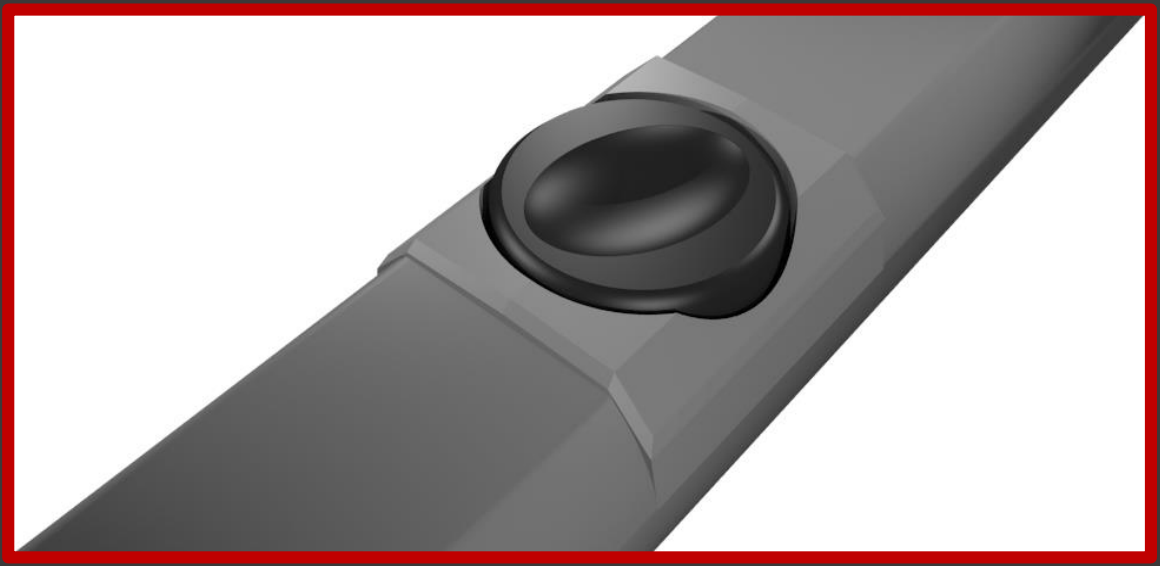
SYSTEM OVERVIEW

A BRIEF FORAY INTO OUR SYSTEM...

WHAT IS THE NAVCANE?

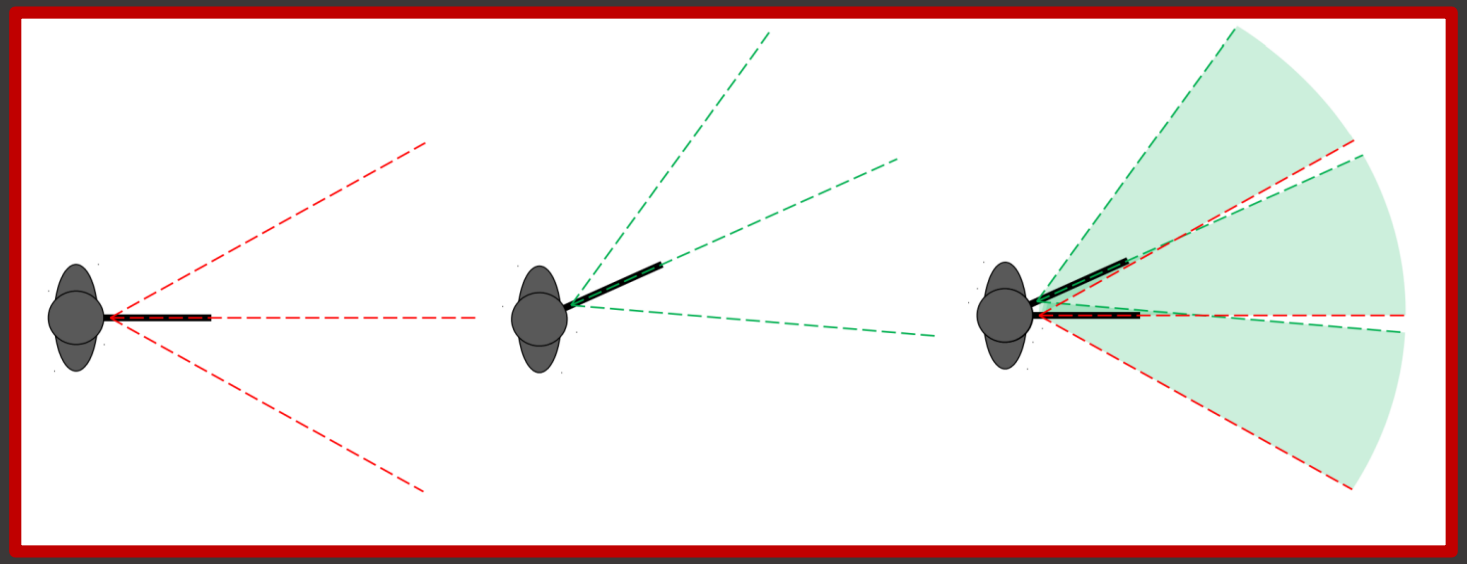
- A MODIFIED MOBILITY CANE
- DETECTS OBSTACLES AND SUGGESTS MOVEMENT TO AVOID THE OBSTACLES
- DETECTS AND WARNS USER ABOUT DEAD ENDS AND OVERHANGS

HOW TO USE THE NAVCANE?



