Project proposal for
DST &Texas Instruments Inc.
India Innovation Challenge Design Contest 2016
Anchored by IIM Bangalore

Omnidirectional Nav for the Blind

Dr. Ambedkar Institute of Technology

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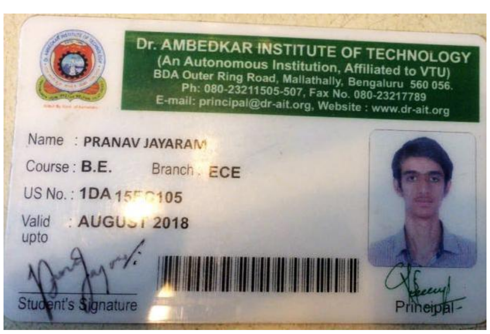
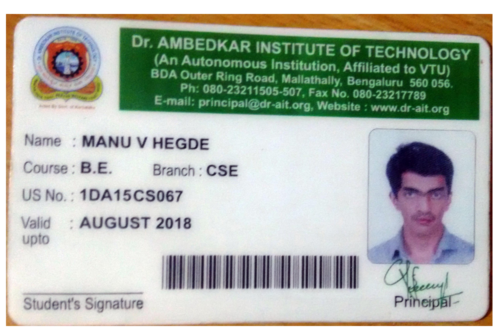
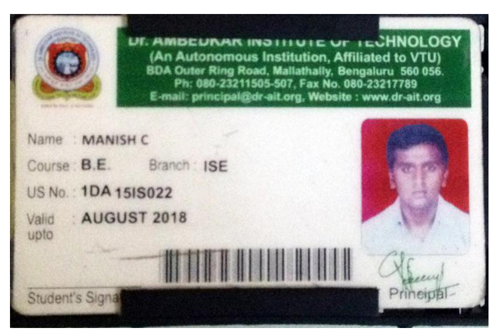
S.No.	Student Member Name	Role (Choose one of the following – Marketing, Technical, Operations & Other Roles as applicable)	Justification
1	Pranav Jayaram	Technical & Operational	Hardware Design and Implementation
2	Manu Hegde	Technical & Operational	Software Design and Implementation
3	Manish C	Marketing	Networking in the Domain







An Initiative by

Supported by

Omni-directional Navigation Device For Visually Challenged

"TO HELP THE HANDICAP TO BECOME HANDICAPABLE"

PROJECT SUMMARY

Problem statement

Out of the 1.3 billion people in India,45 million people are visually challenged and in need of assistance. 32 million visually challenged people require either a helper or a cane. Blindness causes considerable social challenges due to his/her inability to participate in many activities such as sports, academics etc. It leads to the feeling of low self esteem. Blindness affects a person's ability to perform many duties severely limiting his/her employment opportunities as explained by WHO.

Issues being addressed

Although there are many aids that can hep serve the purpose of safe movement assistance,it is not cost effective or feasible to implement.So,by providing an easy to use,low cost,electronic travel aid ,we can provide an optimal solution which is feasible to implement. A blind navigational aid can be implemented that utilises a multi directional sonar system for obstacle detection and an electronic compass for traveler heading detection. The system controls and gathers information from the sensors in real-time and presents the navigational information using a 3D audio interface based on Head Related Transfer Functions. This paper describes the hardware and software design for this real-time system.

So just imagine, a product which maps and suggests a safe path for movement and also warns about imminent dangers from any possible direction within a given range by using generated 3D sounds of distinct tones.

INNOVATION

Our proposed product aims to provide a 360° view of the surroundings for the blind without using a camera!

- We create a protective virtual bubble with a radius of 8m around a visually impaired person using a wearable solution.
- The proposed product is Cost effective,Ultra low power consuming ,Non-intrusive and user friendly.
- It provides a safe path for movement and maps the contours and obstacles in the path of the user.
- The person is guided to find his way ,avoiding obstacles with help of distinctive 3D sound and also force sensors on his □nger tips, ushers the person towards the safest direction of movement.

All that he has to do is to put on a pair of socks and a cap and he can walk comfortably without his cane.

- This product incorporates the use of Ultrasound and PIR(Passive Infrared) technology. Ultrasonic sensing provides very precise proximity detection using time of flight techniques using which , a set of transducers can detect the obstacle and the perfect position of the obstacle is located using Vectors and Positional geometry of the sensors.
- By using GPS navigation,the location of the person can be tracked from a remote location by his family members.

