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A COMPARATIVE STUDY OF ASSISTIVE DEVICES FOR VISUALLY IMPAIRED PEOPLE

Ms. K. Madhumathi
Research Scholar
School of Computing Sciences
Vels Institute of Science, Technology and Advanced Studies (VISTAS)
kmadhumathi99@gmail.com

Dr. A. Akila
Associate Professor
School of Computing Sciences
Vels Institute of Science, Technology and Advanced Studies (VISTAS)
akila.scs@velsuniv.ac.in

ABSTRACT

Various categories of devices are available that aid Visually Impaired (VI) people for their assistance like obstacle detection, path finding and purposeful navigation. Each category of device has its own objective. This paper provides an overview of such devices. In addition to that comparison of assistive devices is done to finalize about which type of assistive device will be providing better user friendliness for the VI people.

Keywords: Assistive Device, Visually Impaired, Raspberry Pi, Arduino Uno

I. INTRODUCTION

Visual deficiency, blind or visually impaired requires more attention nowadays. VI people face difficulties in their day- to- day tasks in both indoor and outdoor environments without others support. Traditional methods like guide dogs and walking cane are less efficient than the technologies currently available. Many devices that aid VI people were devised so far for the betterment of their lifestyle. These devices are using various technologies for capturing contextual information, storing and processing them so as to guide the VI people for their purposeful navigation and other tasks.

II. ASSISITIVE DEVICES

An assistive system comprises of various components for capturing contextual information, processing of information and sending feedback to the user. All these components can be fitted inside a single wearable or as a collection of separate components combined together for assisting VI people.

An assistive device consists of separate processing units (or modules) for doing specific tasks and an interface. Assistive devices can be categorized into 2 major categories as Sensorial networks ETAs and Video camera-based ETA's. Sensorial networks ETA's

(Electronic Traveling Aids) uses ultrasonic sensors, infrared sensors, BLE, RFID and video camera-based ETA's uses monocular, stereo, RGB-D camera as its base components.

III. WEARABLES

Electronic devices which can be used to measure, analyze, transmit data also which can be physically worn by individuals constitute Wearable technologies or generally termed as Wearables. These devices can be used in almost every industry from measuring heart beat rate to transmitting data from one point to the other, hence termed to be "SMART" in nature. It can be worn around head, ear, neck, chest, hand, wrist, finger, waist, thigh/leg, ankle, etc.

IV. TECHNOLOGIES USED IN ASSISTIVE DEVICES IN RECENT YEARS

A. Augmented Reality (AR):

AR (Augmented Reality) markers are used to provide information about various environments such as staircase, rooms, etc. and used in identification of those environments which are pre-registered.

B. Convolutional Neural Network (CNN):

Object Detection and Image Classification are performed using Deep Learning models. These models are based on Convolution Neural Networks (CNN). CNN is implemented via OpenCV and the Raspberry Pi processes the data provided by the modules and also handles the audio feedback part. Image classification is done with more accuracy using pre trained CNN, compared to other image classification techniques.

C. Deep Learning Technology

Deep learning is constituted by algorithms which gets structured as an Artificial Neural Network (ANN) resembling human brain. ANN makes decisions intelligently on its own by the data learnt.

D. Online Computer Vision Service

Through Computer Vision service, specific requirements of users can be fulfilled by returning information from advanced algorithms which has capability to process images captured. These services have machine learning and deep learning systems as their base. Computer Vision service is used in applications where detection of images is necessary for automation.

V. LITERATURE REVIEW

An indoor assistive system that uses RGB-D sensors with AR markers to identify various indoor structures was demonstrated by Xinrui Yu et al. It uses neural network to recognize and localize obstacles captured by RGB-D sensors and communicates verbal information to the visually impaired [1].

An idea proposed by Bin Jiang et.al. **e**mploys binocular vision sensors, Object Detection Based on Convolutional Neural Network so as to enable visually impaired users the captured images information from the cloud computing to make more manageable decision for their movement [2].

