NAVIGATION SYSTEM FOR BLIND

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ABSTRACT

The mobility of visually impaired people is restricted by their incapability to recognize their surroundings. Visual impairment makes the person depend on another person for all his works and daily chores. The paper is about the study of current solutions for the navigation of the visually impaired person and also it represents the architecture of a system that we have proposed that helps a visually impaired person to navigate independently in an enclosed area. Through the system that we are proposing, we aim to eliminate the dependency of a visually impaired person when travelling from one place to another. The main goal is to provide the information regarding the current location, the distance and the direction to the user by providing continuous audio feedback in his/her understandable language. The paper aims at the study and implementation of a navigation aid for the blind and visually impaired, which has the potential to one day replace braille.

Keywords: - *Navigation system, visually impaired, blind, Cognitive Services, Kinect, Depth Sensor, Augmented Reality, 3D sound*

1. INTRODUCTION

Visually challenged persons face constraints in independent mobility and navigation. Mobility means the possibility of liberally moving, without the support of any supplementary person, at home and unfamiliar scenarios. People with visual impairment tackle enormous limitations in terms of mobility. Many researches are being conducted to build a navigation system for blind people. Most of these technologies have limitations as its challenge involves accuracy, usability, interoperability, coverage which is not easy to overcome with current technology for both indoor and outdoor navigation.

1.1 Problems faced by blind and existing solutions

Traditionally white cane is the most popular, simplest tool for detecting obstacles due to its low cost, portability. It enables the user to effectively scan the area in front and detect obstacles on the ground like holes, steps, walls, uneven surfaces, downstairs etc .but it can only be used to detect obstacles up to knee-level. Its detection range is limited up to 1-2 feet only. Certain obstacles (e.g. protruding window panes, raised platforms, a moving vehicle, horizontal bars) cannot be detected till they are dangerously close to the person. Even dog guides are very capable to guide these persons but they are unable to detect potentially hazardous obstacles at head level. Guide dog service stage is on average 6 years and requires regular dog up-keeping expenditure and lifestyle changes.[1]

Several solutions have been proposed in the recent years to increase the mobility and safety of visually impaired persons. A system “Roshni” determines the user’s position in the building, navigation via audio messages by pressing keys on the mobile unit. It uses sonar technology to identify the position of the user by mounting ultrasonic modules on the ceiling at regular intervals. This system is portable, easy to operate and is not affected by environmental changes. But this system is limited only for indoor navigation because it requires a detailed interior map of the building.[2]

RFID based map-reading system which provides a technical solution for the visually impaired to pass through public locations easily using RFID tag grid, RFID cane Reader, Bluetooth interface and personal digital assistance. But its initial development cost is quite high and chances of interference in heavy traffic.[3]

A voice-operated outdoor navigation system developed using GPS, voice and ultrasonic sensor. It can alert user's current position and provide verbal guidelines for travelling to a remote destination but fails to give obstacle detection and warning alert.[4]

Another real-time technology developed to alert visually impaired user by the presence of static/dynamic obstacles in a few meters surrounding, which works without depending on any Smartphone, uses the camera for background motion detection. This system is robust to the complex camera and background motion and does not require any prior knowledge about the obstacle size, shape or position. This camera-based image processing system can be a better option but it requires lot processing power and hence system becomes bulky, costly and it must be transportable.[5]

1.2 Basic Concept

To help the visually impaired people navigate around freely without being dependent on someone else by using Cognitive Services, Augmented Reality, Depth sensing technology and 3D sound technology. The proposed system is formulated to solve the navigation problem faced by the blind by using their strongest sense i.e the sound. Visually impaired have an edge over their hearing abilities, unlike normal people. Therefore the proposed system uses the 3D sound technology to illustrate the surrounding to the blind by identifying objects, distance and direction. This depiction of the environment using voice commands and 3D sound helps the user with the device to move around freely without someone else's guidance.

2. LITERATURE SURVEY

The paper [1], Visual Challenges in the Everyday Lives of Blind People refers the challenges faced by blind people in their everyday lives are not well understood. Blind people confront a number of visual challenges every day – from reading the label on a frozen dinner to figuring out if they're at the right bus stop. While many tools have been introduced to help address these problems using computer vision and other sensors (talking OCR, GPS, radar canes, etc.), their capabilities are dictated as much by the state-of-the-art in technology as they are by real human problems. A deeper understanding of the questions that blind people would like to ask in their day-to-day lives may help to direct innovation to solve them.

