Application for Assisting Mobility for the Visually Impaired using IoT Infrastructure

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Abstract—**The Internet of Things (IoT) is a revolution in the field of Computing and communication. IoT can offer assistance and support to people with disabilities to achieve a better life. Visually impaired (VI) people face many challenges while traveling. Despite many research efforts in this area, no single solution has not been widely accepted by the blind community, mainly because existing systems cannot satisfy all of VI's mobility needs. Various application frameworks are examined in order to demonstrate the interaction of the components of IoT with an Android Application. Our ultimate research goal is to enhance the mobility of VI people in a wider range of travel activities.**

Keywords—IoT, accessibility, visual impairment, context-aware navigation, android, GPS, real time tracing

I. INTRODUCTION

IoT is a revolutionary model that considers pervasive presence in the environment of a various things or objects that communicate through wireless and wired connections and different addressing schemes are able to communicate with each other and help to communicate with other various connected things or objects to build new applications to achieve a appropriate goals. In this paradigm the challenges facing during research and development to create a smart connected world are huge. There are various real as well as digitally and virtually connected or communicated devices in the world are intersect to build a smart network that makes transportation, power, communication, Metropolitan cities and numerous other areas more smarter. The main objective of the IoT is to allow things or objects to be connected and communicated from anyplace, anytime, with various things and anyone can use any path to communicate in the network and can give any service [1]. Objects can be formed as self recognizable and they can obtain intellect by enabling the ambiance related decisions and they can even communicate data and information among self. They have the capabilities of accessing the information that has been collected by other objects or various connected things that they can be factors of different complex services. This evolution is related with the exposure of cloud with several competences and the change of the Internet to addressing of Internet protocol (IPv6) with unlimited addressing capabilities. Many advanced applications can be necessitate, the electric vehicle(like cars) and the smart house automation, in which electric appliances and services that provide intelligence, security alert, network connection, saving energy , tele-communication, entertainment and computing devices like computers that are integrated into a one ecosystem in shared service interface[1].

We believe that the IoT can offer people with defect or disability, which support them, and gives assistance to obtain a better caliber and allows them to lead a social and economic life. IoT technologies are powered by tools that in-turn help to increase an individual independence [2].

VI also known as Blindness or loss of eyesight, is an inability to see through a certain degree which causes problems that cannot be diagnosed by conventional methods, such as use of spectacles or contact lens. Few people face difficulties in visualizing things as they do not use spectacles or contact lens, can also be termed as blind. The term blindness applies to complete or partial vision loss. VI people come across various difficulties with everyday chores such as reading a book, indulging in social activities and independent traveling. Statistics shows us nearly 285 million people suffer from VI of which nearly 246 million have partial vision and more than 39 million are blind. Population with low vision in the prior survey's which reveal that majority of people are over the age of 50. The graph of VI has plummeted since the 1990's [2]. VI has economical limitations for both cost for the treatment and decreased ability towards normal work-life. The lack of support services has made the visually challenged rely on others thus impeding them from being financially active and socialize in the society. Many people with VI benefit from eye vision rehabilitation using assistive devices which help them in adapting to the environmental [2].The proposed model helps to analyze how people with VI's can benefit from the IoT. In recent years, some convenient tools[3] have been build to give assistance VI to walk independently without the aid of another person , such as Belts for Waist, Test platform for hand held, Vibro-tactile Helmet, Active belt and many more. The Three key aspects that need to be taken into consideration of the visually impaired are:

- Locating where the person is.
- Tracing or tracking the person's path.
- How he reaches the desired destination.

This project includes two parts: Hardware and Software. The Hardware components include the blind stick that

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combines and collaborated with the Software component namely IoT and the GPS module residing in the Smart phone. The current position of the user is obtained by GPS. This is a novel approach that helps the VI to reach their desired destination with minimal discomfort.