The two key computational components are the 3D Sound Rendering Engine (3DSRE) and the Sonar & Compass Control Unit (SCCU).

TI modules used

- The MSP430 which is a mixed-signal micro controller. Built around a 16-bit CPU, is designed for low cost and low power consumption for embedded applications.
- PGA450-Q1 is a fully integrated system-on-a-chip analog front-end for ultrasonic sensing in object-detection through air, level sensing in large tanks, and distance measurements for anti-collision and landing assist of unmanned systems.
- Transducers
- TIDA-00489 Low Power PIR Motion Detector with Wireless Connectivity.
- Voltage regulators.

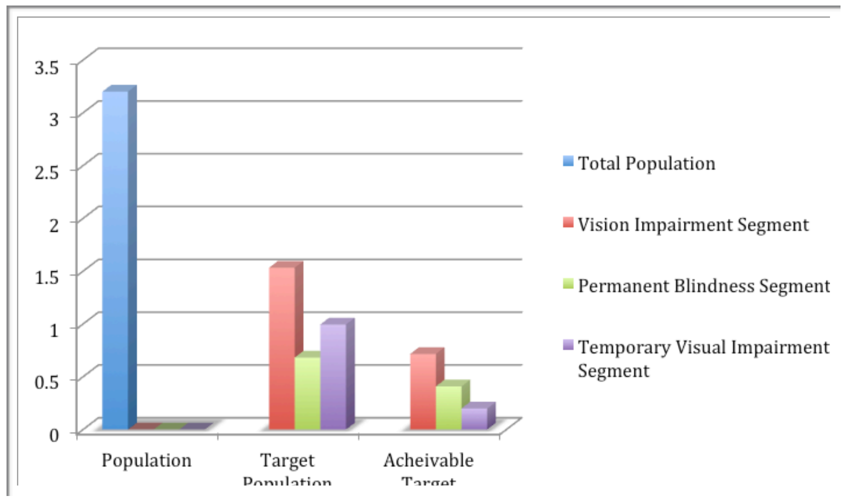
MARKET ANALYSIS

Total and serviceable addressable market(Data from the 2015 census of India)

- Out of the 32 million visually challenged people in India, Approximately 47.6 percent has vision impairment,21.3% has permanent blindness and 31.1% has temporary visual impairment.

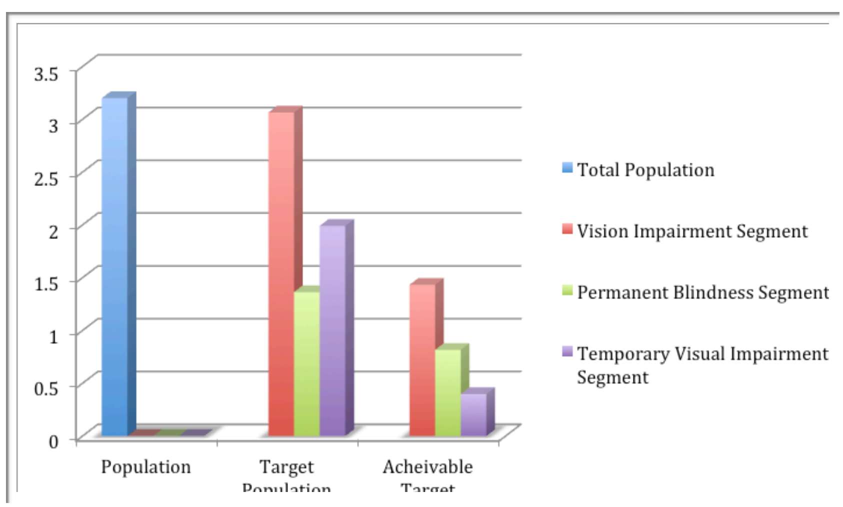
Phase 1

- If 1.2% of the vision impairment segment,0.65% of the permanent blindnes segment,0.55% of the temporary visual impairment segment is targeted in the first phase using third party distribution channels,an approximate of 1.36 million people can be considered .
- This product can potentially be distributed to 10% of the targeted market which gives an approximate of 0.136 million buyers.



