS) with Spatial Data Mining using R language and Pattern Recognition for text, obstacles and specific sign boards using Neuro Optical Character Recognition (NeuroOCR) respectively and delivers output as audio descriptions. The smart kit contains a mobile device for speech to text conversion, the Raspberry Pi that serves as the processing system along with GPS, a High Definition (HD) Camera, an earphone and a bus module device with GPS. The design involves object or obstacle detection algorithm through Ultrasonic (US) sensors and textual, boards and signs recognition using NeuroOCR algorithm. The main aspect being CLARANS as it provides a safe, guided and intelligent navigation system that implements concepts of learning frequent routes along with obstacles and bus transit route details which retrieve required bus routes and their respective distances from the cloud, all come together to create a virtualized vision for the visually challenged.***

***Keywords--- Spatial Data Mining, Neural Networks, Image Processing, Raspberry Pi, Internet of Things, Ultrasonic Sensors, GPS***

## I. INTRODUCTION

Visually challenged people are one among the very bold in the world because they sense, smell and hear ending up learning to rely on their instinct. They are bold enough to the point that they have entered into the field of government, engineering, teaching etc. Also, there is a lot of responsibility for them as carry out their activities with their respective acquaintances, working with objects and various readable documents and end up as people whom we look up to. As a result of their limitations not only in their fields of interest but also with various difficulties faced in everyday life they are unable to chase after their dreams and goals. All across the globe there are many who are born blind and some, through unfortunate accidents, have lost their vision. To deal with such unfortunate and painful loses, here is a technology where they will be able to virtually 'see' and understand the happenings of the world through a mix of audio descriptions and their imaginations.

## II. RELATED WORK

*Jinqiang Bai, Shiguo Lian, Zhaoxiang Liu, Kai Wang and Dijun Liu [1]* aim to overcome the travelling difficulty for the visually impaired group, this paper presents a novel ETA (Electronic Travel Aids)-smart guiding device in the shape of a pair of eyeglasses for giving these people guidance efficiently and safely. Different from existing works, a novel multi-sensor fusion based obstacle avoiding algorithm is proposed, which utilizes both the depth sensor and ultrasonic sensor to solve the problems of detecting small obstacles, and transparent obstacles. For weak sighted people, visual enhancement which leverages the AR (Augment Reality) technique and it integrates the traversable direction is adopted. The prototype consisting of a pair of display glasses and several low-cost sensors is developed, and its efficiency and accuracy were tested and is shown in the paper *Smart Guiding Glasses for Visually Impaired People in Indoor Environment (2016).*

*Rama Murthy.N and P.N.Sudha [2]* suggest using the technologies such as Electronic Navigational Aids and Computer Vision to create a device that helps in navigation of the visually impaired. Visually Impaired persons require continuous assistance of other people for their mobility which makes them largely dependent on others for their social life. Traditional Guide tools were available such as white canes and guide dogs; both are limited and have many disadvantages. The obstacle avoiding technique using Ultrasonic sensor based spectacles, waist belt and shoes, which makes use of two, three and four ultrasonic sensors respectively to detect ground, waist level and head height obstacles especially useful in detection of pits is conceived in the paper *Smart Navigation System for Visually Impaired (2016).*

*Sunita Ram and Jennie Sharf [3]* suggest using Electronic Travel Aids, which transform visual environmental cues into another sensory modality as they also have proven to help visually impaired people travel with a greater degree of psychological comfort and independence. The People Sensor is an Electronic Travel Aid designed to address two issues of importance to visually impaired people: inadvertent cane contact with other pedestrians and objects, and speaking to a person who is no longer within hearing range. The device uses piezoelectric and ultrasound sensors to locate and differentiate between animate (human) and inanimate (non-human) obstructions in the detection path. The distance between the user and the obstruction, along with the nature of the obstruction (human or non-human) is transmitted via modulated vibrio tactile feedback further explained in the paper *The People Sensor a Mobility Aid for the Visually Impaired (2016).*

*Mohd Helmy Abd Wahab, Amirul A. Talib, Herdawatie A. Kadir, Ayob Johari, A.Noraziah, Roslina M. Sidek and Ariffin A.Mutalib [4]* explains their study that hypothesizes a smart cane which alerts visually-impaired people regarding obstacles in front and helps them in walking with less accident. The aim of the paper is to address the development work of a cane that could communicate with the users through voice alert and vibration, which is named Smart Cane. This study explains Smart Cane functions, in alerting users about the obstacles in front by use of audio output as mentioned in detail in the paper *Smart Cane: Assistive Cane for Visually-Impaired People (2016).*

