NISH MOHITH **KURUKUTI**

Bachelors in Technology

PORTFOLIO

This portfolio is meant to be a showcase of my works, showing projects that were developed during internships, and individual projects. In order to keep this portfolio compact, I have chosen to highlight only the more relevant work.

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CONTENTS

OIO an ultra-low cost, opensource, portable and intuitive device to detect DR

OIO(OWL) is an idea conceived in the Fall 2015 **MIT Media Lab Engineering Health Course**. Development of the electronics, enclosure, and optics have continued since Spring 2016 at the **Srujana Innovation Centre** at the **LV Prasad Eye Institute**, Hyderabad, India. It aims at capturing good quality retinal images using an affordable device, mainly to help make identification of Diabetic Retinopathy accessible to all.

The Key features include:

- Ultra Low Cost: Under $400, compared to its contemporaries
- Open Source and Design: Expands the scope of the device worldwide
- High Portability: Weighs less than a laptop
- Intuitive interface: No specialized training needed to operate the device, making it perfect for use in rural areas

The OIO uses a 20D lens, mirrors, light source and camera, a raspberry pi and a touch interface to achieve this. The lens and mirror system are used to compress the optical path and focus the light from retina onto the camera. The camera and pi act as the processing unit and display live images on the display allowing the clinician to easily image the retina.

OWL

It uses a clever arrangement of optics to get results as accurate as a fundus camera

Portable, easy to use, ergonomic, increased user interaction

Cost | under $400

VS

Fundus Camera

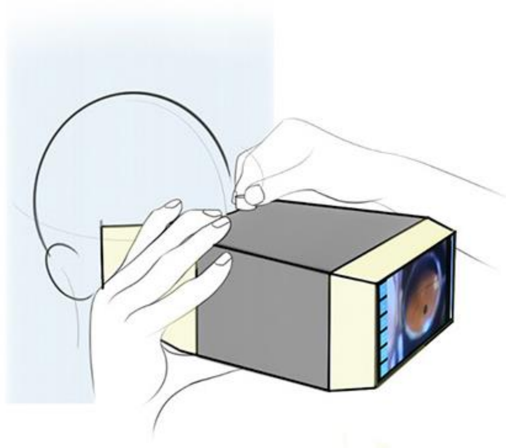
A fundus camera captures the image of a person's retina to check for diabetic retinopathy

bulky, expensive and requires a trained/skilled technician

Cost | $10,000 to 25,000

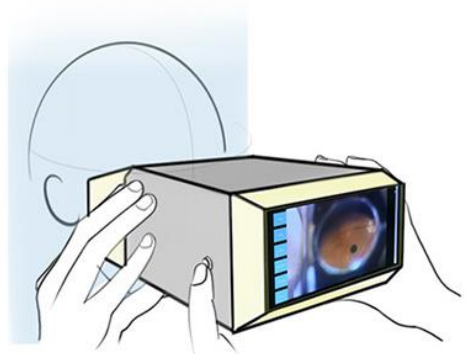
Click, Capture, Cure

1 Ergonomic eyepiece



Align the device to the subject's eye by fixing the eyepiece.Adjust the focus by means of a knob.