Author presents an assistive walker device that uses IOT technology which allows the user to take possible actions by determining and communicating the path to the user. Employs sensors, controllers as hardware and google map and find me applications [3].

A small hand-carrying system was suggested by Nabila Shahnaz Khan et.al which is used to find manholes, obstacles and potholes built using GPRS module and ultrasonic sensors, will generate alarm and has an emergency button that to send help messages in the case of danger [4].

Author developed an assistive device prototype which make use of online image processing service and Microsoft Cognitive Service was developed that aids visually impaired community [5].

IR sensor and microprocessor-based system that alerts VI person via headphone when it detects the obstacles around was demonstrated by Atikur Rahman. Also, performance analysis is also carried out by the author for the system by analyzing accurately by means of error rate [6].

A vision-based wearable system was developed by Andrés A. Díaz et.al to provide immediate feedback to the user. The wearable system is composed of sensors, processing device and haptic belt. The supercomputer with parallel programming capabilities is used as a processing device. YOLO algorithm is used for object detection. The feedback is done through the Haptic belt with four vibrating motors [7].

YOLO algorithm for object detection is implemented by the Author, so as to enable blind people to find their path easily and also assists them in reading text. uses python and an API for text recognition, gTTS for text to speech conversion [8].

A Smart device was proposed in [9] which uses microcontroller for Object Detection, Navigation, OpenCV for Image Processing activities and notify the user through Audio feedback.

A Navigation System based on vision is presented in [10] that support VI users navigating in both indoor and outdoor environments, which uses image-segmentation techniques and a novel global localization method (VB-GPS) that can detect unpredictable obstacles and can provide precise position information of obstacles thus providing orientation and precise locations reliably thereby supporting navigation in both indoor and outdoor environments.

Numerous wearables and assistive devices were developed by researchers that aid VI people in doing their daily activities. They differ by the hardware components used, software and the facilities offered by them to the VI people. **Table 1** illustrates the comparison of assistive devices developed for VI people in recent years.

Table 1. Comparison of assistive devices for VI people

S.NO	YEAR	HARDWARE USED	TECHNOLOGY/ ALGORITHM	INDOOR/ OUTDOOR	LOCATION OF THE DEVICE/ DEVICE COMPONENTS	FEATURES OF THE DEVICE
1	2018	RGB-D Sensor, Processor	Augmented Reality (AR)	Indoor	-	Obstacle Recognition and Localization
2		Binocular Vision Sensors	CNN (Convolutional Neural Network	Surrounding environment	Wearable	Vision Assistance
3		Proximity Sensor, IR Sensor, Arduino Uno	Web Application	Outdoor	-	Walking Assistance
4		Ultrasonic Sensors, Arduino Uno	GPRS Module	Outdoor	Hand-Carrying System	Walking Assistance
5	2019	Raspberry Pi, Pi Camera Module	Online Computer Vision Service	Both	Cap	Narration of the Environment
6		IR Sensor, Raspberry Pi	-	Near By Places	Wearable	Navigation Guide
7	2020	Arduino, RGBD Camera	YOLO Algorithm	Indoor	Wearable	Navigation Guide
8		Raspberry Pi	YOLO Algorithm with COCO Data Set	Surrounding environment	Wearable	Detection of Object, Recognition of text and converting to speech
9		IR Sensor, Raspberry Pi	CNN	Surrounding environment	Wearable	Object Detection, Navigation
10		Servers, Camera, Local Computer	Novel Global Localization Method	Both	Wearable	Vision Based Navigation System

VI. CONCLUSION

In the recent years, more concentration is given to develop an assistive system rather than a single wearable for VI people. A comparative study of devices assisting VI people are compared in terms of the basic hardware components and algorithms used in making such a device in this paper. Analyzed about these devices developed in the recent 3 years and it is found that many researchers opted for development of assistive devices rather than a single wearable.

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