*King-Sun Fu and Azriel Rosenfeld [5]* show extensive research and development has taken place in the areas of pattern recognition and image processing especially in the fields of business (e.g., character recognition), medicine (diagnosis, abnormality detection), automation (robot vision), military intelligence, communications (data compression, speech recognition), and many others. A very brief survey of recent developments in basic recognition and processing is discussed in the paper *Pattern Recognition and Image Processing (2015).*

*Diwakar Srinath .A, Praveen Ram A. R. , Siva R. , Kalaiselvi V. K. G. and Ajitha G. [6]* explain about creating a device that enables the blind to perceive human faces, objects or obstacles and text. The camera present at the nose head of eye glass captures the intended image of the user as snapshots and transfer to the system where it gets processed and produces the specified audio descriptions as output. The system's database holds a corresponding text for each image which is then converted to audio stream when sounded. In case of any mismatch or no entry of the image in the datasets then the new image is stored as new dataset with the name specified through microphone. This avoids mismatch of that image in the future search. Further explanation of algorithms and concepts used is discussed in the paper *HOT GLASS – Human Face, Object, Textual Recognition for Visually Impaired (2015).*

*B.N.Kiran, Smitha.B.C, Sushma.K.N and Varsha.R.Gowda [7]* propose the implementation of RFID as a bus detection mechanism to help the visually impaired in travelling from one place to another. Several solutions have been proposed like walking stick or white cane, guide dogs and GPS guidelines to deal with this difficulty. Although some of them have shown to be useful in real scenarios, they involve an important deployment effort or use artifacts that are not natural for blind users. The development of a bus detection prototype using Radio Frequency Identification (RFID) for blind which has the potential to be a useful aid with further standardization of RFID tags and improvement of current RFID readers, interfacing reader with microcontroller (ATMEGA328-PU), using IR sensor for wireless communication design will be discussed in the paper *Implementation of RFID for Blind Bus Boarding System (2015).*

*Alessandro Dionisi, Emilio Sardini and Mauro Serpelloni [8]* propose a system that uses RFID (Radio Frequency Identification) that will store some information got from radio waves and which will in turn be used to make some decisions. The blind's capacities to navigate in a particular place and to organize their daily activities are of vital importance for their health and well-being. Organizing any kind of simple daily activity can be especially difficult. RFID, or radio frequency identification, is a technology that can provide a support for improving the organization and orientation during the daylight activities. The task of using RFID technology in many different contexts for the blind include scanning passports, shipments and automatic highway toll collecting and is further explained in the paper *Wearable Object Detection (2015).*

*Georgios Nikolakis, Dimitrios Tzovaras, and Michael G. Strintzis [9]* present a means of using haptic application that allows blind people to recognize three-dimensional (3D) objects that exist in virtual environment. The system allows blind people to touch, grasp and manipulate objects that exist in the haptic enabled VE. The system is designed in order to provide an alternative way of human computer interaction to blind users and is further discussed in the paper *Object Recognition for the Blind (2016).*

*J. Pradeep, E. Srinivasan and S. Himavathi [10]* present an off-line handwritten alphabetical character recognition system using multilayer feed forward neural network in this paper. A new method, called, diagonal based feature extraction is introduced for extracting the features of the handwritten alphabets.

Fifty data sets, each containing 26 alphabets written by various people, are used for training the neural network and 570 different handwritten alphabetical characters are used for testing. This system will be suitable for converting handwritten documents into structural text form and recognizing handwritten names as explained in the paper *Diagonal Based Feature Extraction for Handwritten Alphabets Recognition System Using Neural Network (2015)*.

*Adam Coates, Blake Carpenter, Carl Case, Sanjeev Satheesh, Bipin Suresh, Tao Wang, David J. Wu and Andrew Y. Ng [11]* suggest that there are to main components to read text from photographs - text detection from images and character recognition, also showing that many recent methods have been proposed to design better feature representations and models for both. Various methods in machine learning–specifically, large-scale algorithms used for learning the features automatically from unlabeled data–and to show that they allow to construct highly effective classifiers for both detection and recognition to be used in a high accuracy end-to-end system and further explained through the paper *Text Detection and Character Recognition in Scene Images with Unsupervised Feature Learning (2014)*.