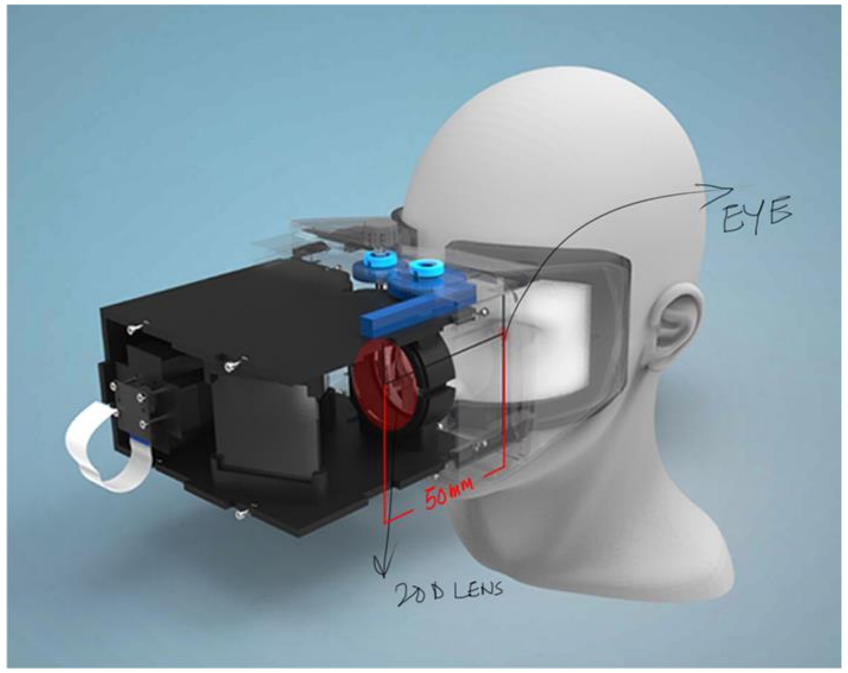
2 Symmetry along horizontal axis

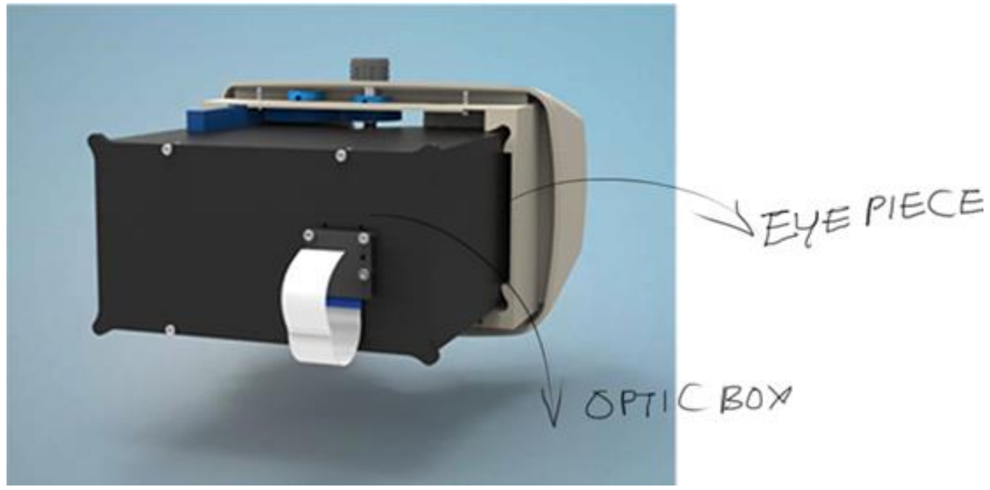


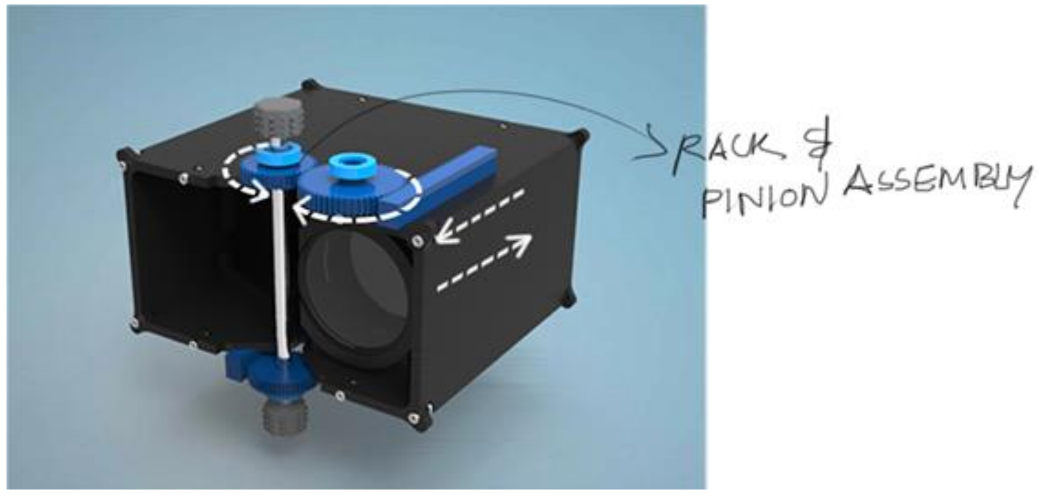
Once the fundus (retina) is observed clearly, capture the image.Flip the device to test the other eye.

3 Crowd-source eye-care diagnostics

Grade the image by means of a macine-learning platform, Theia. Send the image wherever required.

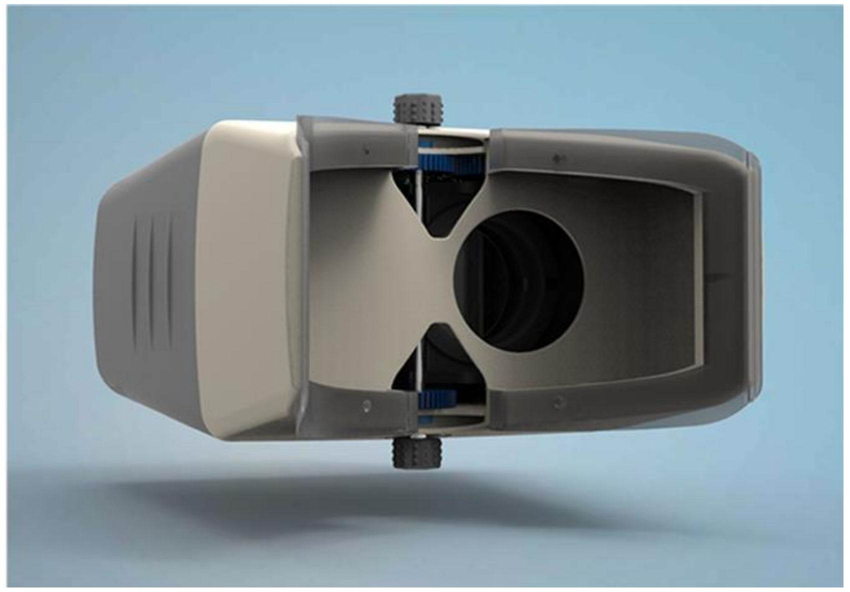




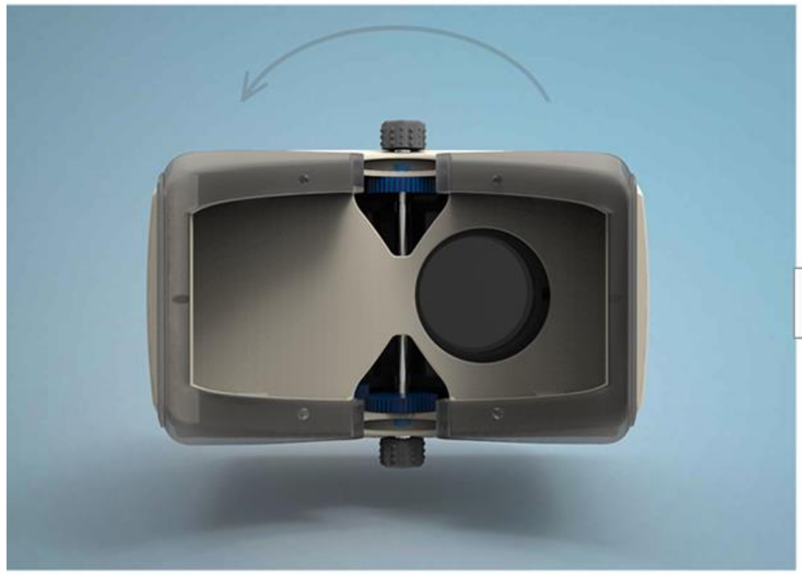


The optic box moves back and forth inside the enclosure by means of sliders integrated as part of the eye piece and the middle housing. The box moves by means of a rack and pinion assembly. The distance between the eye and the 20D lens can be adjusted by rotating the knob. The knob is placed at the center bottom and center top of the device with a rod connecting the two for access during the operation on both sides of the device.

