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Calciamicus : Smart Shoes for Visually Impaired People

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ABSTRACT

The purpose behind developing this project is to provide a cost effective solution to visually impaired people. Visually impaired people and blind people face many difficulties in independent mobility and navigation due to which they are unable to walk like normal people. Also their daily activities are hampered by their inability to adapt or accurate identification of their surroundings, which becomes the main reason of accidents, mishaps, falling off, getting lost in unknown areas etc. Our developed model will ensure the safety of visually impaired person by guiding him through areas whether known or unknown to him. This will be achieved through mini vibrators dedicated for each side of shoes, the Ultrasonic sensors (both on cap and shoe unit) used for Obstacle detection etc. The Microcontroller is the main control unit with Embedded Software design. The GPS (global positioning system) and GSM(global system for mobile communication) modules are also used to track the location of the blind person. These Smart Assistive Shoes would prove to be a new interface between the surrounding and the people who cannot see it.It will alert them of any kind of obstacle in their way and spot any small or big object without using their hands thus it would be surely a user friendly solution.

Keywords : Smart Assistive Shoes,Visually Impaired People, Blindpeople, Navigation, Ultrasonic Sensors, Microcontroller.

I. INTRODUCTION

Different research works have been done till date on the utilization of the fast growing technology for the benefit of visually impaired people and blind people. We too had the same idea in our mind to use the smart technology but with a new perspective and some modifications. Recent study shows that there are around 37 million blind people in the world and approximately 27% i.e. 10 million out of them are present in India. The blind and visually impaired population is ever increasing and thus it was the need of the hour to develop a technology to solve their problems. Calciamicus is that device which will prove to be a simple, cheap, user friendly and smart guidance system for both visually impaired people and blind people of all ages irrespective of their height, weight etc.

1. Our Motivation

We are motivated with the thought of helping the poor people(below poverty level) who are facing difficulties because of their blindness but could not afford any such kind of innovative technology and the reason is "COST".

Hence we are developing this innovative affordale solution called Calciamicus. Calciamicus consists of two units(shoe and cap unit) consisting of sensors, microcontroller, actuators etc. to detect the obstacle, its distance from user etc. Calciamicus is also using the GSM and GPS modules to ensure the safety of the person using it. The vibrators in the shoes and cap will continuously alert the visually impaired person about the ostacles in his/her way.

2. Literature Survey

A. Paper I

The smart white cane is a pure mechanical device dedicated to detect static obstacles on the ground, holes, uneven surfaces, steps and other hazards via simple tactile force feedback. It can be folded in to a small piece and its light weight can be advantageous to carry around when not require. These simply designed canes are only capable of detecting below waistline ostacles. Haptic sensors and controller were emedded in the cane. Battery life was ten hours.

B. Paper II

This paper showed the development of a detachable unit consisting of ranger, vibrator and microcontroller that could be mounted on the top fold of the white cane. The device employs directional ultrasound based ranging to detect obbstacles in front or above knee height within a range of 3m. The user obtains distance information through vibratory stimuli which supplement the auditory cues emanating from the environment and those produced by tapping the cane. The module runs on a standard Li-ion rechargeable battery. For charging the user connects an AC or USB adapter (similar to charging a cell phone).

C. Paper III

Here the developed model consisted of two units shoe and cane unit to guide the blind person. The sharp IR(Infrared) range finder fitted in the circuit placed in shoe circuit works by process of triangulation. A pulse of light (wavelength range of 850nm +/- 70nm) is emitted and then reflected back at an angle that is dependent on the distance of the reflecting object as shown in the figure below.

Bluetooth technology is also used for connecting the shoe and cane modules. PIC microcontroller processes the data of three Infrared sensors on the cane and shoe and gives output command to the voice chip to playback the pre-recorded message.

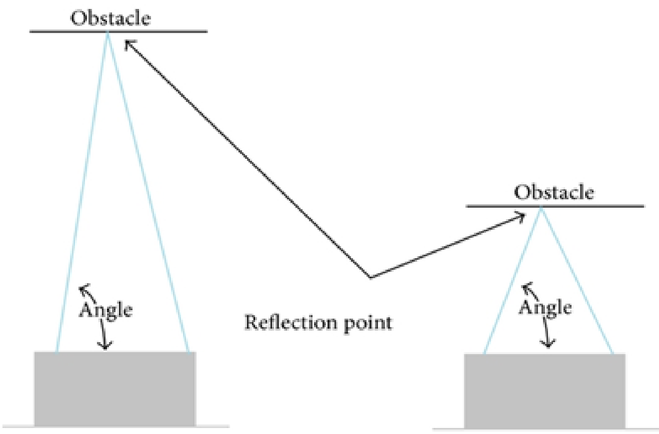

Figure 1. Reflection of light making different angles depending on the distance of the reflecting object.

