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A Survey on Various Techniques and Applications used for Helping Visually Impaired People in Daily Life

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***Abstract*—It is estimated that 16.6 percent of the world's population suffers from a certain degree of sight problems, as stated by the World Health Organization (WHO). In recent times, a considerable amount of work has been put into the production of a wide variety of different devices to support and help people who are visually challenged and to improve their living standards by providing them with more independence. The purpose of the present study is to better understand the variety of cutting-edge methods which were developed to be of assistance to people who are blind or visually impaired and are currently being used in the market. Users may access a range of algorithms of deep learning, numerous sensors, and text to speech and speech to text output options with these programs, which are useful for a number of platforms, including Apple devices as well as Android devices, and are free to download. The purpose of writing this study is to offer a succinct summary of current advancements in the techniques that are being used in this subject. It is crucial that precise information be provided to other researchers in this area of study who are striving to find new applications for their findings.**

***Index Terms*— Object detection, Visually Challenged, Convolutional Neural Network, Sensors.**

I. INTRODUCTION

Studies conducted by the World Health Organization (WHO) have shown that almost 2.2 billion individuals throughout the world are blind or have significantly decreased eyesight, with sixty-two million of them residing in India, of whom 8 million have total vision impairment, according to the research. In comparison to a clear-sighted individual, the visually impaired experience a slew of difficulties in their daily lives, with movement being the most prevalent of them. Because they do not have a comprehensive grasp and information about their physical world, visually impaired people have a difficult time exploring their surroundings, and movement is the most significant challenge they confront. They also utilize canes to detect different items and prevent colliding with them, Canes, on the other hand, are unable to assist the user in recognizing the thing and are incapable of detecting an object that is out of reach. They depend almost exclusively on the experiences they've had in the past as well as their other senses in order to navigate through their environment, but this might result in accidents or injuries if they come across an unknown item in an unfamiliar setting, which can be dangerous. In recent years, technological advancements have resulted in the development of assistive gadgets for the visually handicapped.

When it comes to Assistive Technology (AT), it may be any equipment or software that makes it easier for visually impaired people to perceive their environment while also increasing their ability, independence, and self-sufficiency. These technologies assist the visually impaired person in being more conscious of her or his

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surroundings environment, hence reducing the danger of injuring oneself or being injured by others. By providing individuals with information, assistive technology helps them respond more effectively to a situation. Recent study trends indicate that the introduction of mobile application aids for the visually impaired is on the increase, as opposed to the development of wearable and portable devices aids. It is preferable to have a single device to do many tasks than to have several devices. The research is being carried out in order to uncover numerous useful technologies that have been built on a mobile phone-based platform to aid visually challenged persons in their everyday lives.
The following is the structure of this paper: In Section II, you will learn about the history of assistive technology. Section III delves into the world of existing technologies. References are included at the end of Section IV, which finishes the study.

II. Background

A. Visual Substitution Techniques

Visual replacement is a process that may be characterized as one in which the output is supplied to the user in a manner that does not need the use of vision. This is an alternative for people who are blind and occurs when an image is recorded from an attached device and information is processed, such as digital audio, before the picture is shown.
Visual Substitution may be defined as an option for the blind in which an image is recorded via a digital camera and then the captured picture is further processed to the next stage, and output is supplied to the visually impaired in a digital format, like aural mode. It is possible to classify visual conversion into three subgroups, Electronic Travel Aids, Electronic Orientation Aids, and Position Locator Devices. The area of Electronic Travel Aids development has seen a number of significant advancements made recently, which has led in their being more popular among the vision impaired community than EOA as well as PLD. Users of electronic travel aids, such as NavBelts and Guide Canes, receive information from sensors in the surroundings and then transmit it to them. Blind people frequently use assistive devices as shown in the Figure 1. In addition, the ETA has the following capabilities: recognizing barriers in the route, finding objects that are located relatively near to the obstructions, estimating the distance between both the obstacle to the individual being calculated, identifying gaps and irregularities on the surface, and communicating the information. EOA assist the user along their route by giving instructions or by the use of path markers like, Smart Walker, Wheelesley and other similar symbols.

