ELECTRONIC BUS TRAVEL COMPANION FOR THE VISUALLY CHALLENGED

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Abstract—Technology has reached peaks beyond common man's imagination. With all the advancements, technology has been alleviating many human disabilities. This paper focuses on building a system which aims to help the visually impaired in identifying the correct bus to his/her destination. The system consists of two components : a hand-held device and infrastruc-ture. The user can interact with the device by speech. On the infrastructure side, Wi-Fi access is required at the bus stop by which the device can access the internet. A database, connected to the internet, contains ID and details of all the buses. The device also incorporates an RF communication module that reads the bus ID and informs the user through audio.

I. INTRODUCTION

Famous writer Helen Keller wrote in her essay 'Three Days to See', "I have often thought it would be a blessing if each human being were stricken blind and deaf for a few days at some time during his early adult life. Darkness would make him more appreciative of sight, silence would teach him the joys of sound." This research aims at improving the lives of those who are not able to see the beauty of the world around them. Transportation is always a big challenge for those who are visually impaired. It's virtually impossible for them to travel without a companion's aid. The best means for a blind person to travel independently is to use the public transport system. The task is simple in the case of trains and aeroplanes where there is a good public addressing system in place and even dedicated personnel are available. It becomes little tricky in the case of bus transportation. Such facilities are not feasible in bus stops, but buses are the main means of transport for the common man. Most of the visually challenged people come under this category. So they would greatly depend on buses for their travel. So the challenge is to devise a way that can help the visually challenged to safely board and travel in busesThe situation demands the intervention of technology. In this era, technology is helping mankind achieve things that were once thought as impossible. Now technology has to help a blind person to achieve a herculean task for him - travel independently... 'Electronic Bus Travel Companion for Visually Challenged' is a system that can help blind people to identify and board the correct bus to reach their destination. The system would make use of the public Wi-Fi facility in bus stops to provide this service. This is one of the main requirements of the system but Wi-Fi enabled bus stations are being constructed. So this requirement can be easily met.

Many research work had been done in helping the visually challenged in local transportation. Some have considered RFID alone in assisting the people [1]. It also includes the creation of a database which stores all the data of all the buses. The research work showed various RFID tags such as active, semi-passive and passive tags which could be used in this work. All the buses with different RFID tags would be read at each bus stops and the route would be announced through a loud speaker at the bus stops [1]. This would mean installation of RFID readers and a system at all bus stops. The idea of RFID is used in this paper from [1].

An intelligent wireless bus station is another approach to help the visually challenged in boarding the required bus [2]. It also uses RFID, but along with wireless sensor network, Zigbee and other standards for communication. The research work is mainly the creation of a new protocol used in the creation of such a system.

In the RAMPE system, the user has a Wi-Fi enabled PDA which allows him to communicate to the internet to receive all data about the bus [3]. There is Wi-Fi connectivity at the bus stop that has internet connectivity. The user can interact with the PDA through speech. The details obtained about the bus is conveyed back to the user through speech again, ie. text to speech conversion. The idea of Wi-Fi connectivity at all bus stops is used here. The speech to text and text to speech conversions are also used here.

A bus identification system which uses RFID, text to speech, WLAN and RF communication with the bus has also been proposed [4]. The proposal shows the inclusion of a Braille keyboard for the user to enter the details of the destination. The RF communication with the bus informs the bus driver about the blind person waiting at the bus stop.

A project for helping the blind for easy navigation was mentioned in [5]. In the work, the use of Wireless Sensor Networks (WSNs) and Zigbee were mentioned. The Zigbee helps the bus find the blind person at the bus-stop. Also the blind is aided with GPS for moving towards the bus

II. BACKGROUND OF RESEARCH

Only a small fraction of the world population is visually challenged. But their life is completely different from those who can see. It's not that they can't see anything, blindness limits their lives to such an extent that they have to depend on others for even the simplest tasks. One of the main challenges that visually disabled people face is travelling.

Major section of the blind population has to depend on the public transport system because of the cost concerns. Compared to other means of transport, buses offer good connectivity at reasonable cost. But travelling by bus, on their own, is unthinkable for the visually impaired. They need another person's help for this. This greatly limits the person's mobility. A solution need to be found to this problem troubling the blind population worldwide.

'Electronic Bus Travel Companion for Visually Challenged' aims to solve the above problem and thus improve the lives of millions of visually challenged people all around the world. The system will assist the blind person to identify the bus to his/her destination, detect its presence and hence successfully board it. Additionally the system informs the bus driver regarding the presence of the blind person.

The system is a combination of hardware and software and comprises of mainly two parts, a hand-held device and Technical infrastructure. The hand-held device would be carried by the user. The device takes in the location and destination details from the user, collects the details of the buses to that destination. When the correct bus reaches the bus station the device identifies the bus through RF communication for which additional hardware is included in the device.