Test for right eye

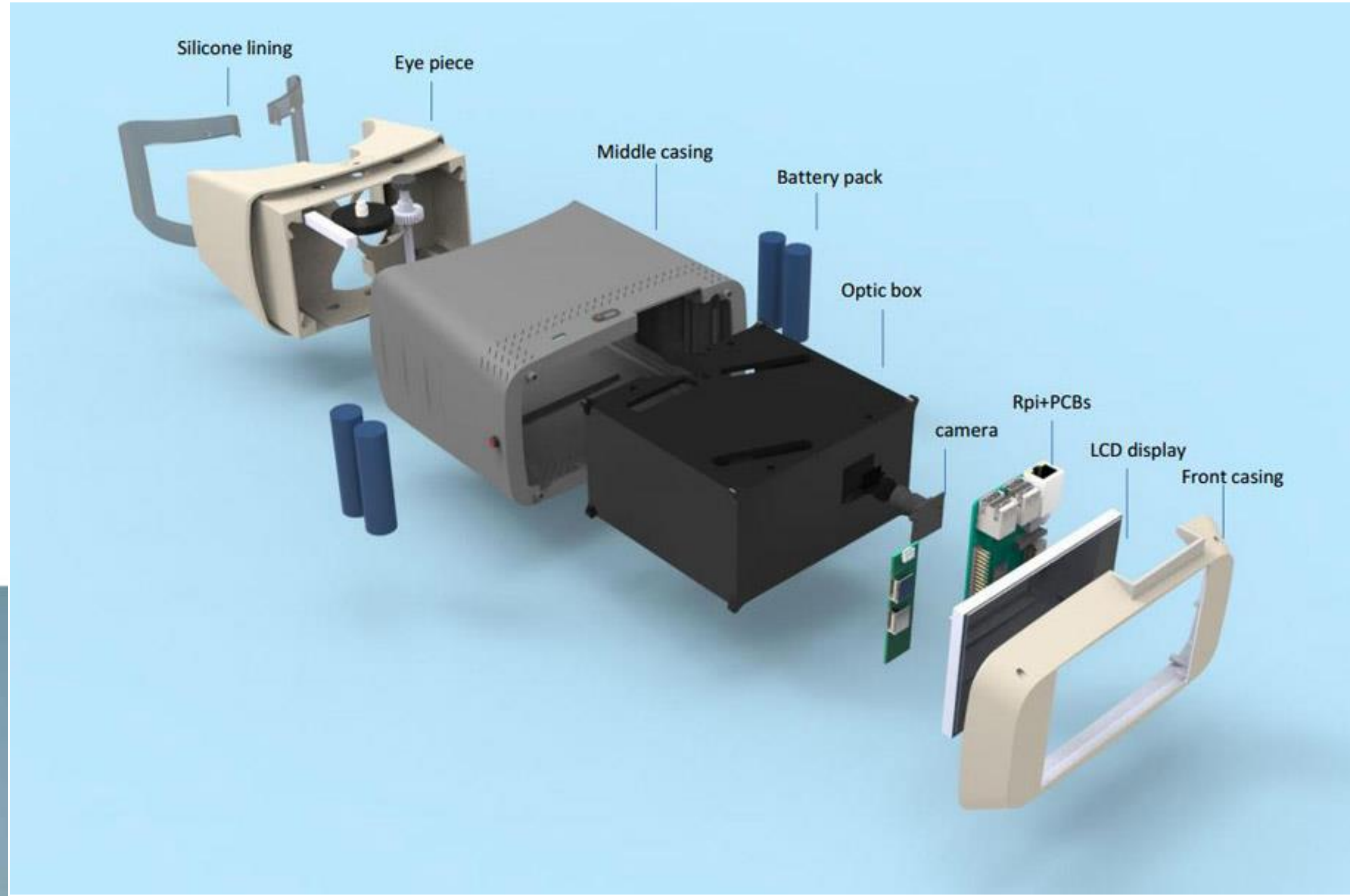


Test for left eye



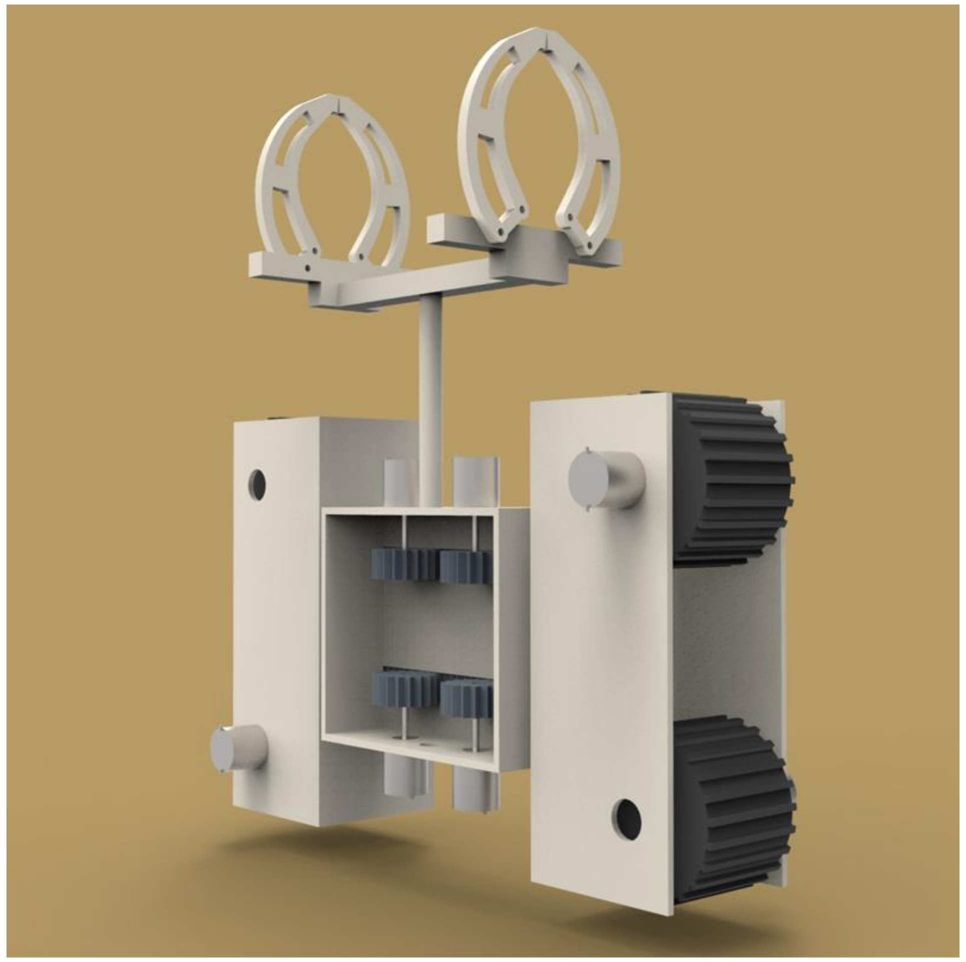
FLIP

only one eye is to be tested at a particular instance.The cavity near the other eye is closed . To test the other eye, the device has to be flipped.



