Abstract

Playfinder will revolutionize the way that children with Visual Impairments (VI) interact with playgrounds.

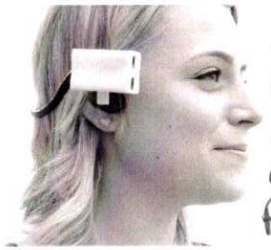
Playfinder combines cutting-edge sensory technology used across different industries to provide detailed wayfinding instructions for VI children to navigate playgrounds. **Playfinder** also provides users with immediate feedback on hazards and other obstacles.

Playfinder consists of a pair of glasses equipped with dual cameras that capture real time activity and potential hazards as well as a miniaturized LiDAR that instantly creates a digital map of a playground which is then converted into wayfinding instructions using cloud computing. The user interface for **Playfinder** will be a mobile app and verbal directions and cues will be delivered via bone conduction technology so as not to interfere with the VI child's sense of hearing.

Playfinder will allow children with visual impairment to enjoy the joy and the health benefits of free play with their peers.

Present Technology

A variety of personal devices and apps exist that are used to navigate and describe the physical environment to those who are visually impaired (VI). Devices can rely upon one of several technologies:

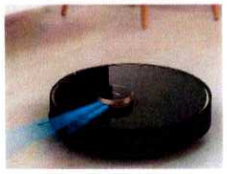


1) Cameras that are worn by the user and record the environment and send data to a Global Processing Unit to be turned into instructions.

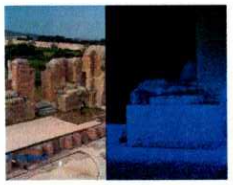
2) Smartphone apps that work with blue-tooth to ID a users location and provide verbal instructions.

3) GPS Smartphone apps that help visually impaired users navigate outdoor spaces.

We examined current sensor technologies, that is, technology that could be used to help those with VI to understand, map, and navigate one's environment.



Robot Vacuum Using Lasers to Create a Map



Actual archeological image vs. LiDAR

LiDAR performed by robotic vacuum

Home-based robotics that assist with household tasks use sensor technologies. These robots use cameras, lasers, and touch sensors to navigate. They create maps that can be saved or modified. This is made possible by SLAM (Simultaneous Localization and Mapping). SLAM data comes from cameras or LiDAR. LiDAR stands for Light Detection and Ranging. LiDAR makes digital pictures using cloud point data. LiDAR is used for robotics, archeology, and self driving vehicles.

History

A 2017 American Community Survey (ACS) found that there were 568,202 children (0-17 years old) with vision difficulty in the U.S. This survey included children that have serious difficulty seeing even when wearing glasses as well as those that are blind. Visually impaired children are traditionally taught to navigate independently with the use of north, south, east, and west, as well as clockface numbers. That is in contrast to what our teammates and other sighted children are accustomed to, that is being told to go "right", "left", or "straight ahead". For consistency, the team decided to use the term "wayfinding" to describe the process of navigating (locating and guiding) a visual impaired individual through a physical space.

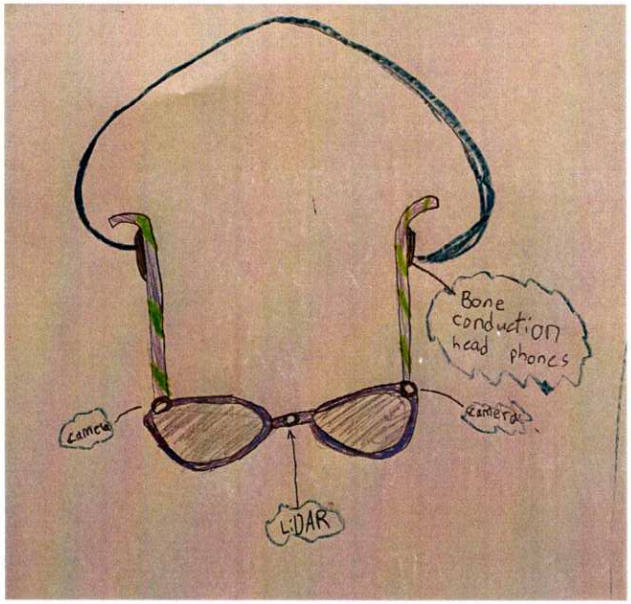
Canes have been used by visually impaired for a long time. VI people use canes by sweeping them back and forth. Because of the way children move (running and jumping) this method does not work well.

