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Evolution of Technologies for the Convenient Navigations and Utilities for Visually Impaired People

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Abstract

The advancement of the various technologies like embedded systems, networking, sensors, actuators and communication can be exploited to design a solutions for the physically challenges people. In this paper an effort is put to survey intensively towards studying the evolution of the innovative ideas proposed for the visually impaired (VI-Ps) people. Many prototype modeling and simulation study is being carried out in this direction. Further, the study outcome provides a strong base to understand the technologies used for designing a utilities and applications for the blind people (BP) and explains about the research trend in this direction.

Keywords: *Visually Impaired, Convenient navigations, RFID, BLE.*

1. Introduction

The advancement of the various technologies like embedded systems, networking, sensors, actuators and communication can be exploited to design a solutions for the physically challenges people. In this paper an effort is put to survey intensively towards studying the evolution of the innovative ideas proposed for the visually impaired people. Many prototype modelling and simulation study is being carried out in this direction. The study outcome provides a strong base to understand the technologies used for designing an utilities and applications for the blind people(BP) and explains about the research trend in this direction.

The blindness or the visual impairments caused due to defect into refractive errors is very high India, it counts to approximately forty plus million people and out of which approximately more than 1.6 million by 13th February 2020 and most importantly majorities from them resides in either village or tier-4 cities belonging to the under-privileged section of the society[1]. The table 1 provides statistics of world-wide visually impaired people

Tables 1: Worldwide Statistics of visually impaired people (source: World Health Organization)

Region	Blind People	Low vision People	Visually impaired people
Africa	7.3	25.4	32.7
America	3.5	25.6	29.1
EMR	8.5	32	40.5
Europe	3	28.7	31.7
SEAR-India	6.9	43.3	48.2
WPR-China	5.3	28	33.3
India	6.8	46.2	53
China	6.1	49.3	55.4

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The statistics shown in the table 1 and its visual display in figure 1 clearly motivate to the researchers to arrive to the respective solutions which are best suited for the VI-Ps, as well to the corporates to take interest to manufacture or develop commercial solutions that caters the need of all the stake holders [2].

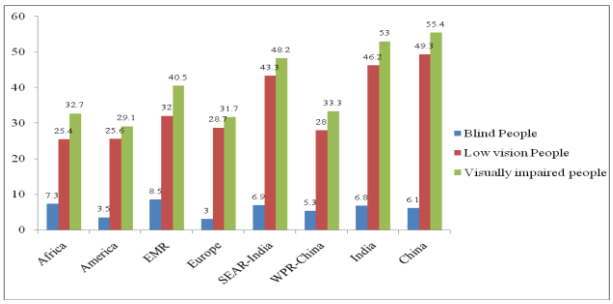

Figure 1: Statics of Blind people, Low vision people and Visually Impaired across world wide

The structural format of survey study work can be organized as follows; section-II describes about applications suitable for the VI & BP. Section-III illustrates the research trend. Section-IV highlights the review of literature; Section-V presents research directions. In the last section-VI discusses conclusion of the proposed study.

2. Applications Suitable for Vi& Bp

There are many applications available for the VI & Blind people:-

- **Navilens:** It is an android OS application that makes useful for visual impaired and blind person, it providing the access information to the user through the QR code. The provided QR codes have a unique functionality available for the consumer's to download tags for their individual use. This application mainly used in public spaces like train stations.
- **BlindSqure:** It is one of the best accessible GPS applications that developed for the VI and BP. It provides an environment, announces points of interest and street intersections when you are travelling.
- **Lazarillo GPS for Blind**: This application is more significant for blind peoples, because it assist them by voice message in the railway-station.

3. Research Trend

A. Background of the Problem

Train is one of the most convenient commute to travel either locally within the city or from one city to another city or places. Generally, the railway stations will have facilities to accommodate more than one train at a time to provide scalable facility to the passengers. In order to do so, there is a provision of many platforms and the people including passenger, associates with the passengers, staffs , vendors and coolies etc can move from one platform to the another platform either through a sub-way or the over bridge which connects one platform to the another platform. It is convenient for the healthy and young people to navigate through the subway or the over bridge but for elderly people or the people who are handicapped by legs and especially the blind people faces an awkward and troublesome to navigate through these means. Therefore, essential and suitable solutions are requiring in this direction.

