Electronic Travel Aid for Amaurotic People

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***Abstract*--This paper presents the architecture as well as the implementation of a system that helps blind person navigate independently. Within an enclosed environment such as the home o environment. Optimal path planning is done by RF TX [7], for the path planning blind person show the RF RX [7]. The blind person receives direction responses using audio signals. In this paper Guide Cane is used for the purpose of blind navigation system. Obstacle sensor senses the object in front of the blind and informs him. Direction to the blind people are given through RF [7] communication from the survived data base in this way Electronic Travel Aid (ETA) is developed for blind person.**

***Keywords*--localization; visually impaired; RF; navigation, Electronic Travel Aid (ETA)**

I. INTRODUCTION

According to National Federation for Blind (NFB) and American Foundation for the Blind (AFB), the estimated number of legally blind people in the United States is 1.3 million and the total number of blind and visually impaired is approximately 10 million with around 100.000 to be students. Worldwide more than 160 million people are visually impaired with 37 million to be blind. The need to for assistive devices was and will be constant. There is a wide range of navigation systems and tools available for visually impaired individuals. *Electronic travel aids (ETAs) are* devices that transform information about the environment that would normally be relayed through vision into a form that can be conveyed through another sensory modality.

Many of solutions rely on Global Positioning System (GPS) technology to identify the position and orientation of the blind person. While such systems are suitable for outdoor navigation, due to the need for line of sight access to satellites, they still need additional components to improve on the resolution and proximity detection to prevent collision of the blind persons with other objects and hence subject his/her life to danger. The use of robot-dog is another technological solution proposed by a number of researchers. It also depends on GPS and incorporates objects avoidance technologies. These solutions are useful, however they can only be used outdoor and miss interpretation of the blind person requests as well as accuracy, issues may have serious consequences on the well being of the user.

This paper presents a system that will enable a blind or visually impaired person to navigate independently inside an enclosed environment such as the home. The system integrates wireless communication technologies, path planning, sensors and other technologies to build a compact portable navigation system. Following this introduction the paper is organized as follows. Section 2 presents the system architecture including the various input/output signals. Section 3 details the system design and implementation. This includes all the hardware and software system blocks. Finally section 4 of this paper presents the conclusions and suggestions for future work.

II. SYSTEM CONCEPT

The elements required to perform the guidance process include defining the destination or target, identifying the current position of the blind person and finally determining the best path to be taken to reach the desired destination. In order to identify user position, the guidance system utilizes RF based localization engine technique that continuously updates the server with the user location [7]. A digital compass located in the push mobile cart enables the system to identify the user orientation. The proximity sensors incorporated in the mobile push cart enable the detection of obstacles. The user of the guidance system pushes the cart that the support its weight during regular operation. Also the wheels are equipped with encoders to determine the relative motion of the user. This information is used to refine the system localization process.

A. System I/O

Figure 1 shows the top level view of the guidance system. As can be seen from this diagram, the parameters that are inputted to the system are User Location, User Request and User Orientation. The guidance system will update the location of the blind person with respect to a virtual map in real time. The user can enter locations or objects. After this a series of computational operations will take place inside the guidance system to generate the speech commands to direct him to the requested location or object.

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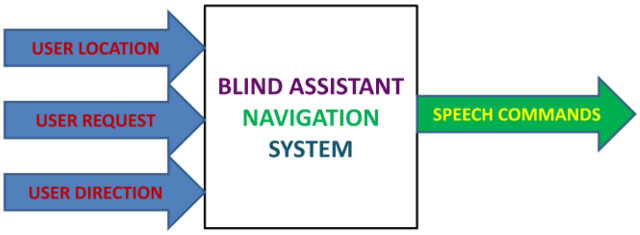

Figure 1. The input/output of the guidance system

B. System Architecture

The overall architecture of the proposed system is shown in Figure 2. The system is composed of two main subsystems. The first one represents the user mobile block which collects information about the environment and also sends the requests and receives the commands from the server. The second subsystem is the server block that processes the collected information from RF network, the output needed to direct the user to the requested target.