Seeing Eye Dogs are specially trained to help VI people safely navigate around obstacles and through crowds. Seeing Eye Dogs have been used for over 100 years.

This is the Pathsounder. It was invented as a mobility aid and uses soundwaves that bounce off of objects. It was worn around the neck.

Playground design has evolved since the American with Disabilities Act was passed in 1990. Playgrounds are made safer with physical and technology changes.

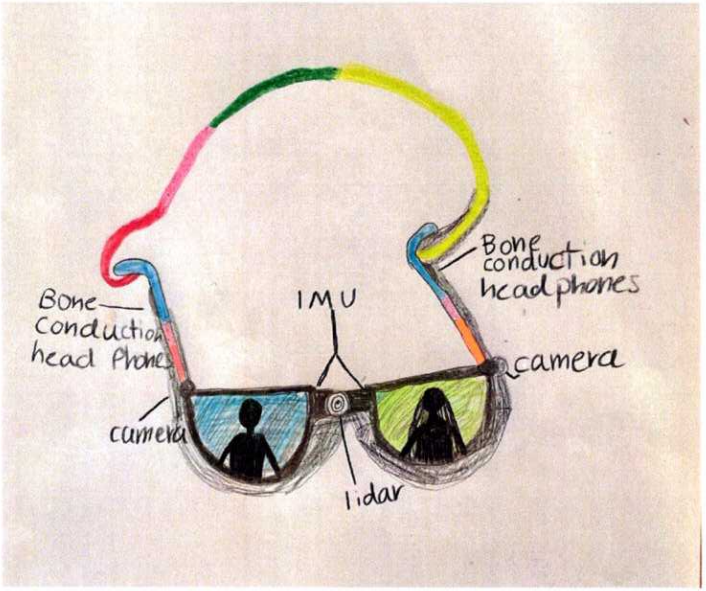
Future Technology



Playfinder is a technology that will allow visually impaired children to play on playgrounds with their peers.

Playfinder will consist of glasses with: 1) A miniaturized LiDAR 2) Dual stereo cameras 3) Bone conduction headphones. Playfinder glasses will use a smartphone/smart watch app as a user interface.

Future Technology



A miniaturized LiDAR device will be embedded in the bridge of the **Playfinder** glasses.

The LiDAR will be used to create a detailed 3D map that will be processed and converted to navigational instructions using cloud computing. The glasses will also include an IMU (Inertial Measurement Unit) to keep track of the person's angle.

The dual cameras will create multiple images per second of what the child is facing and using artificial intelligence (AI) this visual data will processed into verbal instructions regarding the child's current environment.

The combination of these two sensor technologies - detailed point cloud data from the LiDAR and visual data from the camera will be processed and shared as verbal instructions.

Future Technology

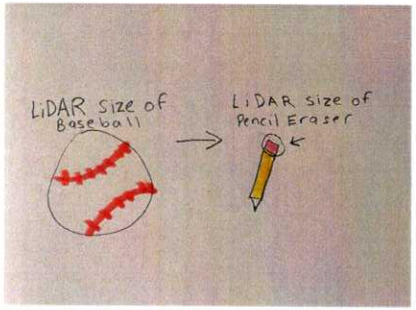
Bone conduction headphones will be integrated within the arms of the **Playfinder**

Bone conduction headphones will be used because it is important not to block the ear canal, as this prevents the user from hearing environmental sounds. Bone Conduction uses vibrations.

The **Playfinder** smartphone/smartwatch app will be serve as a user interface for wayfinding directions and other verbal instructions.

The mobile app will allow user search by dictation, turn by turn instructions and provide hazard feedback. LiDAR mapping could also take place in advance of a visit to the playground and the playground could then become a Playfinder-certified playground.

Breakthroughs



1) The LiDAR needs to be reduced from something the size of a baseball to something the size of a pencil eraser. LiDAR is currently to large to fit in the bridge of glasses.

2) PlayFinder is a wearable technology so there needs to be experimentation done on wearable LiDAR to assure that it is safe.