Infrastructure support is very much required for the system to be operational. The user device needs to access the internet to get the details of the buses. So, for this, an access network is required at the bus stop. A Wi-Fi access point is very much suitable for this as it provides quick and easy access to internet. So Wi-Fi access points are required at bus stops. Additionally, a server is to be created which would contain the information regarding the buses in its database and provide the required information based on the query from the user device.

III. SYSTEM MODELLING

The system includes

1) Hand-Held device
2) Infrastructure

A. Hand-Held Device

The hand-held device will consist of

1) Hardware
2) Software

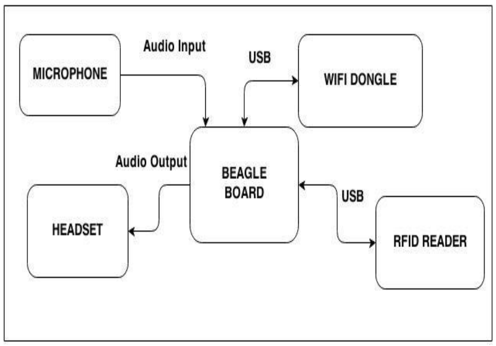

Fig. 1. Figure showing the interconnection of various hardware parts

Hardware

The hardware part (as shown in Fig.1 consists of the following:

1) Embedded Board: The Embedded board that the device is built on will consist of a CPU. This board will have an Operating System (OS), which helps scheduling different tasks and processes. One such platform is the BeagleBoard-xM. The BeagleBoard-xM [5] is an open source hardware platform intended for embedded applications. It has all facilities and capabilities of a mini computer. Some main features of the board are:

- Texas Instruments Cortex A8 1GHz processor
- Micron 4Gb MDDR SDRAM (512MB) 200MHz 4 USB host ports and 1 USB OTG
- Ethernet 10/100
- Stereo Audio in and Audio out with 3.5mm connector DVI-D connector
- RS-232 DB9 connector
- Micro SD-card slot

2) Wi-Fi Module: A Wi-Fi module is incorporated for connecting to the available Wi-Fi at the bus stops. This is a must needed option for various other future purposes.

3) RFID reader: The RF Communication module in the user device allows it to identify the correct bus based on the ID of the bus. Based on the bus ID received from the Database, the user device reads the IDs of the incoming buses by RF communication. The ID received from bus is compared to the ones from database and the correct bus is identified

4) Microphone: A microphone is used to capture the speech from the user. It converts the sound signal to voltage signal. This voltage signal is taken into the system for further processing.

5) Headphone: Headphone is used to provide voice output to the user. The required directions from the software are sent to the headphone as audio signals through audio-out port from the system. These signals are converted to sound by the headphone and the user can listen to it.

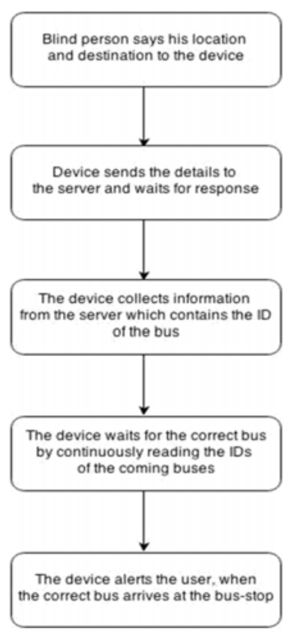

Fig. 2. Application Software flowchart

Software

The software component of the system consists of the following:

6) Operating System(OS): The OS is an embedded OS optimised for the embedded board used. The OS acts as a platform on which the application software works. It allows the application software to interact with the different hardware modules on the embedded board 7) Application Software: The entire functionality of the system lies on the application software (Fig. 2). The application software runs inside the OS environment and interacts with the hardware through the OS. It gives necessary directions to the user and gets the user's location and required destination. It sends this information to the server and receives the bus IDs from the server. From the RFID reader the tags of nearby buses are read. On finding a matching tag the required information is passed to the user.

8) Speech Recognition: The system uses speech recognition to collect the required information from the user. Speech recognition is integrated into the application software. The user is prompted to speak his/her required destination. This is recognized and sent to the server along with his/her current location.

9) Speech Synthesis: The system is required to interact with the user via voice. For this, speech synthesis is incorporated into the application software. This gives necessary directions to the user making it easy to operate.

B. Infrastructure

Infrastructure includes Wi-Fi access point, RF tags and server. The access point needs to be fixed at bus stop. The RF tags are located in buses. This allows the user device to communicate with the bus. The server provides information to the user device regarding the bus timings.

1) Wi-Fi Access Point: Wi-Fi access point located at bus stop will provide internet access. It works based on the IEEE 802.11 WLAN protocol and can support many users. It will provide internet access to all the devices connected to it. The wireless connectivity improves the user friendliness of the device as it can connect to internet without any user intervention.