II. Related Work

According to the statistics given the World Health Organization (WHO), from the available 6.9 billion populations, 110 million populations have very major difficulties in performing day to day activities, while 190 million have severe disability inferred for conditions like blindness, severe depression or quadriplegia. This paper focuses on the people facing various VI and disabilities. The Proposed assistive IoT technology will be the powerful tool to boost independence and increase participation among the visually challenged people. A handful of impressive blind navigation applications have been proposed for both indoor and outdoor conditions. These applications are built by different techniques and technologies.

In [2], the author has given the idea on how IoT can assist people with disabilities and provide the support they need to lead a better life and allows them to socialize in the society.

Mobile communication links are used by application system for the navigation of VI people. The assessment is proposed to enable the implementation of such application system by making use of standard tele-communication infrastructures [3]. It is purely depends on bandwidth which is very low in 2G/3G communication has its limitations.

The idea of an advanced navigation system which provides the navigation information to the VI through a vibro-tactile belt[4]. The system combines various functionality such as GPS, speech recognition applications and Google Maps. This system is very expensive and not every VI can use it.

Another technology is the white cane system that helps VI to independently walk indoors. This system is based on colored navigation lines that include IC tags and an smart white cane that has a navigation device. When a color sensor finds the specific color, the white cane tells the user that is on the navigation line by means of vibration [5]. Here the system is only specified to indoor navigation.

In [6] given the proposal of the system which makes simple street navigation and assistance in outdoor walking in unknown situations less stressful. It makes use of an GPS receiver (external) to increase location accuracy. Due to its external GPS receiver the system is expensive.

The idea on a set of mobile applications assisting the VI in using public transportation. Mainly focused on aiding in urban navigation and provide various ways of accessing data from public transport passenger information system. Here they mainly focused on public transportations and not specified on navigation technique [7].

There is a necessity to combine platforms like sensor networks with the internet in order to enable a true IoT. How a sensor is to be implemented with an IP stack for communication in IP language are discussed in [8]. But the sensors fully depends on IP stack has its limitations.
Based on the limitations observed in the above various works the proposed architecture overcomes some of them in order to facilitate a better living for the visually impaired people.

III. IoT Infrastructure

VI people face many challenges while travelling [9]. Despite many research efforts in this area, no single solution has yet been widely accepted by the blind community, mainly because existing systems cannot satisfy all of VI's mobility needs. In our system we demonstrate how IoT infrastructure for positioning, and web APIs for retrieving relevant information based on user's context can facilitate independent travel for the VI. Technologies supporting for the IoT have tremendous advancement in technical fields, are readily accessible, available and highly versatile and paving way for a rapid growth of things interconnected through Internet world.
These technical advancements open doors for various ways of communication, enhancing human and machine data interaction capabilities. Various industries and institutions exploit IoT to improve their internal processes and services that they provide. The IoT technologies have also conquered different application domains thus converting the world into a single IoT mass. Innovations for the category of people considered special could be achieved with the help of well adapted and specific IoT technology, we could predict these scenarios in the coming days. At present the implementation still requires a major technological upgrade. Focusing on more technical perspective.
By taking advantage of modern smart phones which is having a great potential to become useful mobility aids for VI. The proposed methodology includes 2 parts:

1. Software Architecture
2. Hardware Architecture

IV. Proposed System

A. Proposed Software Architecture

The Fig 1 represents the Graphical view of proposed Software Architecture which explained as below

- Whenever a blind person wants to go from one place to another place, he has to select the route then the system will guide him in a proper way.
- All route details are available in the cloud server. This system has a voice play module which will instruct the user to move in proper direction.
- Admin can Task the Voice Alert and particular time reached voice alert which will be played by the system.

Fig 1: Proposed Architecture to Assisting Mobility for the VI using IoT Infrastructure.