D. Paper IV

In this paper we found that shoes with cane are used as smart assistive device with bluetooth technology. Sensors used ultimately ping the user about the problem by the vibrations. Now the vibrations will be produced through another device which can be placed inside the pocket of the user. Arduino controller keeps polling the ultrasonic sensors. The advantage here was that the blind shoes can charge the battery by itself through kinetic generator pinned under the soles of shoes. The battery will becharged automatically when the user step.

E. Paper V

This paper addressed the development of a model that consisted of two modules, shoe and cane unit. Both are integrated together, working as a single unit facilitated by "Bluetooth" connectivity and offers solution for orientation through digital compass. PIC microcontroller is used here as the commanding system. Rechargeable battery is used here which can last for approximately 12 hours. The advanced feature used here is the GPS(global positioning system) technology of the smart phone which will help to track the location of the visually impaired in case of any emergency.

II. METHODS AND MATERIAL

A. Hardware Requirements
   1. Atmega16 microcontroller
   2. Ultrasonic sensors (HC-SR04)
   3. GSM-sim 900 Module

4. GPS Module(EM-410)
5. Vibrators
6. Voltage Regulator(3-terminal positive-LM78M05CDT)
7. Rechargeable battery-FG20121.

B. Hardware Specifications and features

1. Atmega16 Microcontroller

i. High-performance ,Low-power AVR 8-bit Microcontroller.

ii. Advanced RISC Architecture - 131 Instructions - Most Single Clock Cycle Execution.

iii. I/O and Packages

- 32 Programmable I/O Lines
- 40-pin PDIP, 44-lead TQFP, and 44-pad MLF.

iv. Operating Voltages- 4.5-5.5V.

v. Power Consumption at 4 Mhz, 3V, 35 °C

- Active: 1.1mA
- Idle Mode: 0.35mA
- Power-down Mode: < 1µA.

vi. 512 Bytes EEPROM - Programming Lock for Software Security.

The reason of using microcontroller is because they have the ability to store and run unique programs make it extremely versatile.

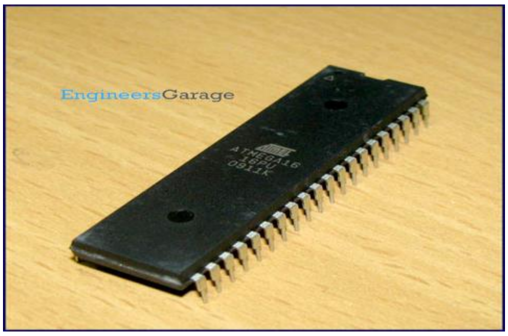

Figure 2. Atmega 16 Microcontroller

2. Ultrasonic Sensors

i. Offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1” to 13 feet.

ii. It operation is not affected by sunlight or black material like Sharp rangefinders.

iii. Power Supply :+5V DC

iv. Quiescent Current : <2mA

v. Working Current: 15mA

vi. Effectual Angle: <15°

vii. Resolution : 0.3 cm

viii. Measuring Angle: 30 degree

ix. Trigger Input Pulse width: 10uS

x. Dimension: 45mm x 20mm x 15mm

xi. Pins

VCC: +5VDC
Trig : Trigger (INPUT)
Echo: Echo (OUTPUT)
GND: GND

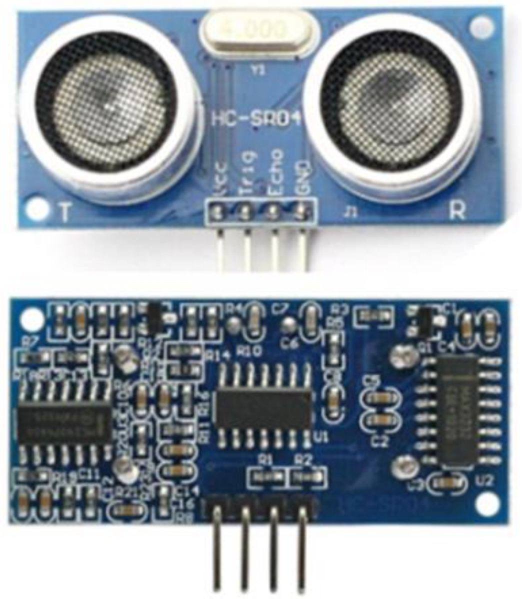

Figure 2. Ultrasonic sensors (front and back view)

The ultrasonic sensor is a robust and flexible sensing agent with relatively few limitations.