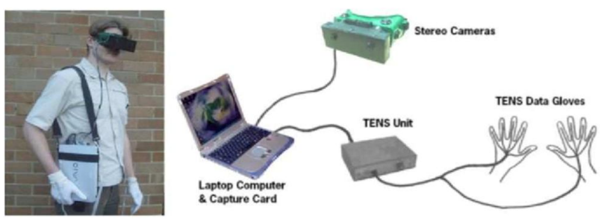

Figure 1. Electronic Travel Aids [5]

B. Difficulties Encountered by the Visually Impaired

There are a variety of challenges faced by the visually impaired people, such as difficulty navigating in an outside area. For them, travelling in crowded areas is a stressful experience. They seek assistance from either assistive technology or from others in their immediate vicinity. They have issues whether they are buying on the internet or doing other things on the internet or identifying the cash amount as shown in the Figure 2. A blind individual will find it difficult to move between online sites. There are several more difficulties that blind individuals must overcome, including home duties, recognizing cash denominations, detecting obstacles, navigating, and attempting to cross the street.

C. Assistive Technology

The use of Assistive Technology may assist the blind people in overcoming the difficulties stated in the preceding subsections. The number of people who use mobile phones has increased at a pace that is comparable to an exponential curve throughout the span of evolution. In today's society, mobile phones, especially smartphones, have become a need for everyone, even for the blind person.
The country of India has 190 million smartphone users, according to recent re-ports. Moreover, the Android operating system is used by the vast majority of these customers' cell phones. Over time, the feature set and

processing capabilities have also evolved. There are certain assistive devices for the visually im-paired that are independent of the smartphone, for example: the smart canes, digital cameras, and other electronic devices of this kind. Despite their high cost, they're quite effective. By using the growing capabilities of Smartphones, we may create apps that do not need the use of external devices, thereby lowering expenses and enhancing the mobility of the individual (reduction of external hardware). In order to design or implement Object Detection Algorithms, deep learning is used in conjunction with machine learning. Pre-trained models for object identification exist in a variety of flavors, including You Only Look Once (YOLO), Recurrent-CNN (RCNN), Fast R-CNN, and Mask R-CNN, among others. Object identification has grown simpler, quicker, and considerably more precise as a result of the development of such algorithms. As a consequence of this, the use of applications for mobile phones as a kind of assistive technology for people with visual impairments has become a more practical choice.

Figure 2. Identification of cash and domination using assistive technology [6]

III. Existing Technologies

According to Mahdi S, A., et al. (2012), "A way to implement a mobility assistance for the blind person, there are several approaches to assess the distance between the barrier and the person." One of these is by the use of ultrasonic technology. Footwear which included a configuration of ultrasonic sensors all the way around the bottom was utilized to assist the visually impaired individual. "The sensors are supported by a customized circuit that is housed inside the user's shoe." [7].

In the year 2012, Nassih, Mehdi., et al stated, "The smart cane makes use of the RFID technique. It is used to detect obstacles and objects in front of the user, as well as to detect the RFID tag, if there is any, that has been placed in different areas in order to navigate the users." There is nothing particularly innovative about this design, it is basically a cane with a bag that the user wears on their back. To power the system, a bag is used, and speakers integrated into the bag's inside convey the output to the user. Although, since it is restricted to the places where the RFID tags have been set, this technology is only useful in a narrow area. In any other case, it will operate as a conventional stick in the areas where there are no tags [8].

The blind Cane, according to this article, is one of the aiding instruments for the blind, and it is quite significant," claimed Alshbatat and Abdel Ilah Nour in 2013. When used properly, the Guide Cane may aid visually challenged individuals in maintaining their safety on the road. Guide Canes are simi-lar to white canes in that they are held in front of one's body when walking. This is due to the white cane's lighter weight and the guide cane's larger weight. [9].

