

EXPERIMENTS AND TESTING

EXPERIMENT VARIABLES

Type, shape & colour of object	E.g., fruit (apple, banana), ball, green apple
Position of object	E.g., relative to hand (LEFT, RIGHT, UP, DOWN)
Whether object is harmful?	Sharp objects such as blades, knives
Other objects in vicinity	Presence of other objects in field of view
Number of humans in field of view	LAKSHYA should tell number of people in view

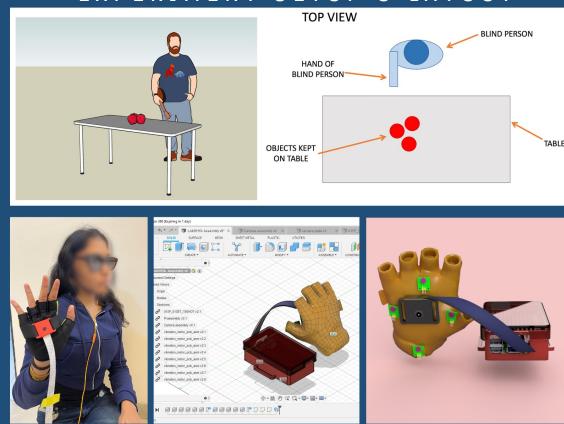
EXPERIMENTS CONDUCTED

E1	Identification and pickup of specified objects that differ in shape	H1
E2	Identification of specified objects without touching them	H2
E3	Identification and pickup of specified objects that have similar shapes but different colours	H3
E4	Guiding the hand of blind person using voice prompts	H4
E5	Identification of sharp objects (such as knives, scissors)	H5
E6	Identification of presence of humans in front of blind person	H6
E7	Identification of family members and public figures	H7
E8	Identification of famous buildings, monuments and places	H8

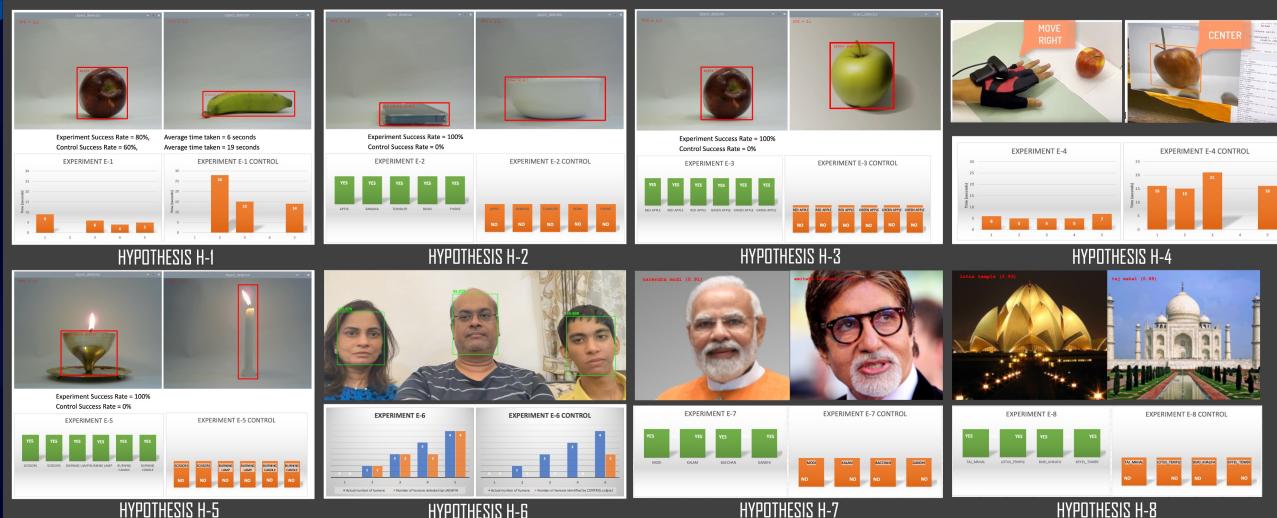
EXPERIMENT & CONTROL

EXPERIMENT: Blind person wearing LAKSHYA
CONTROL: Blind person not wearing LAKSHYA

EXPERIMENT SETUP & LAYOUT



RESULTS



AN INTELLIGENT AND AFFORDABLE DEVICE TO HELP VISUALLY IMPAIRED (BLIND) PEOPLE VISUALIZE AND INTERACT WITH OBJECTS AND PERSONS AROUND THEM, USING AI/ML MODELS of GOOGLE TENSORFLOW

BACKGROUND RESEARCH

Literature survey

(over 100 articles and research papers)
295 million in the world are visually impaired



User survey

(122 blind respondents across multiple age groups)

User interviews + hands-on experiments

- (7 blind individuals studied in detail)
- Collaborated with **Niwant Andh Mukt Vikasalay (Pune)**
- Inputs from **Poona School and Home for the Blind (Pune)**
- Consulted with **Dr. Shantipal Ohol**, Robotics Engineering professor at COEP College, Pune