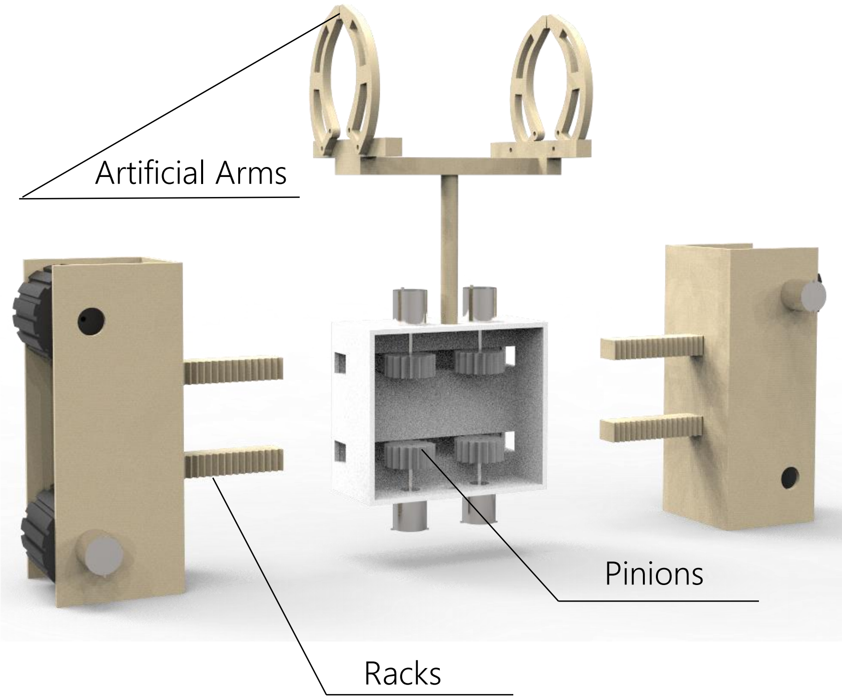
The assembly can be divided into three different parts: front casing, middle casing and the eye piece. The front casing houses an LCD display, the middle casing houses the optic assembly, battery pack and the electronics. The eye piece consists of the mechanical assembly to move the optic box and the silicone lining for multiple usage of the device, as shown in the image above.

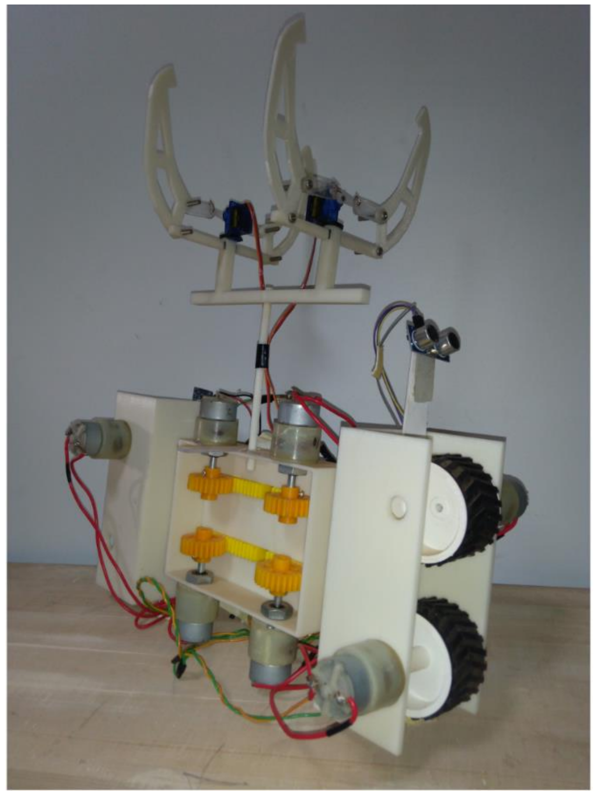
ROTARBE A robotic system for rescue in borewell accidents



Many child deaths are reported in the past due to bore well accidents. During bore well accident an immediate rescue operation is required and it is quiet challenging to perform a rescue operation as the environment inside the bore well is highly unpredictable. Developing low cost robotic system with intuitive control will help a layman use it with ease. ROTARBE is a novel design of a **rescue robot** which would enlarge and attach the bore-well by adjusting to the diameter while travelling up or down the bore-well. It contains two artificial arms, which would help in holding the baby with the visual help offered by a camera and also aid in the survival of the child by providing oxygen and water.

The geometrical model was developed keeping in mind the diameters of the bore wells. In India the typical range of diameters is 8 to 12 inches. Due to chances of tapered bore well walls, a mechanism for the robot to self-adjust to the variation in diameter was required. The rack and pinion mechanism was incorporated into the robotic system to adjust the robot to the variations in borewell diameter. In the past many ideas of mechanisms have been brought up which would help in grabbing the child. Most of the cases had a typical artificial arm, which would help in grabbing the child at the head or torso. The main criteria considered was in most cases the child would be stuck inside the bore well with his torso unable to move. Hence a system with two artificial hands to grab a child at the shoulders have been designed which can be adjusted as per the width of the child's shoulder.