The author said in 2006 that the "Smart Cane" is an invention that was first developed as a traditional blind cane, However, from the moment it was designed, it was equipped with a sensor network. In contrast to the Guide Cane, this new invention is equipped with a variety of HC-SR04 sensors and servo motors, which makes it similar to the Guide Cane idea. The majority of the time, this gadget is made to help the blind person to navigate their environment. As a result of this, the user is able to dodge obstacles and stuff ahead of them, hence the HC-SR04 sensor must be used [9].

In 2015, Sonal Shrivastava and colleagues said, "With this development, the technology of HC-SR04 sensor and sound vibrations came into reality." There are a few things that aren't ideal about it, including the fact that it can't be folded and the fact that it's hard to keep in place. This idea does not have any sensors for detecting water regions, which is another disadvantage [10].

The researchers quoted Muhsin Asaad H., et al. (2013), who said that "a white cane is assigned to detect impediments up to knee level within a range of 2 to 3 feet in height" (0.91 m). In the case that the cane detects an impediment, it will either vibrate or speak out loud. Because of this, the sensor, as well as the controller, are both housed inside the cane as a consequence of this, which has a battery life of 10 hours on a single charge in all conditions. By calculating the amount of time, it takes for the waves to go to the impediment and the amount of time it takes for the waves to travel back, we can determine the delay time. A buzzer is used to provide the user with distance information [7].

According to Manisha Bansode et al. [11], in 2015, they "developed a speech-based system for the blind utilizing a voice recognition module and GPS module installed on an Arduino board." The speech recognition module will get the name of the destination from a blind person, who will be the input to the system. "A GPS receiver continually gets the current position, as well as its longitude and latitude, and compares it to the latitude and longitude of destination," explains the manufacturer [7].

Harsur A, et al. [12] "created a voice-based system for visually impaired people employing ultrasonic sensors, which allows blind people to roam independently inside the outside world." This project is composed mostly of six modules, which are as follows: Interface, Initialization, Address query translation, Route Query, Transversal of the route, as well as identification of obstacles. It is the first module in the system library, and it is in charge of ensuring that the initialization of the system library is completed successfully. In the second section of the module, i.e. Using a microphone, the user interface gathers the address of the destination from the user at this stage. The speech interface that was developed in this module makes use of services such as Text-to-Speech for the voice outputs and the Google Voice Recognizer API for the recognition of voice inputs and outputs. In the last section of the module, i.e., As we go on to the last part of the module "Address query translator converts geographic coordinates to coordinates that contain latitude and longitude."[7].

A. Solution based on Deep Neural Network (DNN)

CNN is one of the widely used Neural networks for Pattern Recognition and It is possibly the most prevalent deep learning architecture, CNN. Mostly, this is due to the enormous popularity and efficacy of ConvNets. Originally launched in 2012, AlexNet has seen exponential growth in the years following. It progressed from an eight-layer AlexNet to a One Hundred Fifty-Two-layer ResNet in under three years. As opposed to its predecessors, CNN has the basic advantage in that it automatically differentiates the features in the absence of the necessity for human direction or involvement.

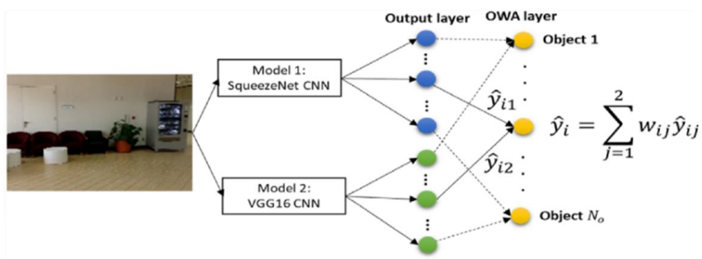

Figure 3. Convolutional Neural Network Architecture [38]

Using multiple photographs of dogs and cats, for example, it may learn about the specific features of each class without the assistance of anyone else. Currently, we are collaborating on an information picture. In a sequential manner, the convolution and pooling processes are carried out, and these operations are followed by a number of layers that are totally connected to one another as shown in the Figure 3. It is assumed that the outcome is SoftMax in the case in which we are doing the multiclass characterization.