3) Processing LiDAR data into wayfinding instructions will require advancements in the speed and capacity of cloud computing.

4) Camera-based artificial intelligence (AI) needs to be improved so that cameras can record and immediately warn of hazards.

Breakthroughs

n/a

Breakthroughs

n/a

Design Process

We discussed several potential technologies to assist blind children:
1) Using a drone to help guide a VI child. We decided a drone would be too intrusive and distracting. 2) Using a personal robot that could roll or fly around. We decided that a robot would not be able to get onto all the play equipment. 3) We learned about 3D digital mapping used in construction to make digital pictures of a space. We thought we could use that data to base our navigation, but we learned that the process is expensive and slow. We then began to be inspired by robotic vacuums

Design Process

we tried a blind fold exercise as a group. Teammates took turns wearing a blindfold while at a playground. The blindfolded child then asked the other kids to help them navigate. This gave us an understanding of the need for very specific navigation and audio feedback like beeps.

Design Process

We were lucky to be introduced to Andy, who is a Robotics engineer at iRobot. Andy spent an afternoon with the team, explaining the concepts of LiDAR, SLAM, and AI and how they are used in Robotics. In addition, we viewed educational videos to explain some of these concepts. Finally, we interviewed a mother of a blind student. She talked about the importance of 3D maps for her daughter and imagined someday they could be available on smartphones.

Consequences

Giving children with visual impairment the opportunity for free play on playgrounds will provide them with motor and social development. It will also be good for their emotional development.

Playfinder will be expensive to develop and produce. Also we feel that there may be some stigma attached to wearing Playfinder glasses. We feel that the benefits outweigh the costs and that Playfinder will let VI children play with their friends!

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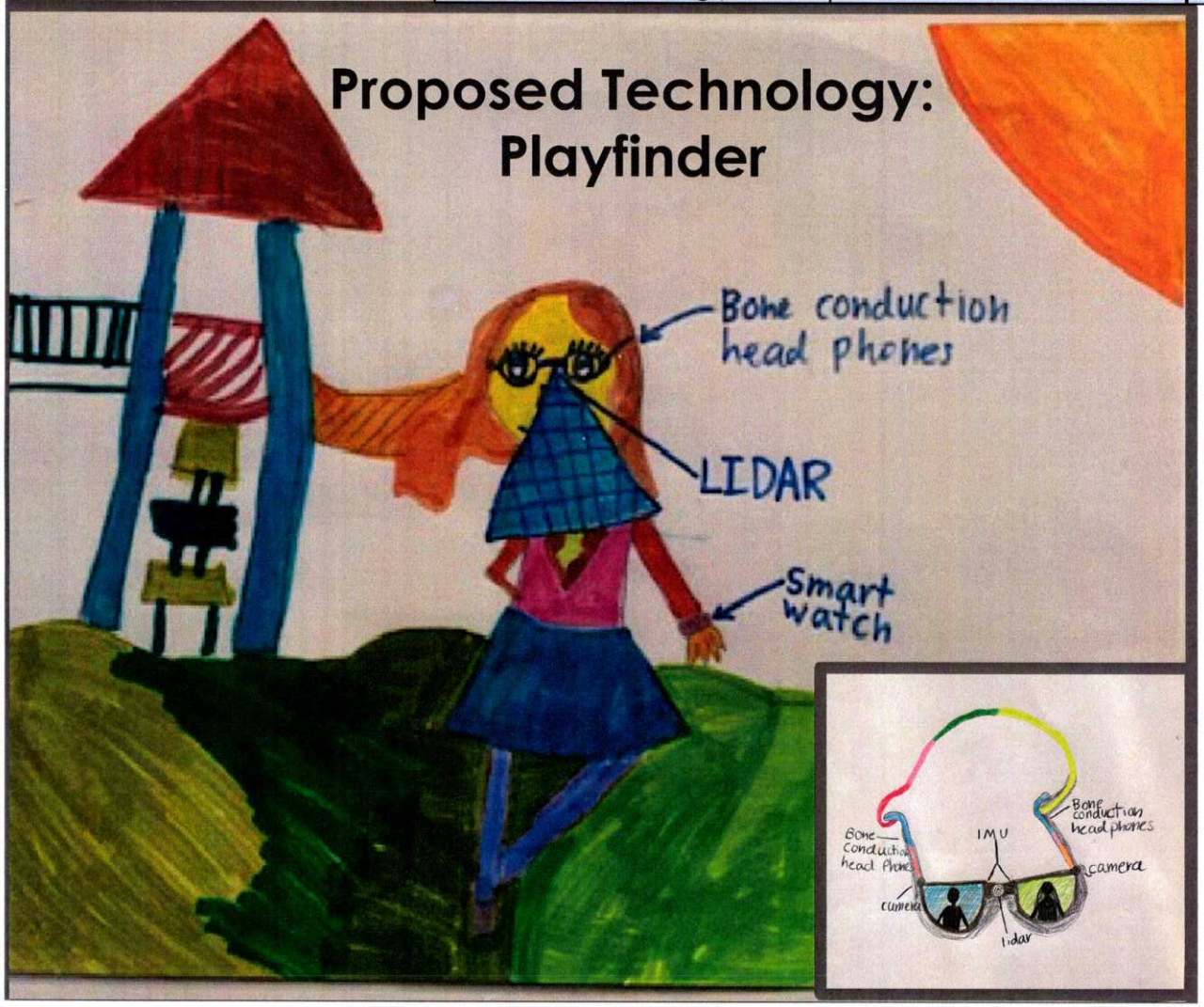