Phase 2

- If 3.3% of the vision impairment market, 1.8% of the permanent blindness segment,2.1% of the temporary visual impairment segment is targeted in the second phase using first party distribution channels,an approximate of 4.08 million people can be considered.
- This product can potentially be distributed to 10% of the targeted market which gives an approximate of 4.08 million buyers



Case Study

Dr.Kedarnath ,(Ophthalmologist,Natesh Surgical care center,Banashankari Stage1,Bangalore-560050).

After a discussion with Dr.Kedarnath , we have been able to understand that it is possible to implement this solution for the visually challenged as in India are no appropriate devices for easy navigation. This can potentially ruin the self-esteem of many visually challenged who are pursuant in sports and outdoor related activities.
Although, he did suggest that blind people have heightened senses of hearing ,smell and touch. So, the product designed must be very optimal and effective to the point.
This discussion has made us understand that it is possible to provide such a solution which can easily be prescribed for any visually impaired person.

Also ,after consulting with Mr.Hemanth, a visually impaired person who is a patient of Dr.Kedarnath, we have come to the understanding that he faces several outdoor and indoor related problems on a regular basis such as, getting on a bus, walking on broken footpaths and pavements or even getting familiar with a new neighbourhood .!
This was our motivation to select this project topic.!

VALUE PROPOSITION

Lean Canvas **Model**

Problem Top 3 problems	Solution Top 3 features	Unique Value Proposition Single, clear, compelling messages that states why you are different and worth buying	Unfair Advantage Can't be easily copied or bought	Customer Segments Target customers
People with visual impairment need assistance to walk. **Using a cane requires more effort as opposed to walking freely.** **No appropriate means to know about the potential threats in the surroundings** **Cannot track the location**	**No requirement of external assistance** **Suggests a safe path for movement** **Omnidirectional threat warning** **GPS Tracking feature for people at home**	**Blind friendly experience** **360 degree threat detection** **Cost effective** **Low power consuming device** **Wearable device** **No camera required**	**First mover advantage:- It is the first of its kind which does not require a camera to map the surroundings.**	**Visually Impaired** **People with permanent blindness** **People with temporary vision disorders**
Existing Alternatives	Key metrics Key activities you measure	High-Level Concept	Channels Path to customers	Early Adopters
Using a cane **Volunteer's assistance**	**Promotional activities conducted at NGOs** **Distribution of the product**	**Ultrasonic and PIR sensor based measurements**	**Doctor's prescription(Opthalmologist)** **Target NGO distributors** **E commerce**	**Outdoor intensive user** **People in their early stages of blindness.**

DISTRIBUTION CHANNELS

1. Third party distribution network

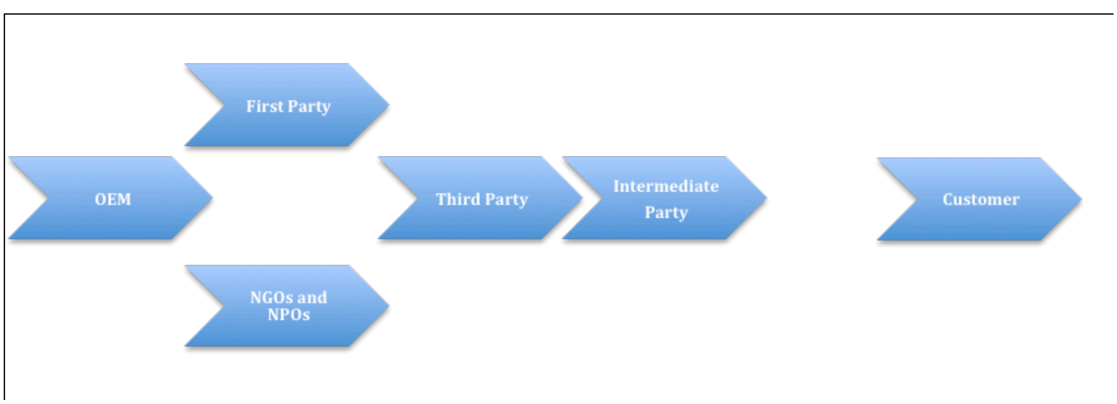
By hiring a third party agency with connections to various doctors(ophthalmologists) ,optometrists and internal distribution network. In a city of approximately 10 million people like Bengaluru, we can potentially reach out to 0.02% of the visually impaired community, which amounts to approximately 20,00 customers. It is a Business to Business based system.