The system will sense analyze and process the gathered information from the user movements in order to provide a subtle guidance commands. These guidance commands are adapted based on the user location in real time. The data required to achieve appropriate guidance information are the following:

1) *The user's location & Orientation*: the mobile node attached to user cart is used to find the location of the user within the map of the house.

2) *The user's profile*: the user's profile contains the user related information such as: list of the desired objects and the user's home map.

3) *The user's request*: the user desired destination or object which can be entered by the user to the system via voice commands

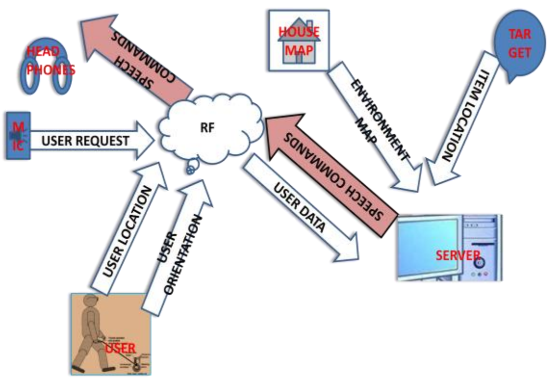

Figure 2. System Architecture

The Guiding Stick Wheel, shown in Figure 2, contains RF Mobile Node that will estimate the user location with to the predefined map of the house. It uses Power estimation Algorithm that is based on range measurements using received signal strength from fixed reference nodes. The orientation of the user is acquired from the digital compass attached to the stick in order to allow the system identify the direction on the map from the user current location to the target location. The microphone acts as an interface between the user and the system. The user will literally say the name of the destination the he/she desires to reach, and then the speech recognition subsystem will apply recognition processes to identify the address of the target. Concurrently, the RF mobile node and the digital compass will detect the user position and orientation, respectively. These readings will be processed by the microcontroller in the Guiding stick wheel and transmit them via RF network to the server. Then the RF coordinator connected to the server side will collect the data and feed it to the navigation application. In this stage, a number of processes will be applied on the data in order to generate a set of guidance commands that will sent the user. Finally, the microcontroller will receive the information from the server via the RF interface and feed it to the voice module to generate the guidance commands verbally.

The block diagram of the Guiding stick wheel subsystem is shown in Figure 3 and the block diagram for the server subsystem is shown in Figure 4. These models describe how the system to operate the guidance of the blind person during his navigation to the requested destination or object