*Virgil Tiponut, Sorin Popescu, Ivan Bogdanov and Catalin Caleanu [12]* explain the 3D obstacles detection system of an integrated environment that improves the mobility of blind persons into a limited area. The proposed solution is bio inspired, i.e. the system detects obstacles in a similar way as a subject with normal sight is looking for obstacles in front of him. For this purpose, both the position of detected obstacles and the position of sensors in 3D environment are available at the output of the system. Based upon this information, an acoustical virtual reality (AVR) is generated, as a substitute for the lost sight of the subject. With focus on 3D obstacles detection, using ultrasonic sensors and the determination of the position of the ultrasonic system, with magnetic sensors and accelerometers the system is explained in the paper Obstacles Detection System for Visually Impaired Guidance (2013).

## III. EXISTING SYSTEM

The existing technology includes a camera to take the snapshots of the surroundings and records video mainly frame by frame and analysis is done using the Optical Character Recognition (OCR) algorithm that does image based classification of text by processing each frame that will then be cross-checked with datasets of the system to check for multiple obstructions. This image based classification provides a great disadvantage as it compares images of text as opposed to understanding the text itself. The taken snapshots are processed with the corresponding algorithm and a relevant text document of that image is retrieved. Using the Principle Component Analysis (PCA) clustering algorithm mainly to recognize Human faces is a rather slow process due to the need of checking each and every cluster especially as the dataset keeps increasing. Then the text document is converted to an audio file and sounded through the earphone. However it focuses mainly on most recent snapshots and is hence slow to process the immediate surroundings. Also it is greatly restricted by its inability to aid in safe navigation and its inability to eliminate dependency on others especially in transit related situations.

## IV. PROPOSED SYSTEM

The proposed system introduces three main features through extended implementation of the existing system. First being, safe and guided navigation with obstacle detection using Raspberry Pi which will be implemented with the CLARANS algorithm that will learn the frequently used routes along with all the static features along the route such as obstacles, sign boards and bus stops/landmarks. The second feature will provide navigation through bus transit by guiding to the nearest bus stand and even providing information on what buses ply between respective source and destination which will be passed as input through android app. Finally text based classification will be done using the NeuroOCR algorithm that uses neural networks to compare each and every character of text using their salient features which will be extracted from the each frame caught by the camera irrespective of font or size.

