PART 5

Solution Innovation: The next section is to describe your proposed, novel AT device or accommodation based on previously assessed user specifications and needs. As a conceptual design it must include:

- the specific functions of the AT,
- how it would be used by your target group (persons with particular disabilities),
- what are its user requirements and restrictions, and
- How would you propose to make or construct this AT. Drawings or figures are important.

Your proposed design must be feasible (e.g., no flying wheelchairs) or based on research that is currently being done by others (e.g., brain-controlled interface).

Introduction

As we know, sight is conventionally considered as the major human senses followed by hearing and touch. But as we know, for the blind people, they develop their hearing and touch senses to a higher level than any other human being. So, we are trying to use that for our benefit. The devices are very diverse with their technology used and the location of the body. As blind people depend on the environment for orientation, mobility, and awareness. The ear (auditory) sense organ detects sound vibrations. It starts the transducing process of these vibrations into nerve impulses which are then perceived by the brain. In this project, I have chosen, it deals with wearable technology which uses image processing and computer vision to send signals to the person's mind to let him perceive the environment around him. There are a lot of apps that are used to detect objects like flowers, insects or some anatomically accurate parts of the body used by science students for their research. But there hasn't been any assistive device such as this which uses this technology for the blinds. First there are multiple locations that can be used to put the device on the body of the user. It can be around the waist as it can be considered as the center of the human body and navel has the body's center of gravity. And since it is in the center, the field of view becomes easier to grasp as it can look both high and low ends for the user around the environment. The only limitation with this idea is it might be harder to attach as constraints like clothing, accessories, etc. can cause a problem. So, to make this device completely portable, the best solution for location is using the eye as the location for the device. Since from the centuries glasses has been used by the visually impaired people and it will be just treated as glasses by the blind user. Main objective for us to develop a compact, user-friendly device to detect obstacles and objects ahead of the user. The glasses will be coming with ultrasonic sensor, to detect a 3D object in front of it. We are choosing ultrasonic sensor as it has the ability to figure out the transparent objects since it used waves as the detecting agent. It will send signals to the vibrating system attached to each side of the glasses. It processes the data received from the Sensor and measures it sends it to the vibrator for indication. It is also created with different levels of vibration according to the size, height, and location of the object.

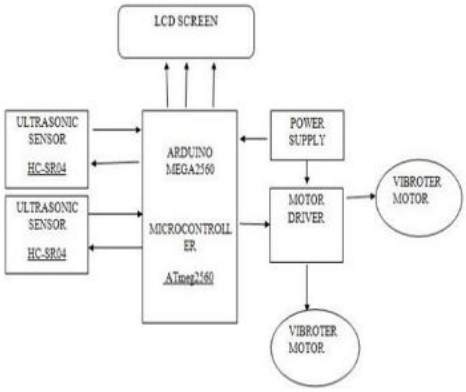

Fig 1. Flowchart of the mechanism

The proposed device will consist of multiple modules integrated together to perform the operation, Raspberry Pi, a display unit, a software unit, power source, sensors, and output in the form of vibration and projecting image to the brain. Consider a scenario, a person is going out to finish some of his chores. He will get out of the house, stand there, the device will be mapping out the area. The device will be using SLAM (Simultaneous Localization and Mapping) algorithm to map the environment using ultrasonic sensors. It will create maps as the person walks forward. Simultaneously, the device will be working on path planning to let the user know which path to take and what to avoid. It will be done using GPS to constantly tell the device processor about the entire route to the end point along with the path planning algorithms, it comes up with. The device will be using the trendiest RRT* (Rapidly Exploring Random Tree) algorithm for motion planning. As most of the previously used algorithms are efficient for static obstacles, the most efficient RRT* is used to avoid that limitation. By rapidly exploring the high-dimensional configuration space represented by the implicit roadmap, the RRT* is able to optimize the best path. From the output vibrations, we can signal the user about the obstacles, either static or dynamic.