- Once end user logs into the android application, he has to select the route from the list of route details already available in the cloud server.
- As soon as he selects the route, android application gets the GPS coordinates of current mobile location and checks with the GPS coordinates of routes landmark and inform the end user as shown in Fig 1, where he is and how about of his further movement.
- Android applications keep on checking the GPS coordinates of mobile route landmarks, once the next landmark is reached, it will instruct the user, how to move further.
- Once the end user reaches the destination, it informs through voice, he has reached his destination point.

B. System Design

The proposed software system design is shown in Fig 2. Whenever a VI person wants to go from one place to another place, he has to select the route then our system will guide him in a proper way. All route details are available in the cloud server. The server retrieves the longitude and latitude information from the cloud navigation system. This system has a voice play module which will instruct the user to move in proper direction. User can able to set the Task Voice Alert and particular time reached voice alert will be played by the system. The clients in the system are those who want to keep track of the VI person making use of the internet to which the cloud web server is connected.

C. Functional Requirements for software design

1. This system has two applications as mentioned below
   - J2EE Application: This is running in cloud web server.
   - Android Application: This is installed in the mobile phone of VI people.
2. Admin user: He is a super user who can access the cloud web application [10] and create route and landmark details and can also be able to edit the route and landmark details.
3. End user: Can register through the android application. Once after register, he has to login to the application in order to use it.

D. Algorithm

The Algorithm 1 shows that the input to the application is given in the form of predefined routes from which the admin selects a route. The output is a voice navigation that routes the visually impaired in the form of speech. The first step is to initialize the variables for route identification and route co-ordinates. Thus N holds the values for the number of landmarks and D (N) is an array that holds the distance information. The Euclidean distance is iteratively calculated and stored in D. If the distance is found to be small then the relevant message is sent to the android mobile based on which the voice navigation is carried out.

Algorithm 1: Selecting Optimized Route from Android Application
Input: Select the Route from list of Routes
Output: Voice Navigation
Initialization:
First Initialize
RI=0;
X=0;
Y=0;
Let **N** be the no. of landmarks
Let **D (N)** be the Distance to **N**
for *i* = 1 to N do
    Calculate **(X, Y)** and stored it in **D**
    Go to NEXT
    if (**D(N)** = smallest distance) then
    Send **MSG** to Android phone
    End if
End for

E. Optimized Route Selection

The process control flow Fig 3 Represents the overall system. It determines the navigation information of the predefined constraints. The control flow after retrieving the coordinates of the mobile is shown in Fig 2. The algorithm android applications retrieves GPS coordinates from the mobile phone and send into cloud application, once GPS coordinates have received, cloud application has to calculate the distance between received GPS coordinates and roots landmark GPS coordinates[11]. After calculating, it has to pick minimum distance and check with the threshold value, if it is less than threshold value, it determines the user is in landmark which is having less distance, otherwise he is not in the route.

V. HARDWARE ARCHITECTURE

The Hardware Implementation mainly consists of a general foldable blind stick [12], two ultrasonic sensors (range approx six inches) at the bottom of the blind stick and just above it will be another small range ultrasonic range detector. The control unit, which mainly is the Arduino UNO board acts as an oscillator or echo processing circuit, signal conditioner and a decision maker.

- **Ultrasonic Sensors**:Used as an obstacle detector and also detects holes/potholes/stairs.
- **Arduino Uno Board Kit**:The Arduino UNO Kits [13] are ultramodern series of embedded intelligent controller units. This chip based on controllers that usually have a microprocessor mounted on the module board, 13 pins for several of inputs and output purposes, Reset button, USB port and in many of its versions ports like RJ45 and so on.
- **Alarm unit:** Sends alarm to the blind person by a buzzing sound or by voice alerts like "STOP!", "DEPTH IS MORE!", "GO AHEAD" etc from android phone and generates a buzzer sound from the buzzer.
- **Battery/power supply:** Supplies power to the whole system and the buzzer as well.