B. Solution Approaches

The authors, (**Adarsh et al, 2015**) present a prototype where they have introduced a mobile platform concept, and this mobile platform can move automatically between the two platform to provide a state of joined or dis-joint of the platforms [2].

4. Review of Literature

The authors **(Adarsh K S, et al, 2015)** in their paper presented and outlined a project overview which corresponds to a system that incorporates a microcontroller assisted mobile platforms for railway stations. The project design targeted to implement an automatic closing and opening operation for mobile platforms to ease the journey of elderly and handicapped persons more comfortable while they travel from one platform to anther over the railway track. Sensor enabled modules are activated between the two sides of tracks and a hardware module of infrared sensor is placed to ensure the presence of a train over the track. If a train comes and stays over the track the sensor one will get activated and it will trigger a control signal to the microcontroller so that the mobile platform becomes close for that period of time. If the train leaves the platform then another sensor module get activated and trigger signal to the microcontroller unit to open the mobile platform so that a bridging can be established between two platforms. The approach uses pulse signals to enable the stepper motor so that the mobile platforms get closed automatically. The approach brings more applicability to perform better scheduling of train arrivals and also this way major accidents can be avoided [1].

Another research study in the similar direction (Syed Mohammad Imran (Ali,et al,2018), where the system proposes technique by which the VI&BP uses the system for navigating the from one platform to the another platform. The model is demonstrated as prototype which is designed which uses micro-controller a based or core units attached with the proximity sensors. When train is near to the railway station the proximity sensors sense the train and give the information to the microcontroller, where the transmission takes place using infrared transceivers which acts as both transmitter as well as receiver. The micro-controller further passes an instruction to the controller of the bridge and the constructed artificial bridge gets closed before any trains reaches to the railway station [3].

The conceptualization of navigation as free as a normal human can do is an ultimate goal, in this direction

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(Rajalakshmi et al, Year) exploits the potential of the latest technologies like Raspberry Pi-3 processor, efficient computing platform like cloud, visual camera / sensor to capture the real time images, ultrasonic sensors for measuring distance of an objects sound waves and an Artificial intelligence capacity using deep neural network like Convolutional neural network (CNN). The methodology adopted is illustrated in the figure 2[5].

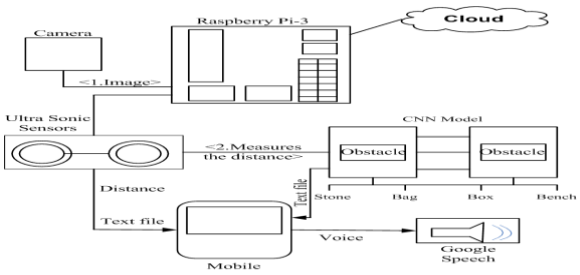

Figure 2: Overall Methodology for Free walk by VI&BP Describe by a figure

A system to help the visually impaired and blind people for navigating a (Kei Sato, 2016) navigation system is used which is called as Pull Dog. The project consist of UHF band which is used for positioning, RIFD, QZSS satellite system and smart phone are used. The visually impaired and blind people use smart phone for navigation that means with the help of voice recognition feed their destination. The QZSS system maps the route and guide with voice output. Thus the project can be used for indoor and outdoor and also can be implement in railway station. As the technologies like RFID, UHF band and QZSS provide high precession navigation [6].