Research findings

- 90% of blind live in poor countries, cannot afford expensive tech
- Haptic perception (touch)** is predominantly used (85% of the time) to identify objects
- Auditory (24%) & olfactory (36%) perceptions are secondary
- Contact-less identification** from far (such as places, monuments) is extremely challenging (70% respondents needed help)
- Often **get hurt by touching dangerous objects** (such as knives, blades, fire) – 49% of the time
- 94% people wanted a **device that could guide them** to objects
- 79% people wanted a **device to identify people** around them

PROPOSED SOLUTION & CRITERIA

LAKSHYA

Hand-wearable device to provide **vision-like** capabilities such as **object detection**, **guiding hand** to specified object, **people and places** identification and narrating **environment** around them

CRITERIA FOR PROPOSED SOLUTION

- Affordable** (less than the cost of an entry level smartphone)
- Easy to use** by blind people (voice commands)
- Should work **fast** (less than 10 seconds per action)
- Non-invasive** technology (should not require surgery)

ALTERNATIVE SOLUTIONS CONSIDERED

- Headset-camera based device (**limited capabilities**)
- Retinal camera implant (**invasive, risky, expensive**)
- Optic nerve splicing and tapping (**too complex, invasive**)

ENGINEERING GOALS

IDENTIFIED SPECIFIED OBJECT	IDENTIFY FAMOUS PEOPLE	IDENTIFY FAMOUS PLACES	COST LESS THAN RS.8000	NO RELIANCE ON VISUALS (E.G. SCREEN)
DIFFERENTIATE SHAPES AND COLOURS	GUIDE HAND TO SPECIFIED OBJECT	INTERACT USING VOICE COMMANDS + PROMPTS	WEARABLE DEVICE (SHOULD NOT REQUIRE SURGERY)	CANNOT USE TOUCH SCREEN FOR INPUT
SAFE FOR BLIND PEOPLE	IDENTIFY NUMBER OF PERSONS	WARN HARMFUL OBJECTS	CANNOT HAMPER REGULAR ACTIVITY	ALL ACTIONS WITHIN 10 SECS

CONSTRAINTS



FEATURES OF LAKSHYA

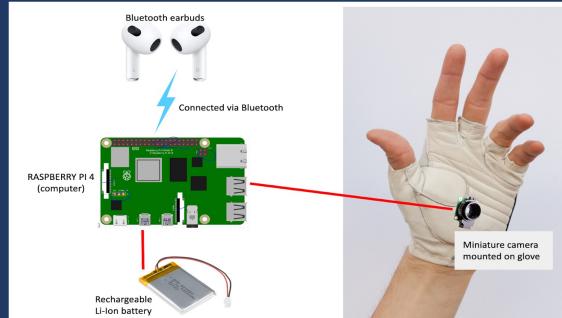
- Hand wearable device (fits like a glove), does not hamper other uses of hand
- User Interface: **Voice commands** and **Audio prompts** + on-device buttons
- Identify objects kept in front of them (differentiate between types of objects)
- Guide hand to pick up object (audio prompts + haptic feedback from glove)
- Identify famous people, family members, monuments, places
- Detect number of persons in front of them (human face detection)
- Warn against touching **harmful objects** (such as blades, scissors, knives)



PROTOTYPE DEVELOPMENT & RESEARCH

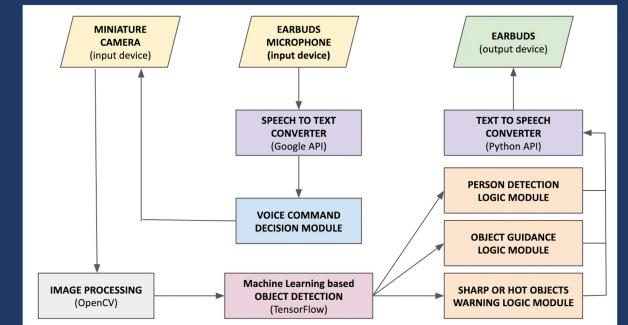
HARDWARE DESIGN

- Raspberry Pi 4 (for all computing needs)
- 5 MP Camera Module (for image capture)
- Earphones (wired/wireless) for voice commands
- Haptic feedback motors, Li-Polymer battery



SOFTWARE DESIGN

- Google TensorFlow (AI/ML library), OpenCV
- Custom trained ML models, Speech-to-Text
- Custom algorithms for object tracking and voice guidance



HYPOTHESES

- H1** – identification objects in front of them
- H2** – objects can be detected w/o touching
- H3** – colour of objects can be identified
- H4** – guide person's hand to object
- H5** – warning for harmful objects
- H6** – number of persons in front of them
- H7** – identify famous people, family members
- H8** – identify famous buildings, places



METHODOLOGIES TO IDENTIFY SOLUTIONS

SCIENTIFIC METHOD

- (Observe, Measure, Experiment, Test Hypotheses)
- Used for background research, problem identification, experimentation with prototype, and results analysis



DESIGN THINKING PROCESS

- (Empathize, Define, Ideate, Prototype, Test)
- For LAKSHYA prototype research, design and development