## V. SYSTEM ARCHITECTURE

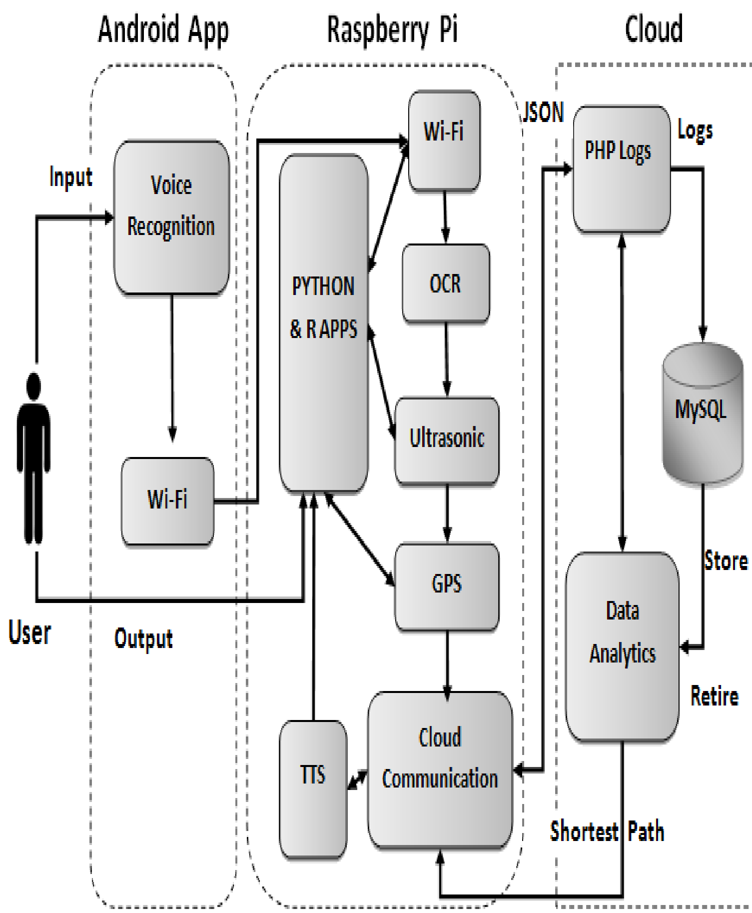


**Fig. 1 Architecture diagram of overall system with its working**

### *A. Android App*

Using an android app, users are able to provide input of their source and destination through their voice. It also allows the option of location tracking using the inbuilt GPS. The input will then be converted to text sent to the Raspberry Pi for processing.

### *B. Raspberry Pi*

The Raspberry Pi performs multiple functions. The first being obstacle detection through pattern recognition especially using the CLARANS spatial data mining algorithm and ultrasonic sensors to ensure a safe and guided navigation. Another feature being that it takes the input from the android app, it searches possible routes from source to destination that will be stored in the cloud and returns best route along with possible bus routes as output directly to the user via the speaker. Also together with its guided navigation, it provides ability to read text from various boards like buses, signs, etc. using the text classification NeuroOCR algorithm.

### *C. Cloud*

The cloud is mainly accessed through the Raspberry Pi which will search the database for bus numbers on the respective routes and also stores commonly used routes in the nearby vicinity. Also the process of training takes place using PHP logs and will be based on various boards and obstacles along the respective route providing safe navigation and the output will be sent to the Raspberry Pi.

## VI. MODULES

The overall system includes 6 modules, each of which has their own specific functions and working.

### *A. Android Google API – Speech Recognition*

The mobile device containing an android application to recognize voice and convert it to text will be used to take advantage of quick and efficient conversion using Google APIs as opposed to Raspberry Pi.

### *B. Data acquisition from Embedded Sensors*

A Python application will be created to indicate how the system should function as and when it receives an input through the Ultrasonic Sensor (US) and a High Definition (HD) Camera, which will be the obstacle and signs respectively.

- Using the input from Ultrasonic Sensors, the application will be able to process the distance between the wearer and the obstacle and establish what the obstacle is with the live video captured by the camera based on the objects that get dynamically stored in the cloud.
- Using the input from the High Definition Camera, the Neuro Optical Character Recognition (NeuroOCR) will be used to gather text of all sizes and fonts from the image frames and classify them.

### *C. Wi-Fi & Cloud Network Communication*

The wireless network creates the foundation of internet of things in the system and is the main way of data transfer between the mobile, raspberry pi and cloud. It also follows latest standards in network communication that is enforced using JSON. Wi-Fi network connects the mobile with the raspberry pi to transfer the converted text. It establishes communication with the private cloud to store and retrieve data regarding obstacles, text, routes and bus routes.

### D. *Cloud Based Data Log for Training Set*

The cloud will contain all the data needed for training and testing the neural networks and clustering algorithms. Also the process of training takes place using PHP logs as data set first generated after which, it makes use of the user's experience as new data sets. This training involves mainly dynamic route learning with its respective obstacles, sign boards and specific locations/landmarks.

### E. *Implementation of CLARANS Algorithm*

The Clustering for Large Applications based on RANdomized Search (CLARANS) algorithm is implemented in R. Its main feature is separating the data set into a number of clusters and then establishes a Medoid for each, thus ensuring that searches be done only for the clusters whose respective medoids are most similar to the objects in question. It is the improvisation of Partition Around Medoids (PAM) and Clustering Large Applications (CLARA) algorithms.

### F. *Voice Based Predicted Output*

All the output will be converted to speech using a text to speech python application and sounded through a speaker directly from the raspberry pi regarding required route to take, obstacles and sign boards along the route, buses and respective bus stops along the route.

## VII. CONCLUSION

Despite being visually challenged, they are some of the bravest people in the world as they face lots of challenges to compete in this world. A life without sight has inculcated within them the habit of touch and sense. However it can neither be sufficient nor efficient in all times. This absence of sight does not prevent them from involving themselves in many areas of industry, education, employment and art. This system provides an imaginary view of the world thus creating a virtual sight by combining their imagination with information obtained from the device. Conclusively, this system makes visually challenged most achievable in their fields of interest. Hopefully, gaining a virtualized vision brings about a light in the midst of their darkness.

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