Table 1: Summary of existing works [REF 2-5]

Sl no	Citation/Authors	Problem	Approach	Advantages	Disadvantages
2	(Adarsh K S,et al, 2015)	Difficulty in using of stairs and bridge for elderly and pedestrian people	Sensors and micro controller assisted automated mobile platform design	without any effort user can easily cross the platform	It is hardware based expensive approach and design optimization of sensor can be achieved
3	Syed Mohammad Imran Ali,et al,2018	people will not use staires and they directly cross the platrom deals to people threat	live status are captured through IR receiver ,using of micro controller ,synthetic bridges	Can be know the train arrive and departure with live status	Artificial bridge are not capable to sustain with heavily load.
4	R.Rajalakshmi1,et al,2018	Finding difficult to use the latest technologies	Convolutional Neural Network model(CNN) are used for tensor flow and ultra-sonic sensors	No large data is required because of using the CNN model	For all the device used here need pre trained models
5	Kei Sato, et al,2016	Facing problem to navigate blind people from one place to other	Pull Dog navigation system - using UHF band RFID and QZSS	Navigation is guided through voice using Pull Dog	Navigation system provides multiple routes for destination. Choosing shorter path is difficult

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One more system is implemented to come out from the challenges faced by the visually impaired and blind(Sen, et al, 2018) Mainly it talks about the visually impaired and blind finding difficult to move around independently without any help from others. But in real time the visually impaired and blind people face some challenge in crowded area like in city bus stop railway station etc the main aim of the paper is to help visually impaired with the help of ultra-sonic proximity sensor for artificial navigation system without any fear and this can be implement in outdoor and indoor system. Using the reflection property for ultrasound to detect the obstacle and path holes early the application is user friendly to use and versatility [7].

The more secure way to reach the destination of the visually impaired people(Samartha Koharwal,et al,2019) is to come up with the technology where will try to help the visually impaired people to move independently. Some of the method like cane care pull dog are not reliable for visually impaired people to use because training and managing of the system is difficult task. The technology called RFID where it cannot be used in outdoor scenario.

The main goal is to implement artificial navigation system called Third eye. The micro controller gets all the information from these three components such as IR sensors, sonar sensor and camera to process the information to detect the obstacle. The application is very small pen size stick that can be handled easy and also get secure in life threat [8].

In addition to all the system an indoor navigation system is implemented for visually impaired and blind user (Ganz, et al, 2018) The navigation system called as PERCEPT at Boston in North Station subway and it is the real time implemented application for visually impaired and blind users and it is developed for large area coverage and obtains the very good response from the user. An interface is used to communicate with the visually impaired and blind user that is transportation hub and the user have to specify the land mark and destination address in earlier stage itself so that they can move from the particular place to reach the destination independently hence the application is said to be is user friendly [9]. The following figure shows the presented approach of PERCEPT navigation system.

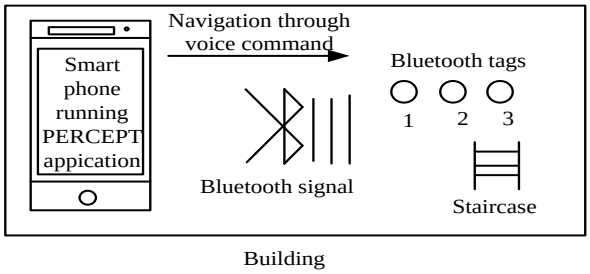

Figure 2: PEREPT approach overview

An alternative solution for indoor navigation system for (Kabalan Chaccour, et al, 2016) visually impaired people to move from one place to another place freely without any help from the others. The System is composed of IP cameras which are connected to ceiling of the room and the smart phone is used for human machine interface. Image processing concept is used to know that the user reach the destination without any obstacles or with the obstacle identification along with this they can obtain the feedback from the user. The system can help through voice commands [10].

By the conceptualization of the navigation (Fannuci, et al,2011) to help the visually impaired and blind user for navigating the direction in outdoor with the help of mobile phones the main goal of the paper is to ensure the safe path for visually impaired and blind users. White canes are modified by smart canes. Smartphone help the user with extra features to navigate and to identify the tactile by means of electrical circuit machine where electrical circuit will generate the magnetic field to detect the obstacle with the signal as vibration to the smart phone and handled GPS is used to track the destination of the user and to navigate the users. The smart cane measures the object in centimeter. And this application can also be implement in indoor scenario. Thus the smart phone is connected with smart cane controller and handled GPS. Hence the application finds the safest path to the users [11].