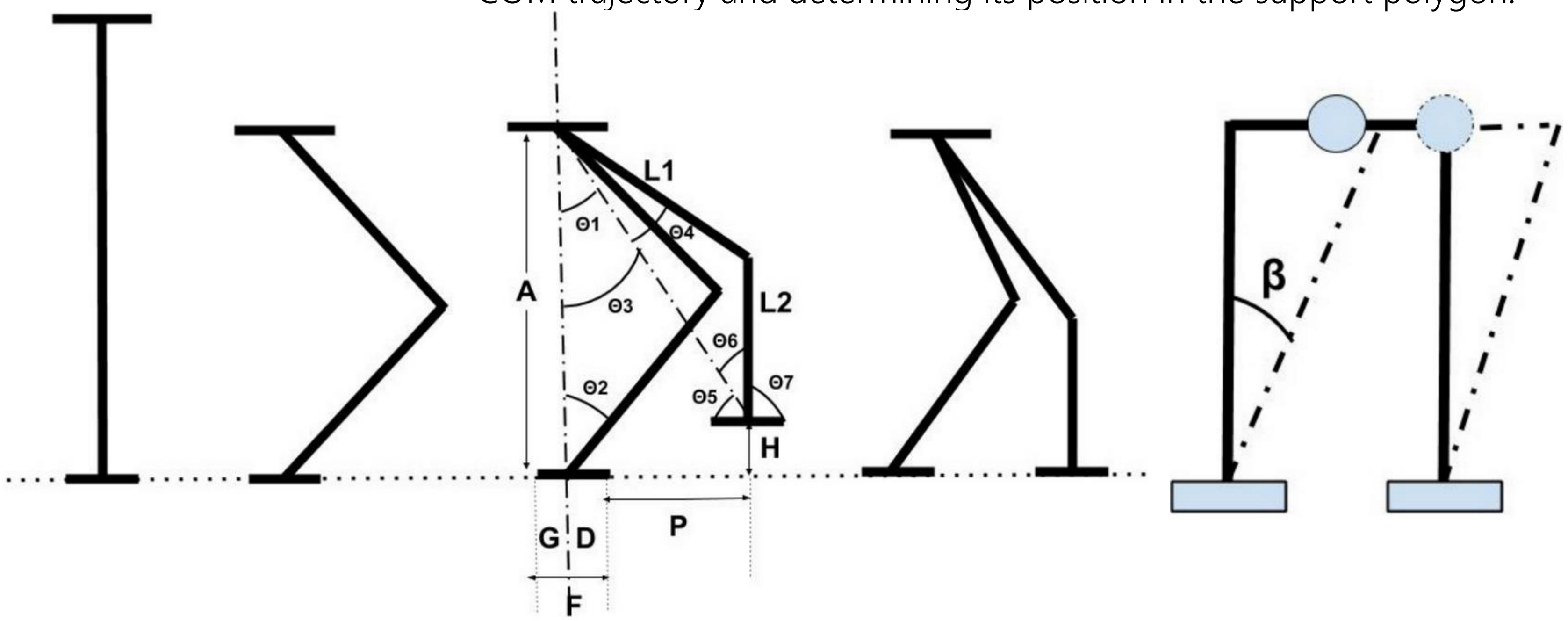
The robotic system consists mainly of three blocks which are designed to fit best to the bore-well condition. There are two side blocks which are hollow inside and cut on one side. These blocks on one side consists of motors and wheels which would help the robot to move up and down the bore-well. On the other side two racks are attached which protrude out from the block. The racks consists of guides on either side. The third block houses the gearing mechanism wherein the protruded racks from the adjacent blocks go inside. The block contains grooves to accommodate the racks. The racks and guides fit into the grooves and motors coupled with pinions are present in the block which mesh with the racks forming a rack and pinion geared mechanism, which is used in the expansion and contraction of the robotic system. The robot can fit to any size of the bore-well and adjust while traversing up and down the bore-well using the mechanism. The robotic system houses a camera and life support system to provide oxygen and water.

To test the design, a prototype using off the shelf materials and a mechanical assembly manufactured with **ABS** using 3D printing was developed. The design was tested by creating an artificial borewell environment and by lifting weights using the robotic system with manual assembly.