The paper[2], talks about the use of a white cane for the mobility of blind. Traditionally white cane is the most popular, simplest tool for detecting obstacles due to its low cost, portability. It enables the user to effectively scan the area in front and detect obstacles on the ground like holes, steps, walls, uneven surfaces, downstairs etc .but it can only be used to detect obstacles up to knee-level. Its detection range is limited up to 1-2 feet only. Certain obstacles (e.g. protruding window panes, raised platforms, a moving vehicle, horizontal bars) cannot be detected till they are dangerously close to the person. Even dog guides are very capable to guide these persons but they are unable to detect potentially hazardous obstacles at head level. Guide dog service stage is on average 6 years and requires regular dog up-keeping expenditure and lifestyle changes.
The paper[3], describes the project named Roshni for the blind. Several solutions have been proposed in the recent years to increase the mobility and safety of visually impaired persons.

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The paper[4] and paper[5] talk about the solution for easy navigation for the blind using GPS and location tracking but there are various disadvantages of the solution. RFID based map-reading system which provides a technical solution for the visually impaired to pass through public locations easily using RFID tag grid, RFID cane Reader, Bluetooth interface and personal digital assistance. But its initial development cost is quite high and chances of interference in heavy traffic[4]. A voice-operated outdoor navigation system developed using GPS, voice and ultrasonic sensor. It can alert user's current position and provide verbal guidelines for travelling to a remote destination but fails to give obstacle detection and warning alert[6].

The study of paper[7], Design and Implementation of a Voice Based Navigation for Visually Impaired Persons guided us about the use of Voice commands and it's prevalent applications. There is various technology being developed in order to foster voice-based systems for navigation. This idea is applied to the system that we have proposed as an aid for the blind to navigate.
Google Glass is a wearable computer with an optical head-mounted display that is being developed by Google in the Project Glass research and development project. In paper[8], the author talked about the use of google glass for the aid of blind. We considered google glass as an alternative to Kinect for the same purpose. The system that is proposed can use Kinect as it's the main sensor or google glass as well. The proposed system is independent of the hardware it is connected to.
The paper[9] presents a system which extends the use of the traditional white cane by the blind for navigation purposes in indoor environments. Depth data of the scene in front of the user is acquired using the Microsoft Kinect sensor which is then mapped into a pattern representation. Using neural networks, the proposed system uses this information to extract relevant features from the scene, enabling the detection of possible obstacles along the way. The results show that the neural network is able to correctly classify the type of pattern presented as input.

The paper[10] illustrates NAVIG, a system developed using augmented reality. Navigating complex routes and finding objects of interest are challenging tasks for the visually impaired. The project NAVIG (Navigation Assisted by artificial VIsion and GNSS) is directed toward increasing personal autonomy via a virtual augmented reality system. The system integrates an adapted geographic information system with different classes of objects useful for improving route selection and guidance. The database also includes models of important geolocated objects that may be detected by real-time embedded vision algorithms. Object localization (relative to the user) may serve both global positioning and sensorimotor actions such as heading, grasping, or piloting. The user is guided to his desired destination through spatialized semantic audio rendering, always maintained in the head-centred reference frame. This paper presents the overall project design and architecture of the NAVIG system. In addition, details of a new type of detection and localization device are presented. This approach combines a bio-inspired vision system that can recognize and locate objects very quickly and a 3D sound rendering system that is able to perceptually position a sound at the location of the recognized object. This system was developed in relation to guidance directives developed through participative design with potential users and educators for the visually impaired.

3. ARCHITECTURE

The proposed system uses the strongest sense of the visually impaired person i.e., Sound. It will illustrate the surroundings to the user by giving sound signals. The system will identify the direction, distance and places/objects in its vicinity.The inputs are the surrounding objects which are identified by the system and the corresponding sounds are generated to help in navigation for the blind. The system uses Kinect as the basic device for its working.
The system uses two sensors: RGB sensor & Depth sensor