Table 2: Summary of existing works [REF 6-10]

Sl no	Citation/Authors	Problem	Approach	Advantages	Disadvantages
6	Sen, et al,2018	Travelling / walking in crowded place by blind impose great challenges	Ultrasonic proximity sensor and GPS module for blind	Upcoming obstacles and pat holes are identified through ultrasound	Sensing accuracy changes with temperature and also the sensing distance is low about 2cm
7	SamarthaKoharwal,et al,2019	Visually impaired people find difficult to move from one	AI based application like IR sensor, sonar sensor	Embedded vision system are simple, configurable and	The sensors range is low, the object detection algorithm utilizes 100% CUP

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		place other with help of cane / trained dog	and cameras are used for navigation	efficient	hence microcontroller gets hot
8	Ganz, et al,2018	Indoor navigation system for Visually impaired and blind users	Bluetooth low energy tags for indoor navigation in real time	Can be implemented in high crowded places like subway stations	Bluetooth range is low, hence need to use more number of tags to guide VI&B
9	Kabalan Chaccour,et al,2016	To overcome from the barriers for the visually impaired and blind	Image processing and IP cameras are used to connect with the smart phones	object recognition functionalities enables to detect the obstacles	remote processing concept can also be implemented
10	Fannuci, et al,2011	Visually impaired find the difficulty in using for mobility aid System	Smart cane controller and portable GPS receiver to Navigate	The system is implemented in the indoor scenario	difficult to test and validate the system in all cases is different case

One more technology is developed to overcome from the issue faced by the visually impaired people (Jee-Eun Kim, et al, 2016) to use the smartphone to get navigation where it will direct route to move around with the help of Bluetooth low energy technology (BLE). A special concept called StaNavi. STANAVI is a navigation system gives the voice commands to move around. StaNavi was developed for blind people provided with the entire feature they need where it also include the communications features for single use while walking in a cane and the entire navigation system. So that the user will get the overview of the entire journey[12].

A further the implemented system should be cost effective to use because most of the visually impaired people cannot afford it to (Kim et al al,2014) use the new technology which are less is cost are in existing the using of white canes to detect the obstacles is for certain period of time. The portable system is developed with less cost for visually impaired to travel around. The application can be used in two forms the one is used to detect the obstacles in the environment with sensing signal and other is remote navigation to reach the particular destination. With the help of these devices (ultra-sonic sensors, GPS) the application is developed [12].

A indoor navigation concept to move around like shopping mall museums for visually impaired people (Paul Chippendale,et al,2015) assist with developing of an application for android called ‘pedestrian dead rocking’ and ‘Computer vision algorithms’ are made available with off-the-shelf. The smart phone is connected with smart watch. An interface is made between the user and the application to navigate the visually impaired people. Sensors are connected with devices like pedometer to measure the distance. Hence the user will get proper direction to reach the destination in easier way [13].

In the existing system there are many methods are used to help the visually impaired people like using of canes and echolocation system but(G.Lavanya et al,2013) it will not help the user to use with the traffic. The contribution of the application is to use the wireless sensor network (WSN) for bus system. The Visually impaired people and blind people can use the technology called ZigBee in bus station where it identifies the bus for user and indicates that visually impaired and blind people are present in the bus station along with the bus number such that blind can give the input for the system through voice command using microphones the input from the user are processed in the micro controller GPS are used to track the location of the bus. The bus number is converted into voice. Zigbee transceiver in bus sends the bus number to transceiver [14].

Some other latest technology for visually impaired and blind people (Esteban BayroKaiser,et al,2012) to help in directing the route to move around is ‘Wearable Navigation System’ Where it can be implemented for indoor and outdoor system. The application will navigate and track the location of pedestrian to obtain the result of the implemented system some special technology has to use, which is known as Simultaneous Localization and Mapping (SLAM) where it can be developed for mobile robotics. Once the map is obtained the user can use the technology with range laser and inertial measurement unit for wearable computer for data processing and voice through headphones. Thus white cane is must for this application because navigation directions are gets through with white cane only [15].