2. Tie ups with ngos and npos

The Rotary Club of India, Lions Club and alike are the agencies with the best outreach in the visually challenged community in India. So,by establishing a relationship with these organisations, it is possible to achieve the distribution as shown in table.1&table.2 of Phase1 and Phase 2 respectively.

3. First party distribution network

This type of a distribution channel mainly aims to give a direct Business to Client based distribution system.



TECHNICAL SOLUTION

TI Modules Required

SCCU(SONAR AND COMPASS CONTROL UNIT)

- The MSP430 Micro controller.
- PGA450-Q1 Ultrasonic sensing module.
- Generic Transducers.
- TIDA-00489 Low Power PIR Motion Detector.
- Voltage regulators.

3DSRE(3D SOUND RENDERING ENGINE)

The 3D Sound Rendering Engine (3DSRE), based on a portable PC, continuously interacts with the user. The system runs a Matlab based program. It acts as a host system for the SCCU, communicating with it through the serial port. In addition the program polls data bit 0 of the parallel port (designated “bearing request”) for user input, once every cycle. Normally the 3DSRE functions in the .”Obstacle Map Mode”In this mode the detected six range readings modulate the amplitude of six individual phantom sound sources placed in their associated angles. This makes the phantom sources appear closer or farther away in the virtual environment (Figure 1).

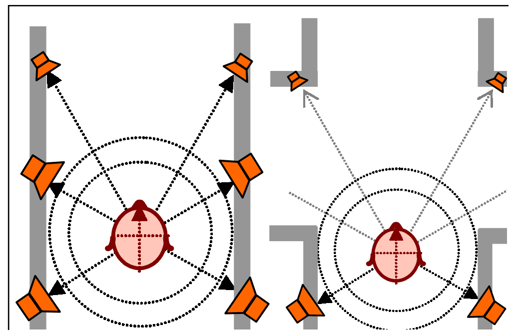
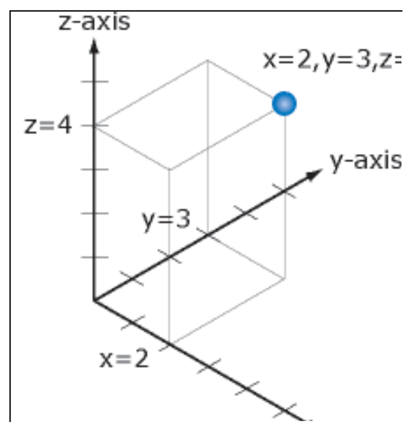


Figure 1.The speaker sizes indicate the magnitude of the phantom sound sources. The sound sources are placed at the position where the obstacles are detected

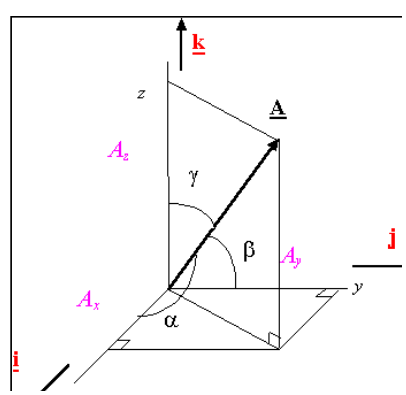
Distance measurements from transducers

In the presence of an obstacle in the X+,Y+,Z+ plane, the distances d1,d2,d3.i.e.x,y,z is measures using the SCCU.Next,the angles (ϴ1, ϴ2, ϴ3) between the axis and the obstacle are calculated.
By using a PIR Motion Detector, the relative position of the obstacle with the origin is determined.



Types of relative motion

case1 Point may be fixed and planes may be moving. Instance A person many be in stand still when an obstacle approaches him.
case2 Point may be moving and planes may be fixed. Instance A person may be moving towards or away from an obstacle.
case3 Both Point and Plane may be relative motion. Instance A person and an obstacle can be moving in random directions.