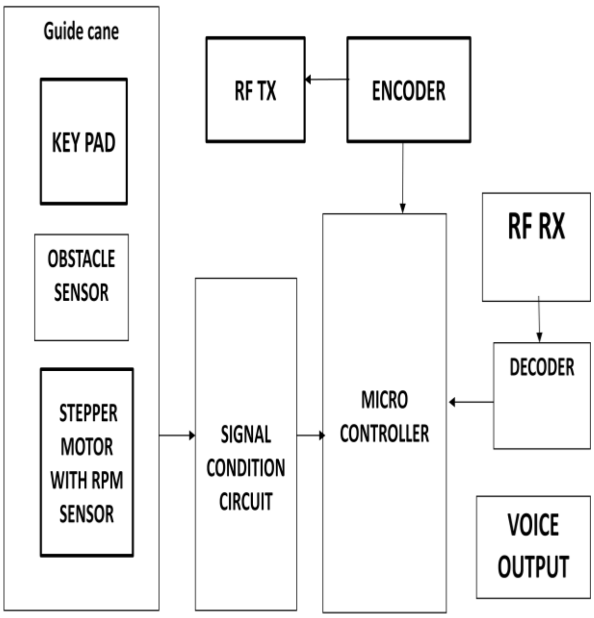

Figure 3 Block diagram of the GuideCane Model

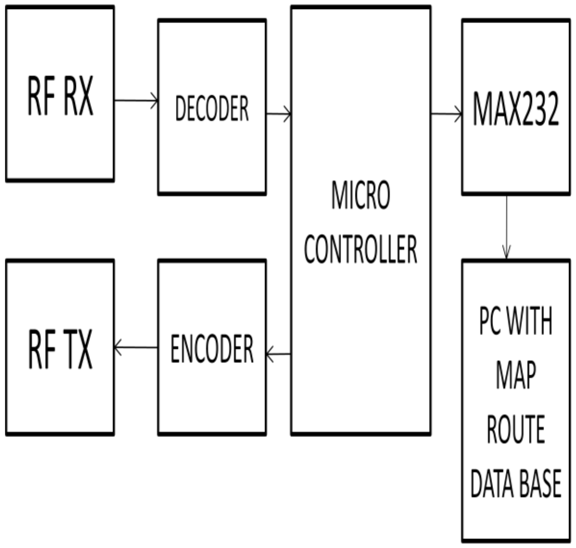

Figure 4 Server Data Model.

a. The person has to enter the destination & starting point
b. Then the details are send through RF TX to the system
c. In the system side it is received by RF RX and decode and get the directions from the data base and transmitted to the person
d. The person receives the data as a voice out put
e. He has to follow the running announcement
f. The distance travelled by him was detected by the stepper motor fitted with rpm sensor that data is send to the system for every 30 seconds
g. Based upon the distance travelled it gives further direction change commands to the person

C. Hardware

The set of components that have been utilized to develop such system are as follows:

a) *Microcontroller AT89C51* **[**2**]**: MCS-51[1] family, originally designed by Intel in the 1980's.Used in a large percentage of embedded systems. Includes several on-chip peripherals, like timers and counters.128 bytes of on-chip data memory and up to 4K bytes of on-chip program memory.
   i) *Features***:** 8-bit CPU optimized for control applications. Extensive Boolean processing (single-bit logic) capabilities.64K Program Memory address space.64K Data Memory address space. Up to 4K bytes of on-chip Program Memory.128 bytes of on-chip Data RAM.32 bi-directional and individually addressable I/O lines. Two 16-bit timer/counters.6-source/5-vector interrupt structure with two priority levels

b) *Encoder HT12E*: The 2^{12} encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12 N data bits. Each address/data input can be set to one of the two logic states. The programmed Addresses/Data are Transmitted together with the header bits via an RF Transmission medium.

c) *Decoder* ***HT12D*****:** The 2^{12} decoders are a series of CMOS LSIS for remote control system applications. They are paired with Holtek 2^{12} series of encoders. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from a programmed series of encoders that are transmitted by a carrier, using an RF transmission medium. The HT12D is arranged to provide 8 address bits and 4 data bits.

d) *Transmitter Module SM TC-4***:** The SM TX – 4 is an AM transmitter module [7] which can facilitate OEM manufactures to design remote control application in shortest way. Low power consumption and wide operating voltage makes the module ideal for battery operated low power application. The SM TX – 4 is small enough to fit in almost any cabinet.

e) *Receiver Module*: This is a SR series of radio frequency module [7] which can facilitate the OEM designers to design their applications in remote in the quickest way. The circuit is designed with SMD components and the module size is small enough to be able to be fitted in many remote control applications. This compact receiver module is very sensitive and heavy immune to other radio interference.

f) *Voice Module APR9600*: The APR9600 [8] device offers true single-chip voice recording, on-volatile storage and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design. the device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications.

g) *MAX 232***:** The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of microcontrollers with PC. The controller operates at TTL logic level (0-5V) whereas the serial communication in PC works on RS232 standards (-25 V to + 25V). This makes it difficult to establish a direct link between them to communicate with each other.

The intermediate link is provided through MAX232. It is a dual driver/receiver that includes a capacitive voltage generator to supply RS232 [5] voltage levels from a single 5V supply. Each receiver converts RS232 inputs to 5V TTL/CMOS levels.

The transmitters take input from controller's serial transmission pin and send the output to RS232's receiver

h) *Sensor IR* **:** Infrared (IR)[6] radiation is part of the electromagnetic spectrum, which includes radio waves, microwaves, visible light, and ultraviolet light, as well as gamma rays and X-rays. The IR range falls between the visible portion of the spectrum and radio waves. IR wavelengths are usually expressed in microns, with the IR spectrum extending from 0.7 to 1000 microns.