A. Flow Structure for Hardware Architecture

The Fig 4 represents the Flow diagram for Hardware Architecture. In this it tells us about organizing structure of IoT component which is embedded in stick and android smart phone. In this we are using Two Ultrasonic Sensors which acts as obstacle detector which is controlled by Arduino UNO Board.

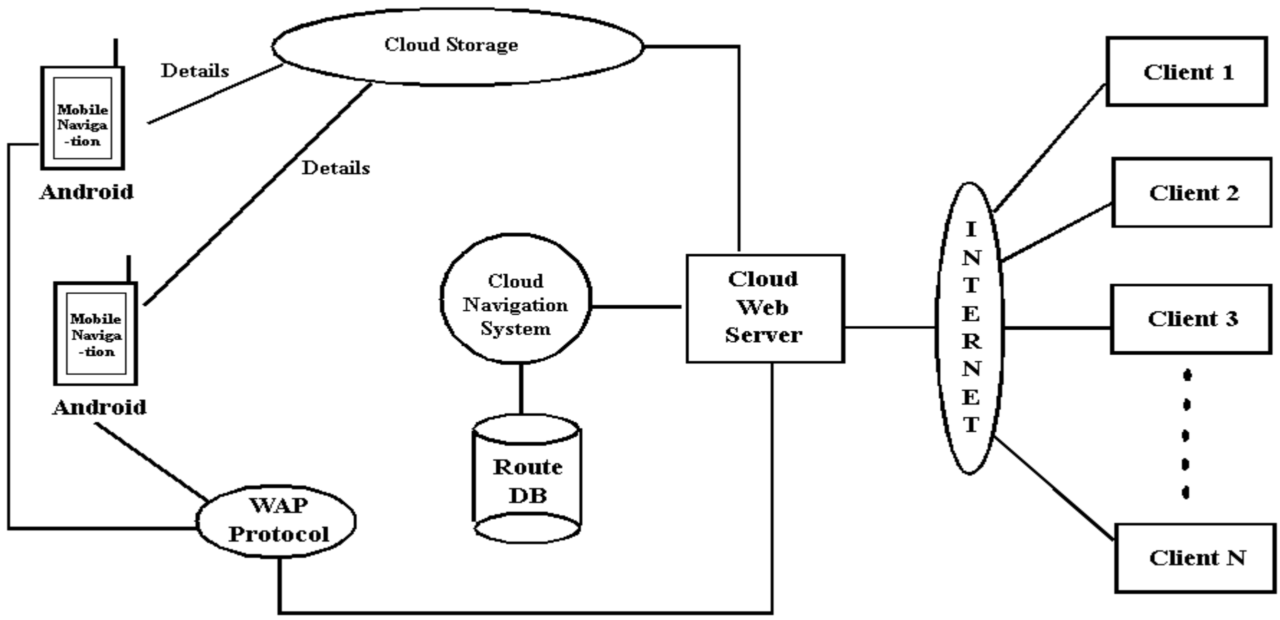

Fig 2: Proposed Software Design Architecture to Assisting Mobility for VI using IoT Infrastructure