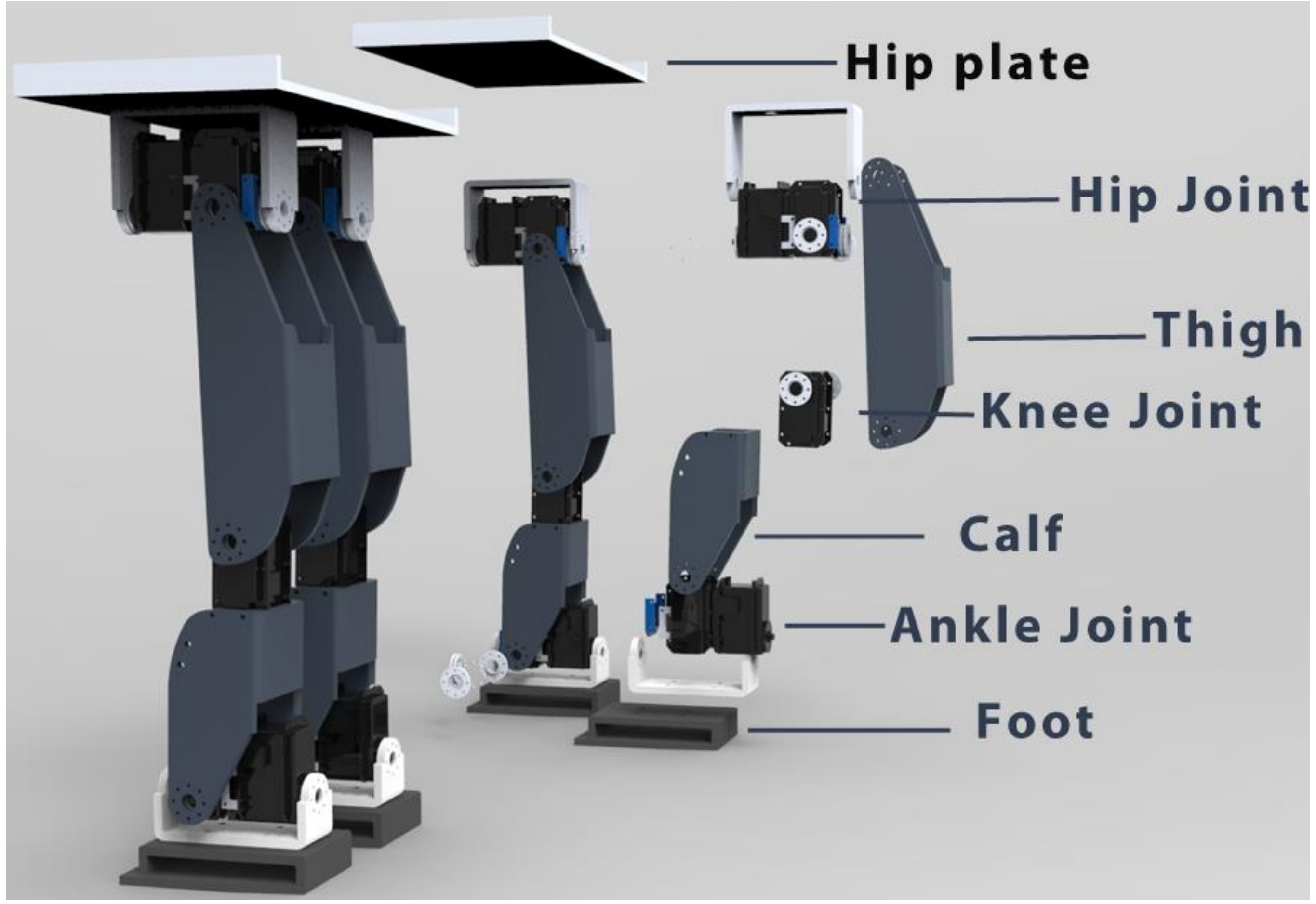
KYZR

Anthropomorphic Humanoid Robot

An anthropomorphic humanoid robot was modelled and a statically stable gait was developed. The kinematic configuration of humanoid consisting of 18 degrees of freedom is designed using the anthropomorphic data. A new method for inverse kinematic of the model has been developed. The dynamic model of humanoid is designed by means of Solidworks and simulated by using SimMechanics (MATLAB) and a statically stable gait is been tested. An absolute method for obtaining exact values in the real-time environment using virtual simulations is developed. Motor torques are obtained from the simulation results and the stability of the humanoid is validated using the center of mass (COM) criterion. Using this criterion, gaits can be generated which is statically stable and has low velocities when compared to the dynamic stable gaits. The stability of the generated gait is evaluated using the COM criterion by plotting the COM trajectory and determining its position in the support polygon.



The inverse kinematics in the sagittal plane and coronal plane. In the sagittal plane different parameters are considered and angles are generated at different intervals for a gait cycle and through cubic interpolation the gait is generated. In the coronal plane the COM point is assumed to not leave the support polygon and the parameter is calculated.



The inverse kinematic modelling of the robot is done with the help of mathematical interpolation. Breakpoints are considered at specific time intervals of the gait and the respective values of angles at the joints of the robot are determined. To determine the joint angles the inverse kinematic modelling is done in two planes, the sagittal plane and coronal plane using the anthropomorphic data. The actual links are slightly smaller than the anthropometric data to accommodate the motors, as the motors are larger than joints of a human. The angles for joints in different phases are calculated and interpolated to get the joint angles for the robot at various intervals of time. Further, the gait in the coronal plane is obtained by considering the COM criteria. Here the weight of the robot is shifted onto one leg before lifting the other foot. Hence the hip is moved and the other leg is lifted to get into the single stance position such that COM is in the support polygon. Later the humanoid was fabricated and dynamic stable gait was developed and tested.

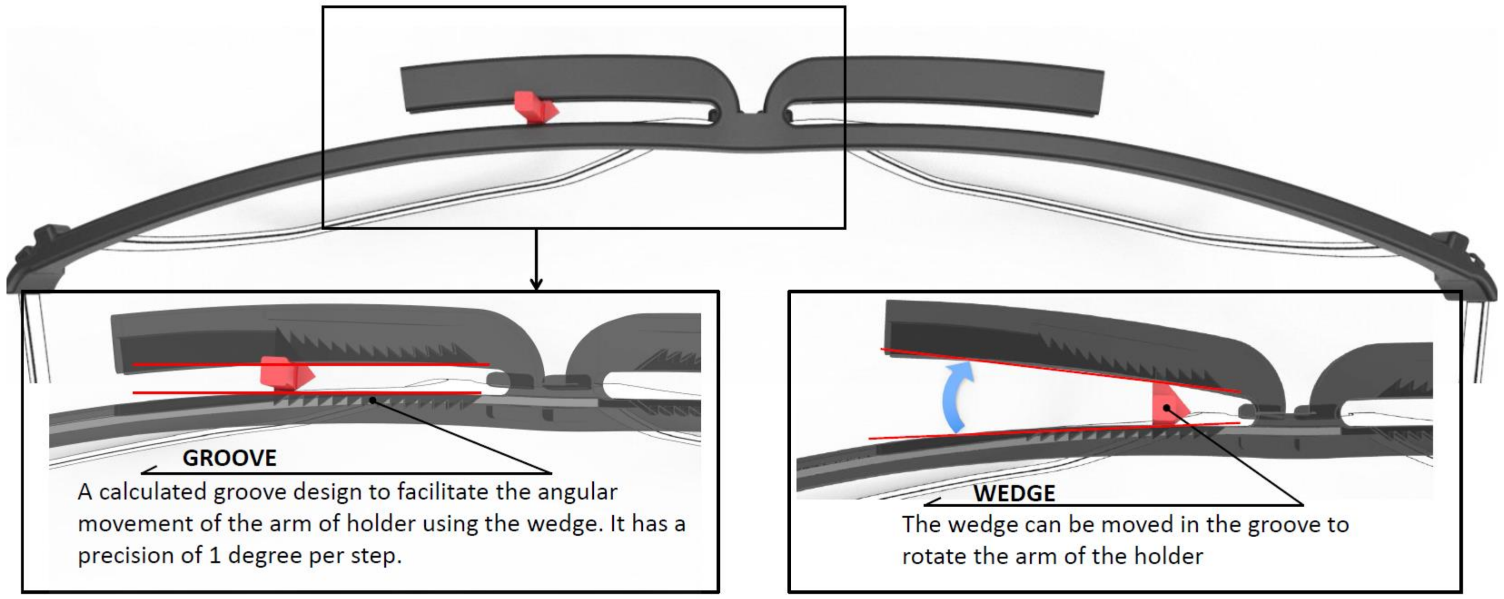
* Video showing the testing of the gait on the biped in simulation : Link