Sensor positioning

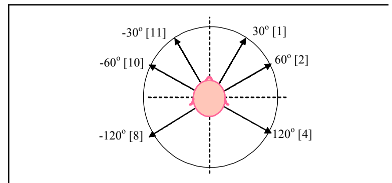


Figure 2. The physical layout of the six ultrasonic transducers. Note tha the sonar directions have been marked as clock positions for

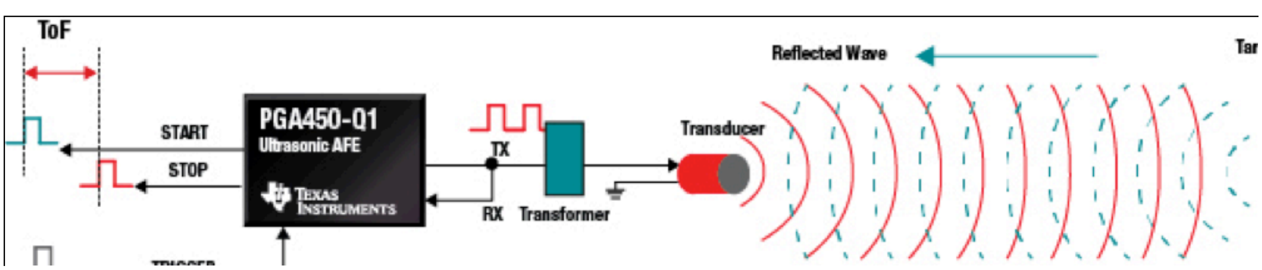
The range detection system is designed for indoor/outdoor range measurements. Therefore, special considerations are required for the ultrasonic sensor characteristics. Six ultrasonic sensors are arranged in an array to measure obstructions from +120º (right) to -120º (left). The configuration of the array is illustrated in Figure 2. The physical arrangement of the ultrasonic sensors suggests that the sensors ideally have a beam spread of no more than ±15º. The physical dimensions and weight of the sensor modules are also important, because they are mounted on a headgear worn by the user. The ultrasonic power emitted by the transmitter must be comparatively low, with a high sensitivity receiver, to ensure minimising multiple reflections that may cause crosstalk between sensors. It was determined that an accurate range reading of 10 feet would be adequate for a blind person to walk freely in an indoor/outdoor environment.Texas Instruments PGA450-Q1 Ultrasonic sensing module has been chosen as the range finding sensor for the application because of its compact construction and comparatively narrow beam pattern.

Principle

This application is based upon the reflection of sound waves. Sound waves are defined as longitudinal pressure waves in the medium in which they are travelling. Subjects whose dimensions are larger than the wavelength of the impinging sound waves reflect them; th reflected waves are called the echo. If the speed of sound in the medium is known and the time taken for the sound waves to travel the distance from the source to the subject and back to the source is measured, the distance from the source to the subject can be computed accurately. This is the measurement principle of this application. Here the medium for the sound waves is air, and the sound waves used are ultrasonic, since it is inaudible to humans. Assuming that the speed of sound in air is 1100 feet/second at room temperature and that the measured time taken for the sound waves to travel the distance from the source to the subject and back to the source is t seconds, the distance d is computed by the formula d=1100 X 12 X t inches. Since the sound waves travel twice the distance between the source and the subject, the actual distance between the source and the subject will be d/2.

How long distance ultrasonic sensing works in proximity sensing

For proximity sensing or object detection specifically detecting long distances from 10cm to 8m, single or dual transducer configurations can be used. In a single transducer detection configuration, the PGA450 AFE excites the transducer and detects the returned echo signal. PGA450 has an integrated 8-bit micro controller for processing the echo signa and calculating the distance between the transducer and the object.The processed distanc is next sent to any generic micro controller of MSP series.



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FEASIBILITY

Product Feasibility(the investment conundrum)

- The product design and production does not require any intensive investment but, an initial minimal investment is required to set up the **distributorship channel** through various sources of ophthalmologists and e commerce portals.

Product cost structure

TI BOARDS	PRODUCT COSTING
MSP430	4$
ANALOG COMPONENTS	
PGA450-Q1 Ultrasonic sensing module	2.81$
TIDA-00489 Low power PIR motion detector.	2.35$
Generic Transducers	1.5$
Generic BLE module	5$
Additional components-voltage regulators,jumpers	1.5$
	17.16$ =1149Rs.

Market Feasibility

- This being a very targeted market, a product in the price range of 1100Rs can achieve the aforementioned **revenue standards**.
- Any person with visual disability below the poverty line can purchase this equipment as well.
- It is non-intrusive,low power consuming and works as an electronic travel aid.
- People with permanent ,temporary visual disability and visual impairment can easily purchase this on a one time investment basis.