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Table 3: Summary of existing works [REF 11-15]

Sl no	Citation/Authors	Problem	Approach	Advantages	Disadvantages
11	Jee-EunKim,et al,2016	Finding the difficulty to reach the destination in indoor areas like in mall railway station etc	blind can get navigation through smart phone	off the shelf concept are introduced in smart phone for easy access	Bluetooth range is very low cannot access all time even though it for indoor but the Bluetooth support only the minimum range
12	Somnathkoley,et al,2012	Difficult to use the audio navigation system due to high in cost	to detect the obstacles GPS and Ultrasonic sensors are implemented	Cost effective technology for visually impaired and blind users	Does not support the indoor function due lack of GPS navigation system
13	Paul Chippendale,etal,2015	struggling in knowing the latest technologies	Pedestrian Dead Reckoning ,Computer Vision algorithms, using an off-the-shelf are made connected to smart watch	Smart watch is used to monitor the people and pedometer sensor is used to safe guard from the threat	Required to build the system along with integration is tedious task
14	G.Lavanya et al,2013	Visually blind facing problem to cross the traffic in bus station	zigbee transceiver help in transferring of data to the user	using of microphones plays vital role to communicate	PDA's for GPS need to be implemented
15	Esteban BayroKaiser,et al,2012	Challenges faced by visually imapaired in using of wearable devices	Wearable device to navigate the people	SLAM is well known for mobile robot and GPS tracking functionalities	No proper directional path is given

The Different technology that is (Alberto Rodr´ıguez,et al,2012) mainly concentrating on the obstacle avoidance system for visually impaired people the stereo camera is implemented for map and ground plane. An algorithm is developed for the obstacle detection in all the cases. The alert is getting through with the audio signals like proximity sensors to guide the visually impaired people to move around safely [15].

Navigation system for the visually impaired people with less cost (BaljitKaur,et al) system. The Combination of these two system that is USB camera and USB laser are combined together and made a system called android system which are connected on the chest. The system measures the distance along with the object from the user through voice as the output. The classification of framework and object detection is done through RCNN [16].

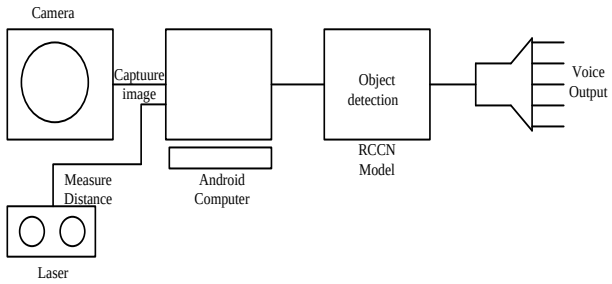

Figure 3: Design approach of [19]

To know more about the navigation system along with the obstacle detection for blind people to travel from one place to other place.(MarutTripathi,et al,2014) Ultra sonic sensors and USB web cameras are used to detect the obstacles. In this paper author implemented a system

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for blind people to get the easiest path to reach their destination. Detection of obstacle is up to 300cm along with feedback via voice through earphones. The camera is connected with Raspberry to capture the image and human presence. The obstacle is capable of recognizing the human face presented in open CV [17].

In real time by conceive means of indoor navigation system through smart phone like shopping mall for visually impaired people (Daisuke Sato,et al,2017). The concept called NavCog3. The indoor navigation directions information can be obtain along with the point to point instruction to move around with this user are able to know about the land mark places and nearby places, if the user wishes to visit. First study is the NavCog3 system is implemented on 10 users for better accuracy and performance in the real time scenario then second study the NavCog3 system is implemented on 42 users such that they can easy or freely move/walk in the shopping mall [18].