Infrared sensor units are capable of emitting infrared light, which cannot be seen by the human eye, and are able to turn on devices

i) *IR Transmitter***:** An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. Such LEDs are usually made of gallium arsenide or aluminum gallium arsenide.

ii) *IR Receiver***:** An IR LED, also known as IR Receiver, is a special purpose LED that receives infrared rays in the range of 760 nm wavelength. The main component of a receiver unit is usually a photodiode.

i) *Electromechanical Relay***:** The electromechanical relays are based on the comparison between operating torque/force and restraining torque/force. Each relay can perform only one protective function. Protective relaying is necessary with almost every electrical plant, and no part of the power system is left unprotected. Between generators and final load points, there are several electrical equipments and machines of various ratings. Each needs certain adequate protection.. The relays used in this project are compact, self-contained devices, which related abnormal conditions relays distinguish normal and abnormal conditions.

j) *Stepper Motor***:** Stepping motors can be viewed as electric motors without commutators. Typically, all windings in the motor are part of the stator, and the rotor is either a permanent magnet or, in the case of variable reluctance motors, a toothed block of some magnetically soft material. All of the commutation must be handled externally by the motor controller, and typically, the motors and controllers are designed so that the motor may be held in any fixed position as well as being rotated one way or the other. Most steppers, as they are also known, can be stepped at audio frequencies, allowing them to spin quite quickly, and with an appropriate controller, they may be started and stopped "on a dime" at controlled orientations

D. Software

An interface is designed to enable the system administrator to debug the system, or monitor the movement of the blind person within the house. In addition, the obtained information can be sent to service center in order to diagnose the condition of the blind person. Although the system requires a server; however, the computational process is done in real-time. Figure 6 show that the user icon in the interface continuously follows the location of the blind node which makes the guidance procedures more accurate. Also, it can be seen from the interface that it has a drag and drop menu that enables the system to easily evolve with respect to the user's needs.. Finally, the path-planning algorithm is also handled by the software, where Re-active path planning method is used to connect between the user and the desired target. This algorithm is simply connecting between two points which are the user and the desired target.

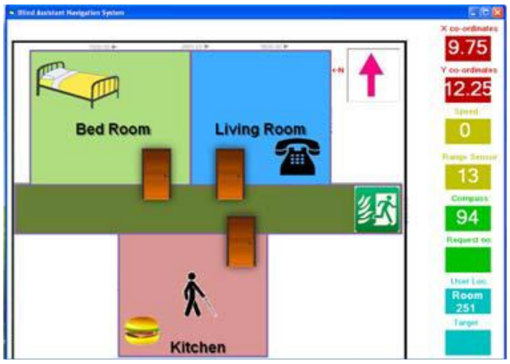

Figure 6: System Application Software

III. CONCLUSIONS

This paper presented the architecture and implementation of a system that assists a blind person to navigate inside an enclosed environment such as the home. The system can be considered as a semi-autonomous device. It provides full autonomy for global navigation (path planning & localization), but relies on the skills of the user for local navigation (Obstacle avoidance) ([10], [11]).

This device offers innovative solutions in order to replace the conventional methods of guiding visually impaired person. In addition, it can be easily applied anywhere where it can handle places like malls or airports. This system will allow the visually impaired to wander freely and independently. The system described in the paper is at the prototype stage and hence there are many options for improvements. Some of the improvements are:

- *Adjust to Outdoor Environment***:** The next version of this system can be equipped with a GPS in order to allow the visually impaired person to use the system for both indoor and outdoor.
- *Smartly Adapt to User Behavior*: intelligent manner could be a very helpful feature. It would allow the system to not only guide the user to a desired location, but also to adjust according to the user habits
- *Monitoring through Mobile Devices:* another promising improvement is adding monitoring software for mobile devices in order to allow relatives or medical services to watch the user movement at any time

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