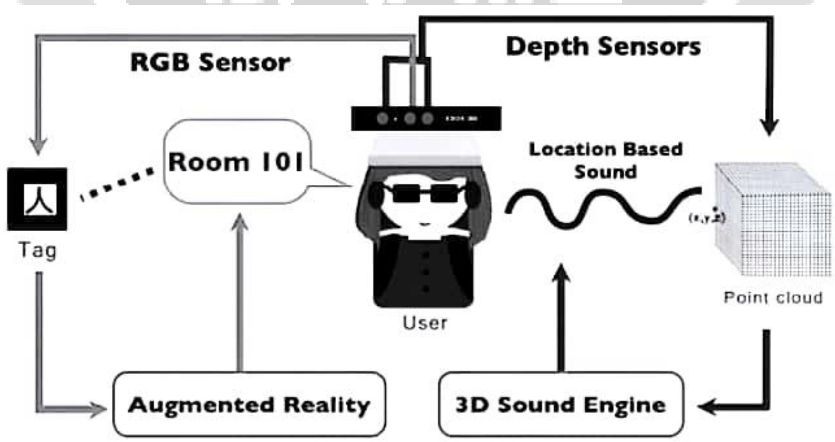

Fig -1: Architecture

3.1 Kinect

Kinect (codenamed Project Natal during development) is a line of motion sensing input devices that were produced by Microsoft for Xbox 360 and Xbox One video game consoles and Microsoft Windows PCs. The innovative technology behind Kinect is a combination of hardware and software contained within the Kinect sensor accessory. There's a trio of hardware innovations working together within the Kinect sensor:

1. Color VGA video camera - This video camera aids in facial recognition and other detection features by detecting three colour components: red, green and blue. Microsoft calls this an "RGB camera" referring to the colour components it detects.
2. Depth sensor - An infrared projector and a monochrome CMOS (complementary metal-oxide semiconductor) sensor work together to "see" the room in 3-D regardless of the lighting conditions.
3. Multi-array microphone - This is an array of four microphones that can isolate the voices of the players from the noise in the room. This allows the player to be a few feet away from the microphone and still use voice controls.

Fig -2: Portable Kinect sensor

3.2 Methodology

The first task is to identify the places and objects around the user. Cognitive services and Augmented reality are used to achieve this task. The RGB sensor of the Kinect is used to identify the tags and using Augmented Reality tool the corresponding useful information is generated. A library of custom tags that are used in almost all the public buildings like room number indicators, washroom indicators for a particular gender, lift indicator, etc will be created and stored in a database. The RGB sensor detects the tags in the surrounding and then using the Augmented reality kit it extracts only the tag from the background and compares it with the tags in the database. After successful tag detection and identification using Augmented reality tool the corresponding information regarding the tag is conveyed to the user in a human understandable language. This is based on the marker based augmented reality.
Marker-based augmented reality (also called Image Recognition) uses a camera and some type of visual markers, such as a QR/2D code, to produce a result only when the marker is sensed by a reader. Marker-based applications use a camera on the device to distinguish a marker from any other real-world object. Different forms of augmented reality markers are considered as images which can be detected only by a camera and AR software as digitized virtual contents that are available on the scene[11].

Cognitive services are used to describe the user’s surroundings, read the text, answer questions and even identify emotions on people’s faces. We use Computer Vision API(Which is a part of Microsoft’s Cognitive services) to extract rich information from images captured by the camera on Kinect in real time. The system describes the surroundings to the user by using Cognitive services in his understandable language.

The concept of the using Depth Sensing technology has been around for a long time, but it is still in the phase Of discussion and design. By using Depth sensing cameras and 3D technology we can help the blind to travel the world. The Distance of the object will be detected by the depth camera sensor of Kinect. Then Kinect will generate the sound of particular frequency based on the distance of the object. The depth sensors detect the object in the surrounding and map its coordinates with the point cloud to get the exact location of the object. These coordinates are then rendered to the 3D sound Engine which uses the Fmod SDK library to generate the 3D sound of particular frequency depending upon the distance. The 3D sound will be produced to indicate the exact location of the object.

If the object is far then the frequency of the sound will be low but if the object is near to the user then it's frequency will be high. The frequency of the object also increases and decreases in real time depending on the movement of the user.

4.FUTURE SCOPE

our idea along with the Real sense Device like Kinect has a lot of scope. This device if collaborated with various branches like Augmented Reality, Internet of Things (IoT) can be used mostly in every field for a user with the ease of functions. Our Application can be coordinated with any kind of hardware like Xbox Kinect, Asus Portable Kinect, Google Glass, Oculus Rift, Hololens, Intel RealSense Device.

5. CONCLUSIONS

The navigation system for the visually impaired solves the problem of the physically challenged to move around without the support of any other human being. The system clearly instructs the user of his surrounding in a language the user can understand, which can make the user take action accordingly. The system identifies the various objects coming in the way of the user and inform him/her about the direction and distances clearly. By using the strongest sense of the blind, our system makes them self-sufficient to move around in their surroundings. Our solution offers simple easy to use the device with just on and off buttons. There is no need for the user to learn new technology. The user can easily adapt to the device and take advantages of the device.

The application we will make will be cheaply available in the market with the use of any smartphones. This application will be improved and one of the future enhancements will be achieved. The device will be light and it will be easy to carry. The device will be next step towards revolution.

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