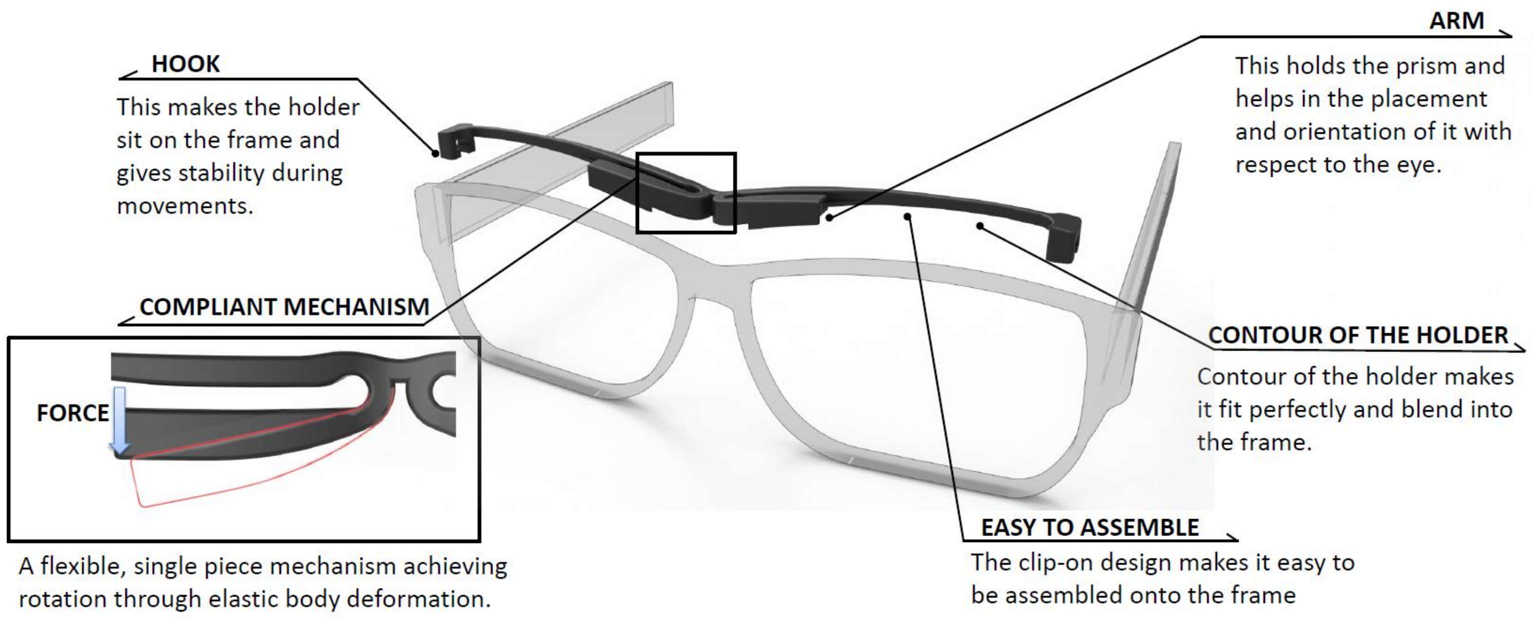
MxP Mount

A mount to test Multiplexing prisms

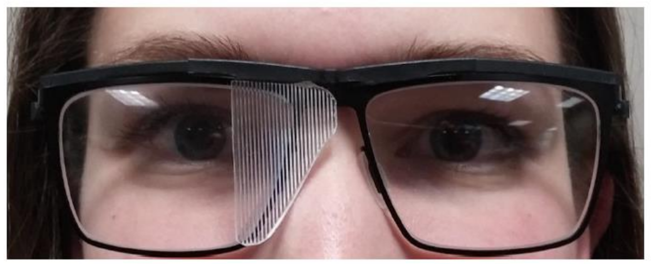
Patients with acquired monocular vision (AMV) cannot see the environment on the blind side. The devices used previously for visual field expansion for AMV needed the patient to scan into the prisms and this created an apical scotoma (blind area) in the visual field. A novel design of prism called multiplexing prism (MxP), which can expand the visual field in both cases avoiding these limitations was developed. The MxP prevents apical scotomas by superimposing the see-through view and the shifted view. These prisms are placed near the nose bridge (nasal field) to expand the nasal visual field unilaterally for AMV. The optimal configuration of the MxP for wide visual field expansion is determined by taking into consideration the power of the prism and the rotation of the prism with respect to the spectacles of the patient. The prism rotation angle, power, and size are best fitted individually as they are unique for each person and due to change based on facial geometry.

To test the MxP, a mount that could position the prism in the visual field had to be developed. The design needed had to accommodate different types of patients with different facial contours and nose. A unique requirement for this design was that it should not interfere with the nose at the nose bridge as people of different face-forms would have different visual fields.





In most cases, the end of the nasal visual field might not be at the edge of the frame of the eye and might extend into the nose bridge. As people use different spectacles, the mount had to be generalized for all frames. The angle of the mount housing the prism segment should be adjusted as per the patient's visual field and thus a range of angle had to be specified. Looking at the patients visual fields and expansions needed the optimal angles were between 0° - 15°. A design with a compliant mechanism was developed to position and orient the prisms.