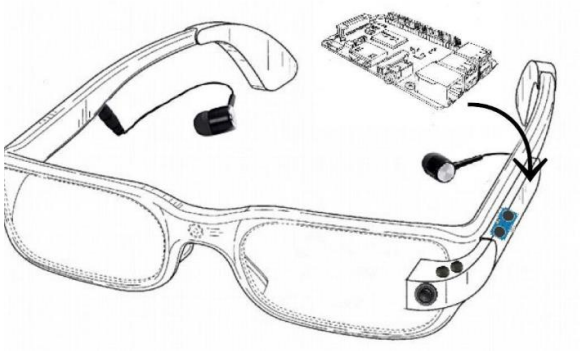

Fig 2. Internal Design

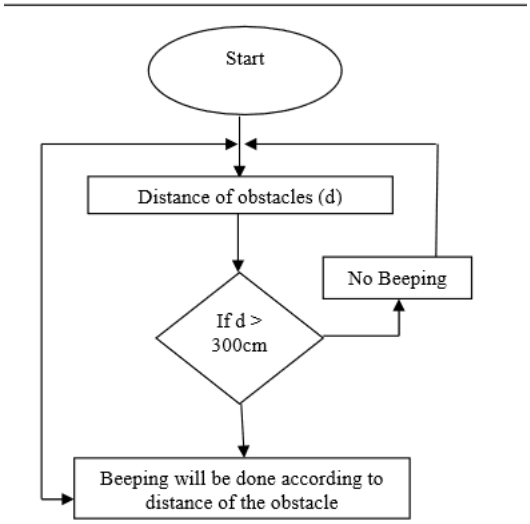

Fig 3. Flowchart of the obstacle avoidance planning

When a person becomes blind, especially those who are not born blind, their visual cortex to be completely undamaged. There is a future goal for this device to be upgraded by bypassing the eyes directly and sending signals to the brain.
The device needs another part that will be like an implant which will consist of electrodes that receive information from a camera from the glass. The mechanism will get better with the number of electrodes. To get a rich picture, we will need thousands of electrodes to describe a decent image of the object. So, for now, we are trying to focus on the category of those who have once perceived the world and have a basic idea of the things around themselves. Using image processing and object detection, we can describe the objects and obstacles and faces to the person while using those wearable glasses.

Specific Functions:

- We are describing the functions with the various scenarios.

- It will be having voice commands which will be taking commands for the user to specify the user's needs. So, the user will be able to tell the device their locations, destinations, time crunch, command to identify something, time, weather, and it will be synced with the apps on the phones, health watches, tablets for flexible use.

- It will be having GPS built up in the device, which will be figuring out which route to take, the traffic, updates on roads etc. It will be having camera and sensor to map out the field of view for the user and simultaneously plan out the path which will signal the user to follow.

- In case of any change in the trajectory, the device will create new paths on the spot just like how GPS maps reroute the path for us when we drive and take a new or different turn or route.

- We can add multiple destinations to the device, it will make decision with the priority given or by default it will make the entire trip planning with the least time taken by the user.

- The output is preferred by the user to be vibrating system, but for those who doesn't like haptic feedbacks can choose bone conducting voice command for their route.

- The device will be encoded with the images of the people who is well known to the user for faster detection, now if the user meets someone, the device can match up the results and tell the user about the person who will be coming from the opposite direction as if the user knows them and what is the relationship of that person has with the user based on the data encoded.

- The device will be encoded with the google and will work with more accurate and precise version of google lens, so that when the user is at a certain proximity of that object, it can detect the object and sends the information to the user. That way, users can enjoy walking in the environment, like their office, labs, roads, or any public vehicle.

- The most important function for the user will be getting signals on how to take the route based on the obstacle in front. If it is a static obstacle, then the user has to take some different turn as the obstacle won't move. But if it's a dynamic obstacle like a bus or some other person etc., the user can choose to wait for the dynamic obstacle to completely fade from its line of view or create a path to move before it sees an obstacle coming. Of course, this feature will only be used during a pedestrian walk, as any other route works on traffic lights and to cross a road, the people get specific signals to cross.

User requirements and restrictions:

- This device has been initially proposed for people with decent technological skills as we all have seen that young adults are more likely to be technologically advanced than the older generation.

- Even though the mechanism of the device is created to be user friendly, it does take some amount of time to be completely used to the device and for that we send out our technical experts for training.

- The main goal of the device has to be very precise and very accurate, but the ideal case hasn't yet been reached. So, we do believe that the user will use their improvisation skills in case of need.

- Since this device will be taking power, we will be providing a backup battery life like invertor in case the device goes out of charge. We will be making sure that the entire power charging system is very portable and is compatible with most of the adapters and cable used these days.

- The user has to be very motivated to understand the features and functions of this device. The target users for this device are someone who will be using all the features to the full extent. So, we are very selective when choosing a particular customer.

- The budget for this device is at the high end as the materials chosen for the device are very delicate and fine fiber glass and lighter ICs, non-corrosive metals.

- We will be advising the customer about the financial reach, where to apply for and how to budget it and what is the down payment.

- Since this is a new technology and it hasn't been commercially released yet, we will be taking information from the users on a weekly basis at first and eventually we will move to a monthly and quarterly basis.

- We will be needing users with proper mindset to use this device, so we will make sure to get their medical and mental health history and make sure that they have been consulted to a therapist before adapting to a new device which will be a big part of their life.