Playfinder is equipped with:

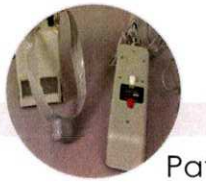
- Dual cameras to capture real time activity and potential hazards
- LiDAR to instantly create a digital map of a playground and provide wayfinding directions
- Bone conduction headphones to provide verbal instructions without interfering with hearing
- A mobile app for smartphones or smartwatches

Where have we come from and what is the future?

MOBILITY AIDS

Seeing Eye Dogs

White Canes



Path sounder

NAVIGATION AIDS

GSP and Bluetooth

Camera Based Tech

Digital Based Playgrounds

SENSOR TECHNOLOGIES

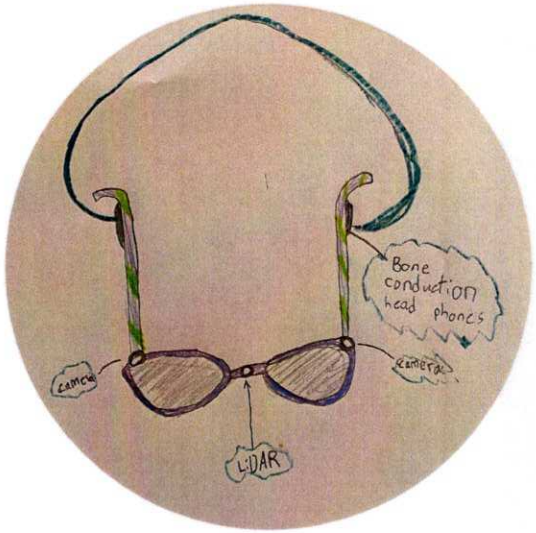
Sonar

Radar

Lidar

VSLAM

Playfinder



How was Playfinder Designed?

Rejected Ideas:
- Drones
- Personal Robots
- 3D Digital Mapping

Understanding Sensory Technologies

LiDAR, Robotic Vacuums, vSLAM

Q & A

Understanding what it is like to live with a visual impairment by interviewing a mother of a child with severe visual impairment

Breakthroughs Needed

1. Miniaturize LiDAR technology
2. Develop technology to create wayfinding instructions from cloud point data
3. Improve speed and capacity of cloud computing
4. Improve camera-based AI to enable real-time verbal feedback on hazards and obstacles

Consequences and Future Vision

Allow **visually impaired children to play with peers**

Technology of this magnitude is **expensive**

Increase access to the **benefits of physical exercise**

The Playfinder glasses are a wearable technology and **may attract attention – stigma**!

The Playfinder would **work towards the goal of the Americans with Disabilities Act** by making playgrounds more accessible

Unsure of the effects of wearable laser devices

What the future holds

Playfinder used in **other recreational settings**

Playfinder technology **becoming smaller and more discreet**

Playfinder continuing to **improve by taking advantage of advances in stereo-camera-only SLAM**