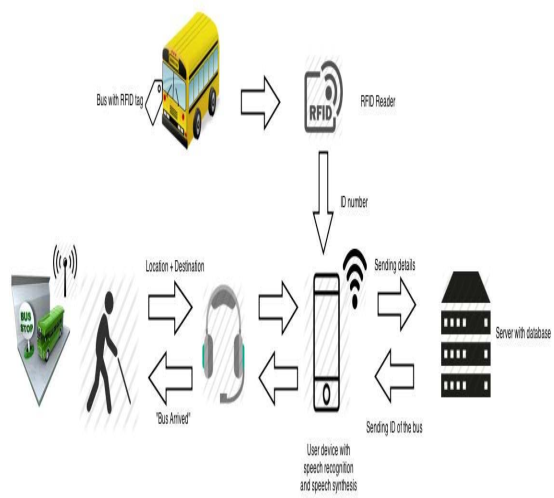

Fig. 3. Figure showing working of the whole system

2) RF Tag: The tag present in the bus communicates with the user device. The RF transceiver receives the query sent from the user device and responds to it by sending the unique ID of the bus.

3) Server: The server contains information regarding all buses in its database. The Database includes the the bus ID , timing at different stops and route details. Based on the destination details and user location provided, the server searches the database and collects the IDs of the buses meeting the requirement and sends it back to the user.

IV. WORKING

A block diagram showing the working is given in Fig.3. The description is given below.

1) When the user reaches the bus stop, the user device automatically connects to the Wi-Fi access point located at the bus-stop through the Wi-Fi module on the device.
2) After ensuring network connectivity, the system asks the user to tell his/her location. The response from user is recorded and recognized. The correctness is checked by speaking the

recognized word to the user. The process is repeated if required.

3) Same process is repeated to get required destination from the user.
4) The location and destination information are sent to the server through internet. The server searches its database to find buses matching the location and destination requirements.
5) On finding the buses plying in the route required by the user at given point of time the tag numbers of the buses are sent to the user device over the internet.

The user device receives the tag numbers from the server. It scans its environment and reads nearby tags. When the read tag number matches with the received tag number, the arrival of the bus is confirmed and necessary directions are given to the user.

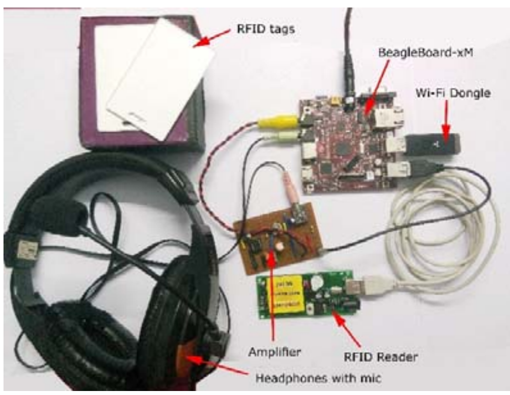

Fig. 4. Experimental Setup

V. EXPERIMENTAL SETUP

A. Hardware Setup

The hardware setup for the system is shown in Fig.4. The BeagleBoard-xM is the embedded board used. The Wi-Fi module is a USB Wi-Fi dongle connected to one of the USB ports in BeagleBoard-xM. The RFID reader is also connected to the board through USB. The headphone is connected to the audio-out port on the board, but the connection from microphone does not go directly to the board. The audio-in port of BeagleBoard-xM is designed for line level ie. it does not accept the microphone signal directly. The microphone output is given to an audio amplifier and the amplified signal at line level is given to audio-in of BeagleBoard-xM. The OS and Application software are contained in a micro SD card connected to the corresponding slot in the board.

B. Software Setup

The software setup consists of the OS and the Application software. Ubuntu operating system is used to boot the device. The version of Ubuntu used is specific to BeagleBoard-xM. In order to boot, the OS is mounted onto the micro SD card connected to BeagleBoard-xM. For this, the card is partitioned into two volumes. The OS kernel is placed in one volume and the file system in the other. The application software is located in the file system. The application starts operation as soon as the OS boots. The application software itself contains many smaller software modules. They are Speech recognizer, Speech synthesizer, RFID reader and Communication handler. Speech recognizer is written in Java with the help of CMU Sphinx open source library. This module is called to convert the voice recorded from the user into text. Popular open source speech synthesizer called eSpeak is used as the speech synthesizer. A regional language Malayalam was also incorporated along with English. This is done to aid users who prefer Malayalam over English. The RFID reader deals with the RFID hardware. The Communication handler deals with internet connectivity and communication with the server.

VI. RESULTS

Experiments were conducted based on the above features and the system worked well at all times. The only problem was the speech recognition software, which was made using Java, was not that accurate all the time, as the words used were places from Kerala. The incorporation of text-to-Malayalam conversion was done in helping those who did not under-stand English. The speech synthesizer output sounded more machine-like, because of non-availability of other good voices. Overall, the system gave good response.

VII. CONCLUSION

Through this research and experiment, an electronic system for helping the blind travel in a bus was developed. Only minimum hardware were used to achieve this, and most of the processing done was through software.

In future, an economical guidance system, for helping the blind move towards the bus, has to be integrated to the above system for better functioning of the whole system REFERENCES

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