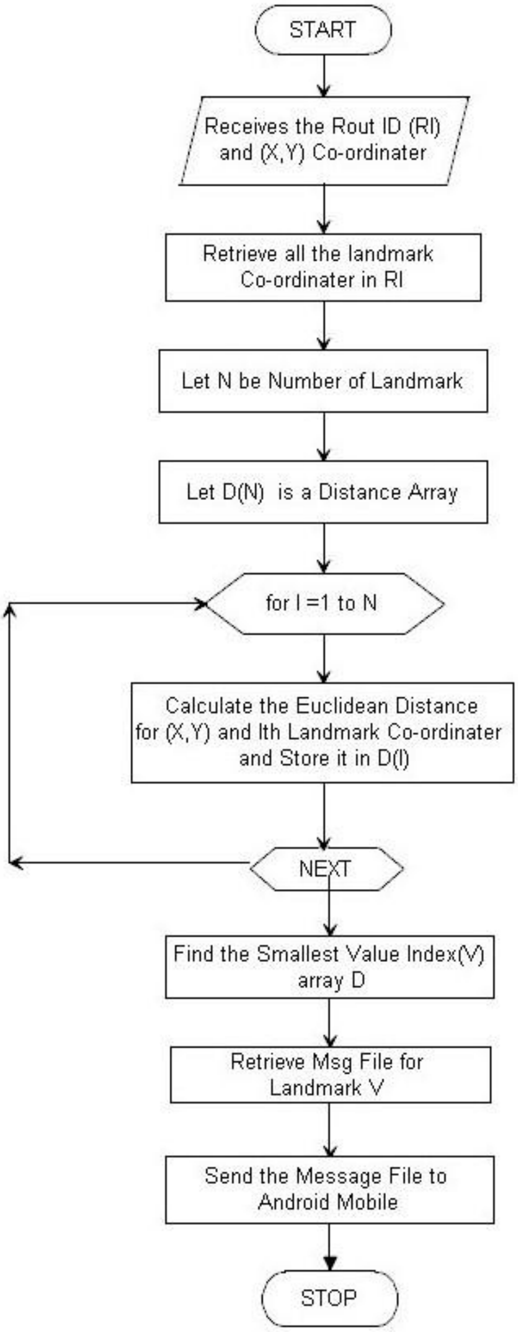

Fig. 3: Selection of Optimized Route from the list of routes.

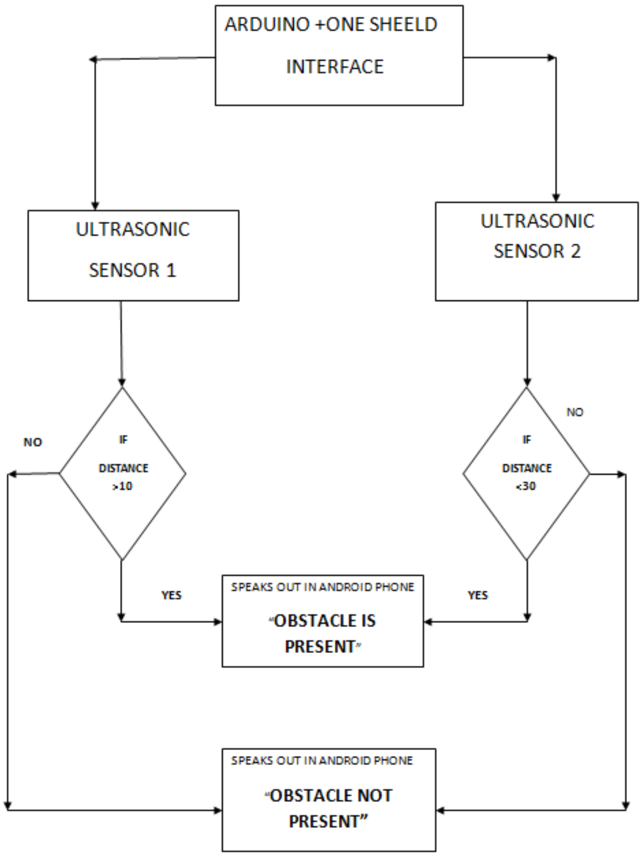

Fig. 4: Proposed Hardware Architecture for VI using IoT Infrastructure.

VI. CONCLUSION

This paper proposes an advanced navigation system to assist the VI walk independently in outdoor environment, which provides the VI with safe walking direction by making use of both Android application and IOT Infrastructure. This system helps in obstacle detection for VI aid applications. The proposed system combined with ultrasonic sensors and a micro-controller function for obstacles detection and also depth. This System is for people with disabilities that are blind to increase safety. The smart blind stick is designed to achieve all the objectives. In future are we planning to conduct longitudinal studies of VI so that we could analyze the travel strategies.

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