- We will eventually make the device more compact and user friendly so that it can be accessible by everyone who demands it.

Construction of the device:

1. Materials Used:
    - The most important thing is to make sure that the material and alloy we choose is lightweight.
    - It should have surface flatness, weather resistance, thermal stability, flexibility for the glasses.

- For the frame we will be choosing the lightest alloy substrate to make sure it has all the necessary components attached to it.

Fig 4. Glass frame

2. Selection of the Electronic components:
    - We will be taking raspberry pi as the micro-computer and load codes on it to make it work efficiently.

Fig 5. Raspberry pi

Fig 6. Initial setup

Fig 7. Idea of the prototype

3. Selection of the Algorithms:

    - We will be using RRT*, A*, Dijkstra algorithms for path planning. It will be chosen according to the necessity of the user.
    - The AI inbuilt in the device will be figuring out which way to follow.
    - We will be using the SLAM method for the mapping of the view.

4. We will be installing a camera which will help us to figure out dynamic objects in the form of blobs moving with their own wavelength to figure out the color using OpenCV.

Fig 8. Webcam

5. We will be using ultrasonic sensors and LIDAR sensors to figure out the environment. The LIDAR will help during the mapping of the environment while ultrasonic will be used to figure out the obstacles. We will use both to increase our accuracy.

Fig 9. Setup after the circuit building prototype

6. LIDAR sensors will help during the mapping when there is an obstacle, the frequency of the sensor will change which proves that there is an obstacle. Setting it to analog signals will give us the frequency in numeric form which will be different on each path that will give us the distance of the obstacle.

7. Ultrasonic sensors will be used during the path planning, also can be helped in mapping as a backup, as LIDAR might not be able to distinguish between transparent objects, ultrasonic uses sound waves which will be reverted from hitting any 3-dimensional object.

Fig 10. Ultrasonic sensor

8. We will be using image recognition to verify the identity of the persons coming in a certain proximity.

9. For the image recognition, we will be encoding images of the person if they remember them as data and encode it.

10. We will also be using this technology for object recognition like google lens. We will be connecting it with the internet so that if the user wants to define an object, they can.

11. For the output, we will be either using haptic feedback or auditory signals as commands or cues to understand the commands depending on the requirements of the user.

12. Face and object recognition will be beneficial to the blind people who are not born blind but disease or an accident cause blindness. As our target user was Joseph, and their cause of blindness was an accident, we are using recognition technology.

Fig 11. Final prototype

13. For the people who are born without sight, we are developing neural implants on the brain that will directly send signals to the image center of the brain bypassing the need of the eye. A lot of research is going on regarding this method. To get an understandable level of image quality, we will be needing thousands of electrodes but that is not feasible for the human brain.

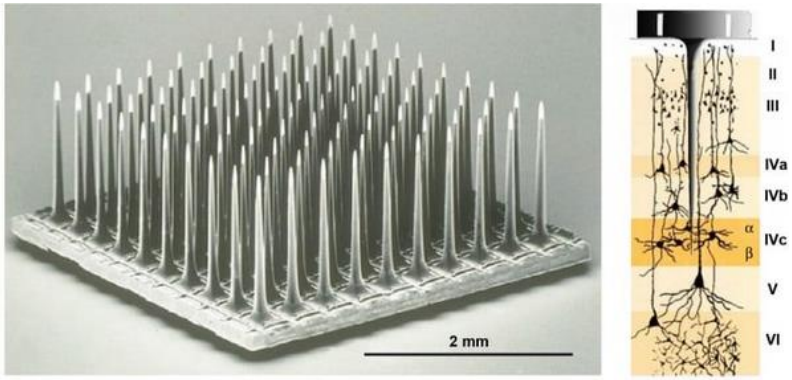

Fig 12. Electrodes used as implants

This is still a temporary technology as longer use of this technology can cause seizures and mental problems such as hallucinations.

Future Goals: While we are working on the prototype, the team came up with multiple new ideas on better ways to use neural networks implants on brain, more compact design, user friendly. We want to create more features on the glasses such as expected accidents, cameras with wider angles of view, better sync with GPS and the internet.

The idea of the development is completely my own, as I have studied the navigation and perception topic in robotics. I used only two research papers to get the reference pictures of similar yet different projects. As the papers are on script recognition using smart glasses for blind people.

- **Saha, Himadri & Dey, Ratul & Dey, Shopan. (2017). Low cost ultrasonic smart glasses for blind. 10.1109/IEMCON.2017.8117194.**
- **Feng Lan, Guangtao Zhai, Wei Lin "Lightweight smartglass system with audio aid for visually impaired people",TENCON,IEEE,Region 10 Conference, 2015**