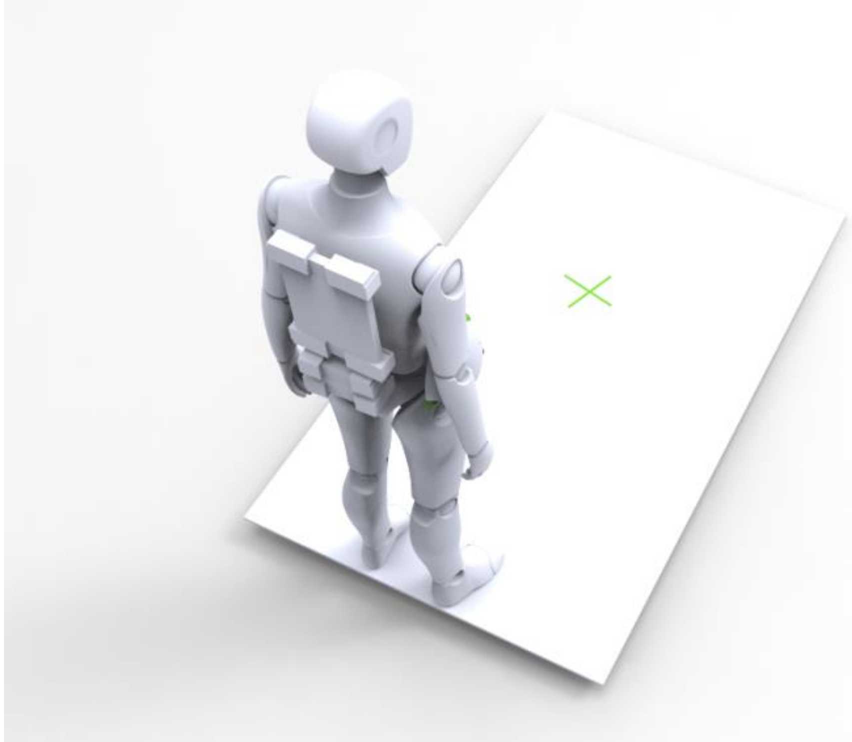


Design of the Mount and prototype during testing

Electronic Travel Aid

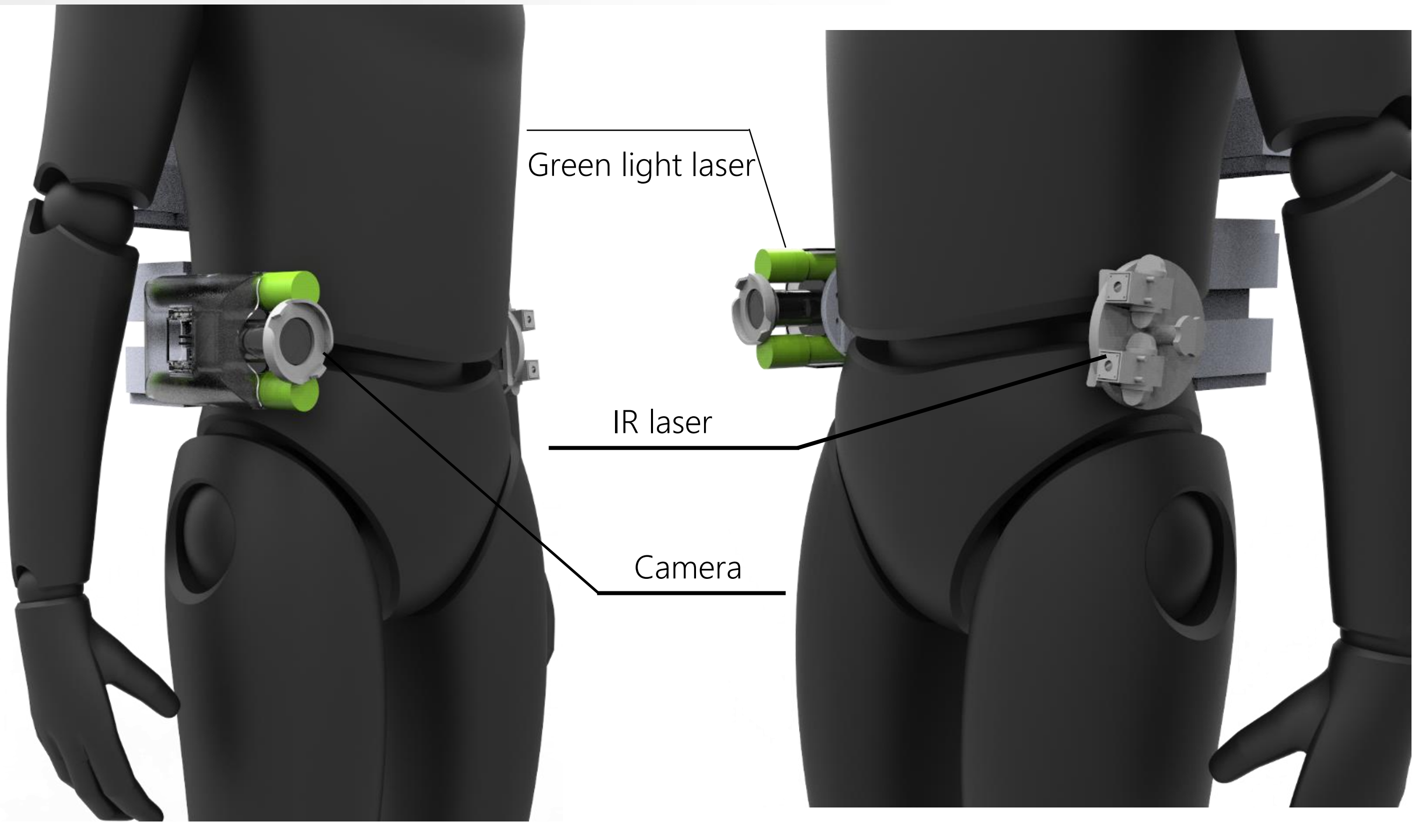
Visual impairment or vision loss is a decreased ability to see which cannot be corrected using glasses. This causes people difficulty with normal daily activities such as driving, reading, socializing and walking. From recent investigations it is evident that the visually impaired community is more susceptible to falls that result in injury. Most of the hazards faced can be categorized into two main categories: collision hazards and tripping hazards. Tripping hazards can be curb in the sidewalk, steps indoors and outdoors, objects left on the ground, etc. A tripping hazard is more dangerous than the collision hazard as they can potentially cause injury even at low speeds of walking. Devices which could detect the imminent threat and alert the person would be a great help in safely navigating the surrounding for the visually impaired community. An Electronic Travel Aid (ETA) is a form of assistive technology having the purpose of enhancing mobility for pedestrian with low vision.

The most necessary aspect of navigation is to determine the contour of the plane ahead of the user and accordingly guide the user. To determine the contour of the plane the 3D surface geometry is invaluable. In this system it is obtained by using a laser scanning system which employs infrared lasers for sweeping the plane and recording the data of the laser distance from the origin to the end of the surface. A camera, located at a baseline distance from the laser projector, records the laser light been projected. This camera would be used to determine the distance between the user and the focused light that is reflected from the surface using triangulation techniques. In this system two laser lines or strips of light will be projected at certain orientation to determine the 3D surface geometry. When this light falls on the surface, for example if the surface is a flat plane the strip of laser light will be a single line and if there is any disorientation of the line, it would suggest that the surface is not a plane. Especially in conditions where steps are encountered the laser strip would be cut at a place indicating the laser strip is falling on two different surfaces and thus the 3D geometry of the surface can be determined as shown in the figure. The design was developed keeping in mind that the proposed system will be mounted onto the body of the user non-obtrusively. Thus a human-centric design approach was considered.



Looking at the lifestyle and the common outfits used it was assumed that the total assembly would be mounted onto a belt on either sides of the hips. Ideally, if a male human be using it the assembly will be strapped onto the belt which would also support his trousers. Thus the assembly would be stable and also move with the user.

Fig. Projection of Laser light on the surface



On the right side, the assembly consists of a camera and two green lasers. On the left side the assembly consists of IR lasers. Lasers on both sides are equipped with line generators to form a line as shown in the figure. During operation, the IR lasers are active and when a hazard is detected the green lasers switch on to alert the user. As eyes are sensitive to green color, patients with low vision would detect the laser light and check their surroundings.