OpenCV is a free and open-source library, OpenCV contains tons of algorithms which are based on computer vision, including routines for actual object identification, that may be used to solve computer vision problems. The Architecture of OpenCV is shown in the Figure 4 below. We can easily analyze videos as well as actual data without any difficulty.

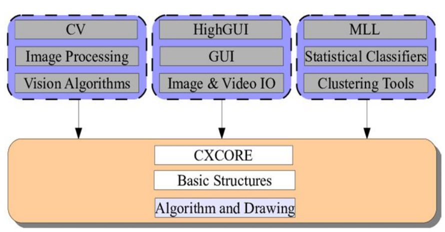

Figure 4. OpenCV Architecture [13]

(2013-15)

VisualPal[14]: Visual Companion: On the Android platform, this application is a specialized picture recognition system that may be used to identify objects. This programme includes modules designed specifically for persons who have a total or partial visual impairment. To accomplish image recognition and object detection, this object identification module employs a combination-al technique which is a blend of ANN and distance techniques such as Euclidean distance. Because the hybrid method takes less calculation time, it is particularly well applicable for the creation of applications for blind individuals. It outperforms standard object identification algorithms in that it lowers the rate of false-positive findings, making it more accurate. Those with partial visual impairment will benefit most from the second module, which detects col-ours and conveys the maximum brightness via a rising frequency of sound that increases in response to an increase in the intensity of brightness.

In this paper [15], This application's objective is to carry out an investigation of the effectiveness of the real-time video processing capabilities of two ap-plications that have been built for the Android platform and are accessible online. The study is carried out utilizing apps developed with the help of OpenCV, and its core module is known as CamTest. The results reveal that OpenCV has a better efficiency of 15 frames per second than the CamTest, which has a speed of 2.8 frames per second. With the assistance of FAST and Black Propagation Neural Network, the FAST technique has a frame rate that is ten times quicker than the Scale-Invariant Feature Transformation (SIFT) and Speeded-Up Robust Feature (SURF) algorithm.

Drishti [16] – The android application is centered on the creation of a platform that is capable of doing the work at hand while satisfying certain standards. Drishti's most important modules include object recognition, hand gesture authentication, currency recognition, present date, emergency calling, present time, location tracking, optical character recognition (OCR), secret chat room, phonebook manager, customized keyboard, and shortcut keys for navigating to the various sections of the application. The YOLO algorithm is utilized for object identification in this case. While Drishti utilizes the Android Gesture Library in order to launch the modules, and the Google Speech API to convert spoken words into text, they also make use of using a gesture to launch the modules for the sake of authentication and convenience.

(2016-18)

In this paper [17], the author has developed a system to provide instructions to a barrier that has been spotted by a camera. It is feasible to use GPS technology in a mobile phone to prevent getting into an accident. With the use of the per-son's camera, a video is recorded, which is then separated into segments, with each segment being handled as an image in the final analysis. By combining the blob detection approach with the ORB method, it is feasible to locate items in this image. An output of audio will be delivered to the user if the essential features for each item stored in the database match. If the essential features do not match, an error message will be sent to the user.

Intelligent-Eye [18]: It is a smartphone application designed to aid those who have vision impairments, and it was developed by the University of California, Los Angeles. The intuitive eye is a multi-featured programme that offers a user-friendly interface that has been specifically built for blind people. Among the many functions, it offers detection of color and light, and recognition of banknotes and objects, to name a few examples. A shifting frequency of sound is used to provide light intensity output to the user based on the strength of the light. Color identification is accomplished by tapping a few times on the screen, which causes the R.G.B values to be recognized, and then the appropriate color is spoken to the user. When you take a picture using your camera, you may use it to identify objects and banknotes.