3. GSM sim 900 Module

i. Power supply – 5V.

ii. Control via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands)

iii. Low power consumption: 1.5mA(sleep mode)

iv. Operation temperature: -40°C to +85 °C.

v. InterfacePinDescription

Rst -- Reset the SIM900 module
P -- Power switch pin of SIM900 module
Tx--UART data output
Rx--UART data in
DT--Debug UART data output
DR--Debug UART data input
‘-’—GND
‘+’—VCC

vi) Current Consumption (pulse)-2000mA
Current Consumption (continuous)-500mA
vii) Baud rate115200bps.

Figure 3. GSM Sim 900 Module

4) GPS Module(EM-410)

- ✓ New improved GPS Module with external high-gain patch antenna and memory back-up for OEM and hobbyists projects.
- ✓ This unit features low power consumption, high sensitivity.
- ✓ The unit is ideally designed for navigation systems, distance measurements, vehicle monitoring and recording, boating direction and location, together with hiking and cross country exploring.
- ✓ SiRF Star III high performance GPS Chipset
- ✓ Very high sensitivity(Tracking Sensitivity:159dBm)
- ✓ Extremely fast TTFF (Tiem To First Fix) at low signal level.
- ✓ Supports NMEA 0183 and SiRF binary data protocol
- ✓ Built-in SuperCap to save system data for rapid satellite acquisition.
- ✓ External patch antenna with 27dB Gain
- ✓ Acquisition Time, cold start 42 seconds
- ✓ Includes Connecting Cable
- ✓ Power Supply - 3.3Vdc
- ✓ Dimensions - GPS: Length - 47mm , Width - 25mm, Height - 7.5mm

- o Antenna: Length - 18mm , Width - 18mm, Height - 4mm.

Figure 4. GPS Module(EM-410)

5) Mini Vibrators

Minivibrators used in mobile phones are having leads are small and weak, so when we apply too much voltage across it, it would vibrate too much and break the leads. In addition, if it vibrates too much, it may be uncomfortable for the user. We limited the vibrator's output by outputting only if the output voltage would be less than 50/255*5V = 0.98V

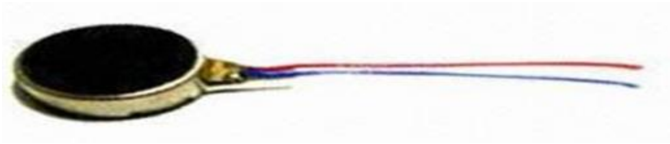

Figure 5. Minivibrators

6) Voltage Regulator

- ✓ Employs built-in current limitting .
- ✓ Thermal shutdown and safe-operating area protection
- ✓ Adequate heat sinking.
- ✓ Eliminate the noise.
- ✓ Output voltages of 5V,12V,and 15V possible.
- ✓ Line regulation 7.2V<=VIN<=25V.

7) Rechargeale Battery

- ✓ Nominal Voltage 12V.
- ✓ Nominal Capacity 1.2Ah,20 hours rate.
- ✓ Maximum Charging current 0.3 A.
- ✓ Weight 0.60 kg
- ✓ Operative temperature range-20˚C to 50˚C.

C. Software Used

A. Atmel studio 6.1 used for simulation.
B. Embedded C coding language used for programming purpose.
C. Eagle software used for PCB designing.

III. RESULTS AND DISCUSSION

Comparison of the Existing And Proposed Technology

TABLE I

Existing	Proposed

1.Includes Shoe and cane units which kept the hands busy of the blind person.	1.Shoe and cap units together work to alert the blind person keeping his/her hands free.
2.Some technologies had Only rechargeable batt - ery with no piezoelectric transducers.	2.Array of piezo electric generators are introduced for self power generation along with 12V rechargeable battery.
3.Bluetooth connectivity provide.	3..No Bluetooth connectivity provided
4.No facility of GSM.	4.GSM module provided.