In addition to use the many technology for visually impaired and blind (SimonaCaraiman,et al,2017). Provides a computer vision based sensory substitution device for visually impaired and blind. In this project the computer vision based technology like 3Dacquisition system and 3D processing pipeline are used to create the 3D representation of the surrounding environment of the user. The surrounding is communicated to visually impair by means of bearing and tactile senses. The system can be used for indoor and outdoor system using of hardware and software mentioned above [19].

An another concept to detect the obstacle near to the visually impaired people (B.Ponkarthika,et al,2018) to help with the direction. The system uses the Electronic travel aid with feature like computer vision. When the obstacle is present near to the user .The smart cane capable of sensing will give the voice alert by vibrating the canes to avoid from accidents. Using ultra sonic sensors it will detect the obstacle and alert the blind users, in addition to this a heartbeat sensor is used to recognize the heart pulses of user this technology is used because whenever there is a problem faced by blind by means of user location is tracked and sends the voice commands through android application to the user such that the navigation is directed independently using voice commands. If the sick is lost it can be found using the smart cane detection device [20]

Table 4: Summary of existing works [REF 15-20]

Sl no	Citation/Authors	Problem	Approach	Advantages	Disadvantages
16	Alberto Rodr´ıguez,et al,2012	Finding difficult in knowing the obstacle in the environment	ground plane estimation and audio waning component are implemented to find the obstacle	Portable devices will help to communicate	more accuracy is not available detect the obstacle for blind
17	(BaljitKaur,et al)	lack of technology for visually impaired and blind	USB camera and USB laser used to get the information from outside source	cost effective technology are used	lack of navigation technology
18	MarutTripathi,et al,2014	Difficult to detect the obstacle in surrounding	Ultrasonic sensors, web cameras are made connect to the raspberry pi	less time to train and human being detection features is also present	ground level obstacle is the main thing for visually impaired where is option is not present in system
19	Daisuke Sato,et al,2017	insufficient accuracy in indoor navigation system	smart phone based indoor navigation system	landmark of the place help the visually impaired to reach the destination	may be facing the issue in the navigation system/navigation error

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				more securely	
20	SimonaCaraiman,et al,2017	lack of sensing technology for visually impaired	hearing, tactile sense to sense the visually impaired by to ensure pervasiveness	computer vision based technology is known along with the feedback	The system is not capable of focusing on mobility scenario

5. Research Gap

The study forms a basis of investigational analysis which brings more insight into the current trend and technologies meant for visually impaired people. On analyzing the above researches following research gaps are outlined:

- It is mostly observed that there are many usages of sensor/sensing devices which assist towards developing better smart systems for visually impaired people but most of the traditional approaches are hardware-based and involves computationally expensive tasks and also poses higher cost in deployment scenarios.
- Sensor nodes are low-powered devices where the captured data is needed to be analyzed properly to make the systems more reliable from the viewpoint of operations. However, most of the systems lacks in analytics which restrict the applications of sensor based technologies for limited use-cases.
- Most of the systems more-likely found be in earlier stage and better research outcome in terms of solution approach is yet to be obtained.
- The existing research approach doesn't focus on comprehensive navigation planning of the railway environments and also in many approaches it is found that Signal quality is not considered as ley factor and without which the application to support VIP is not possible.
- Most of the hardware based approach having higher dependency on GPS systems only whereas inertia motion is not considered. Thereby software approaches are mostly preferred in many places to reduce the cost of implementation through hardware modules. However, the analysis of various significant studies clearly outlines that the research effort is still at its early stage and so much of effort has to be kept to build smart systems which can assist the visually impaired people to do such tasks regardless of any external support and effort.

6. Conclusion

The technological advancement in the electronic and networking engineering has led many feasible solutions for various research areas. The combination of networking and embedded system is offering various application solutions to provide better experience to the visually impaired people so that they can move anywhere and use any-thing without any external supporting agent and effortlessly.

This paper provides better insight into the current research trend corresponds to the applications for visually impaired people and also outlines the research gap which is needed to be addressed to provide a better perspective of future line of research for improving the application modules for disabled especially blind and visually impaired people.

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