(2019-21)

EYE-ASSISTANT APP [19]: Eye assistant is a remote programme that does not need the use of a remote server to function. Text detection and object detection in real-time are provided by two modules in this package. The user just has to launch the programme, and it will begin to operate without the need for any more commands. The user is then given the choice of detecting objects or reading text, with the results being presented as voice output as a result. Because this programme scans items in real-time, there is no need to snap a photo and use up valuable storage space on your phone.

B. Solutions based on Applications

VizWiz by ROCHCI [21]: It is possible to take an image with their mobile de-vices and then publish an inquiry regarding that picture using the VizWiz ap-plication from ROCHCI [10]. By email or Twitter, the requests are sent to a web worker for the response. Responses are received within a few minutes, on average and in some cases, as little as seconds in certain cases. This enables the visually impaired person to make more informed judgments in the future.

SayText by DocScanner [22]: People with vision impairments are the target audience for this application, this application has the capacity to recognize the text that is included inside the image, and the text that is recognized is then turned into audio playback. For example, on a menu, signboard, or other such items. This programme scans the content of a picture and turns it into audio for the user's enjoyment and understanding.
TapTapSee by NetIdeas [23]: This is a programme that has been developed specifically for those people who are blind or have some other kind of visual impairment. Its functioning is managed through the CloudSight Image Recognition Application Programming Interface (API). TapTapSee application uses mobile phones camera and also voiceOver capabilities which will help to capture the pictures and video of objects in order to identify them. The recognized object is narrated to the visually impaired person with the help of mobile phone speakers.
Digit-Eyes [24]: Product information is produced by scanning universal product codes and playing information of audio about the product. This software is available for iPhone and web browser use. People who are visually challenged or have difficulty recognizing items can benefit from the software, which is free to download. Over 35 million goods and objects are catalogued by Digit-Eyes in its UPC/EAN database, which is updated daily. User-generated content is included in the database. A total of ten languages are supported for product information.

C. Solutions based on Sensors Collected Data

In this paper [25], the author collected the data by making use of two free sources: a camera lens installed in a standard mobile phone to record the video and HC-SR04. Acoustic feedback allows it to obtain data about the surroundings, decode it on a semantic level, and warn users of potentially dangerous situations. The Figure 5 shown below is an example where the system works by making use of gathered data.

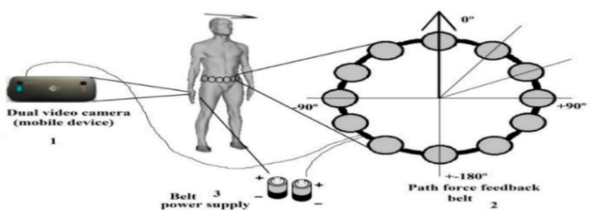

Figure 5. Sensor Based Solutions [26]

As a result, the visual computations can distinguish between faster-moving deterrents that are positioned at greater distances. When using sonars to identify objects, the maximum distance for object detection is restricted to 5 meters in the ideal scenario.
In this paper [27], a wearable handheld gadget is made specifically for the use of persons who are blind or have a vision problem. In addition to an integrated central processing unit circuit board on which an artificial vision-based obstacle detection pipeline has been designed, the system includes a number of other components, and the system includes a proprietary RGBD camera that offers detailed depth measurements. Due to the device's inability to handle complicated designs such as RCNN, it additionally supports the classification of identified obstacles via the use of a CNN architecture known as LeNet. The Random Sample Consensus framework is utilized to differentiate between the ground and the other objects that are being identified. The linear-quadratic estimation is used to improve stability while simultaneously reducing noise. With the use of a haptic interface and auditory signals, the device gives information about the surroundings in a tiny and lightweight package. Detection rates are 98 percent, while classification rates average 72 percent, according to the company's data.