1. Working Principle

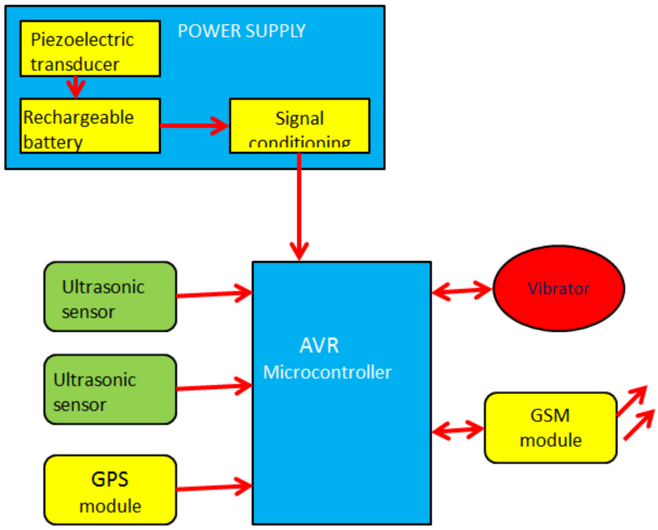

Figure 6. Block diagram of Calciamicus

2. Obstacle Detection

The Ultrasonic sensors installed on the outer surface of the shoes and cap play the vital role of obstacle detection. An electromagnetic wave is transmitted which strikes the obstacle in the surrounding area and returns back as an echo signal. This signal is received by the sensor which is given to microcontroller. Microcontroller produces appropriate signal which is given to the corresponding vibrator which in turn produces vibrations.

TRACKING –
The GSM and GPS modules installed play a significant role in tracking the visually impaired person's location and sending the required information i.e. address and distance information to the concerned person.
The GPS module with the help of satellite continuously keeps a track of the location (longitude, latitude etc.) on a timely basis. This information in case of an emergency is sent to the relative or friend of the blind person at home or some other location with the help of the GSM Module.

In emergency situations for vision impaired, this information helps tremendously.

3. Hardware Implementation

We have tried our best to keep the hardware implementation as compact as we can. The heart of the system is the microcontroller which has been mounted in the shoe unit. The sensors are placed over the shoe and cap surfaces as per the requirement. For the cap unit we have tried to fit the entire circuitry in to a compact box. The wirings are also placed such that they do not disturb the user.

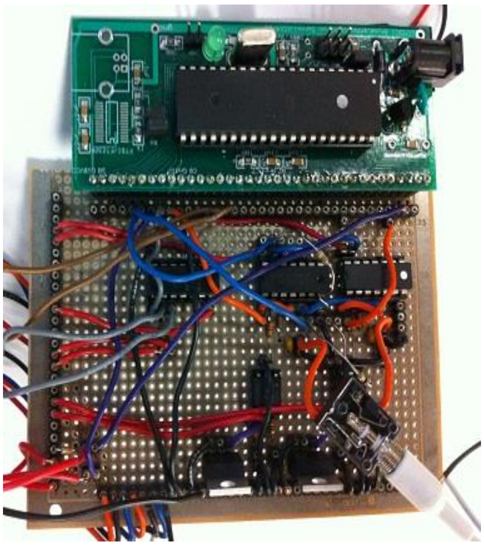

Figure 7. Shoe unit

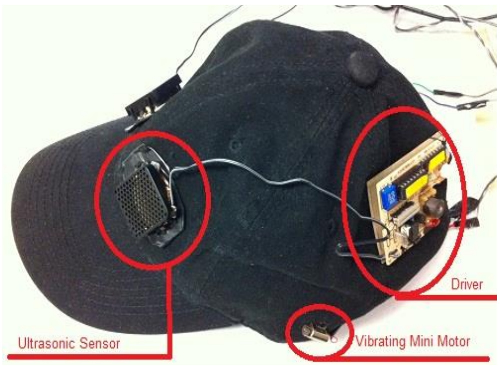

Figure 7. Cap unit

IV. CONCLUSION

It is found that the developed model's support system is accurately alerting the user about the obstacles coming in his/her way and the tracking system is also proving its appropriate function. Using this system the blind person bypasses every obstacle and reaches the desired destination.

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