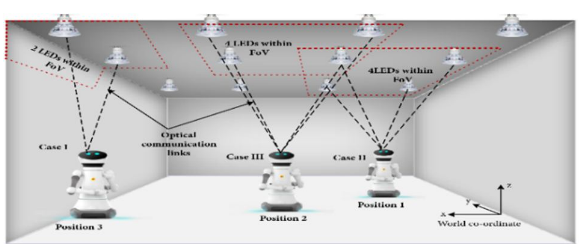

Figure 6. Location-based on Sensors [28]

In this paper [30], RFID is a technological advancement that may assist in enhancing the organization and direction of people when participating in day-time activities. Figure 6 depicts the system, which works on the

Location-based sensors. The device may be able to deliver a few bits of information to someone who is vision impaired. about the distinguishable and expedite the search; in addition to differentiating between medications, The user may get an audible indication from the device, which will assist them in locating the ideal item in the shortest amount of time feasible. A few chunks of information are made available to those who are visually challenged regarding the distinguish-able of a designated item, namely the manner in which it is near or far away.

IV. CONCLUSIONS

Using a survey approach, this research examines assistive devices that have been created to help visually impaired individuals in the identification task. According to the results of the study, sensors-based assistive devices were formerly the only assistive devices accessible to those who were visually challenged. Sensors are usually incorporated into a cane or a wearable device, depending on the application. A comparison of the many sensors that have been employed, as well as their merits and shortcomings, is shown in Table I below.

TABLE I. SENSOR BASED APPROACH

Type of Sensor	Features	Advantages	Disadvantages
Ultra-Wide Band	Range of Frequency between 3.1Ghz to 10.6Ghz	The transmission range is better compared to other sensors	Costly
RFID Camera	Range: Up to 460 Meters.	Facilities collection of data	Low Detection range then UWB
HC-SR04	Range: Up to 1 Meter	Low Cost	The Detection Range is Low
RGB-D Camera	Range: Between 0.15 Meters to 4.0 Meters	The detection range is good	Costly

Because of the increased computing capability of smartphones, the number of apps developed for them has increased dramatically in recent years. These programmes are useful for visually challenged people, but they need a continual internet connection. Table II provides an overview of the numerous methods that were employed to develop these applications, as well as their benefits. Through this study, we attempted to compare the most effective methods for developing visual assistance for the visually challenged. On the basis of several features, Table III compares and contrasts the approaches used. However, as smartphone's processing capacity and usefulness increase, the need for sensor-based solutions will diminish.

TABLE II. DEEP NEURAL NETWORK BASED-APPROACH

Type of Network	Model Name	Advantage
Convolutional Neural Network	CNNdroid	Supported to all the convolutional layers
Open-Source Computer Vision Library	ORB	Strong Resilience
Convolutional Neural Network	InceptionV3	High Precision
Convolutional Neural Network	YOLOv2	More precision and less processing time
Open-Source Computer Vision Library	FAST	Extremely High Computing Accuracy

TABLE III. COMPARISON BETWEEN DEEP NEURAL NETWORK-BASED AND SENSOR-BASED APPROACH

Attributes	Deep Neural Network Based	Sensor-Based
Cost	Many Applications are free	Sensor cost is higher
Field Perspective	Long Distance	Broad
Response time	Sufficient	First
Time required for computation	High	Low
Complexity of System	Simple	More Complex

However, as smartphone's processing capacity and usefulness increase, the need for sensor-based solutions will diminish. Deep learning-based solutions, on the other hand, will continue to grow in importance. As a result of the bigger developer community for deep neural network-based algorithms, they are more often updated than improvements in sensors. Deep neural network solutions currently do not perform as well as sensor-based solutions in terms of efficiency and performance, but in the future, as smartphone processor power increases and algorithms improve, deep learning solutions may be able to completely replace sensors.

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