- PLACE YOUR HAND ON THE HANDLE AND PUT YOU THUMB IN THE RECESS, AS SHOWN ABOVE
- MOVE FORWARDS WHILE SWEEPING THE CANE BACK AND FORTH.
- FEEDBACK REGARDING OBSTACLES IS CONVEYED THROUGH VIBRATION AND ROTATION OF THE RECESS

SUB-SYSTEMS



- CONSISTS OF THREE SUB-SYSTEMS:
  - DATA COLLECTION - RESPONSIBLE FOR MEASURING THE ENVIRONMENT
  - INFORMATION PROCESSING - WHICH CONVERTS THE RAW DATA FROM THE SENSORS TO USEFUL NAVIGATION INFORMATION
  - FEEDBACK - INDICATES TO THE USER A SAFE DIRECTION TO TRAVEL

POSSIBLE EXPANSIONS IN FUNCTIONALITY

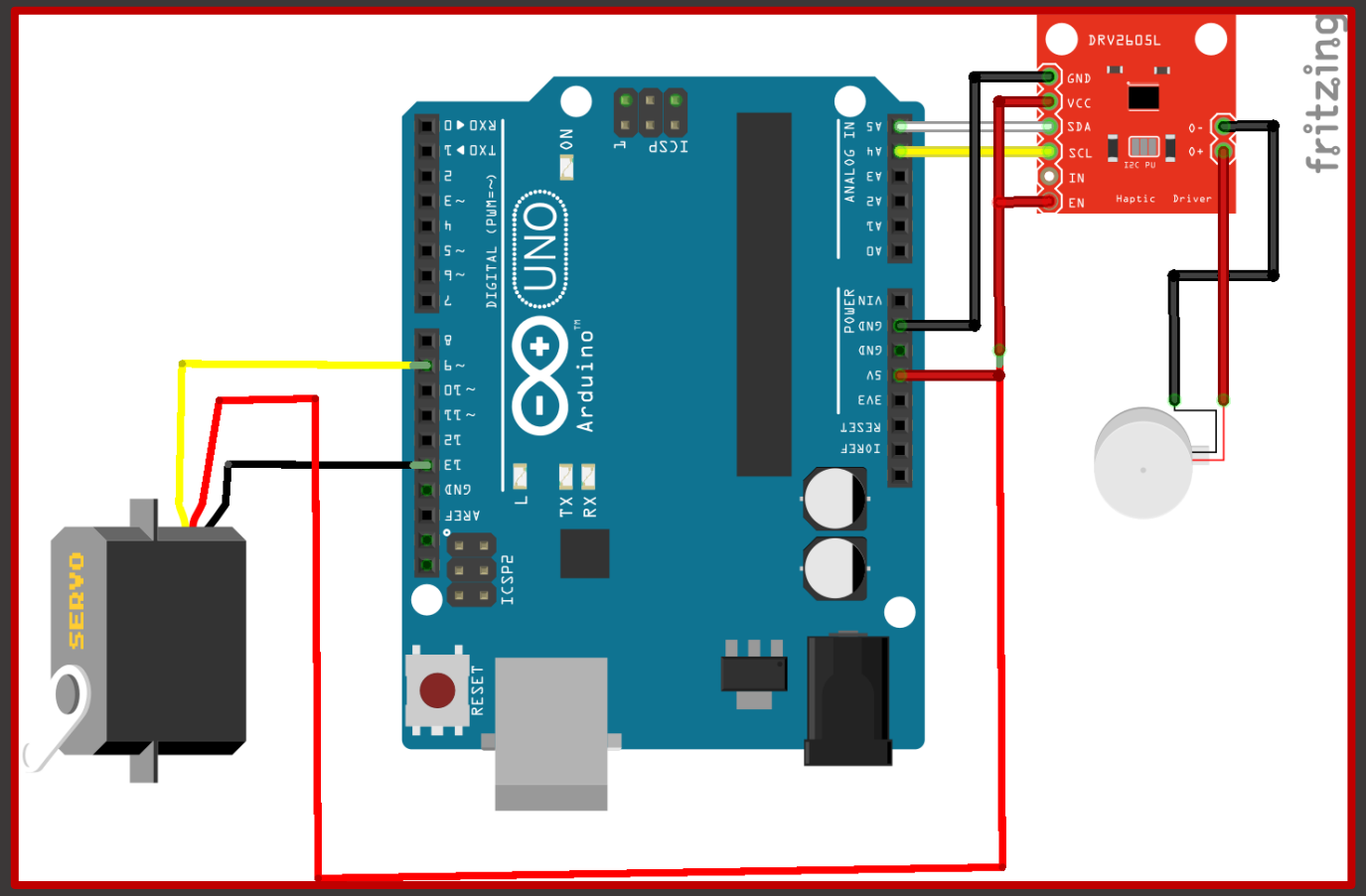
- SMARTPHONE APP INTEGRATION
  - CUSTOMIZATION
  - AUDIO FEEDBACK OPTION
  - INDOOR NAVIGATION USING INDOORATLAS

HTTP://WWW.PROTEXTMOBILE.NET/WP-CONTENT/UPLOADS/2013/04/GELD-VERDIENEN-MIT-EIGENER-SMARTPHONE-APP.JPG

Electrical Design

An in-depth look at the electronics

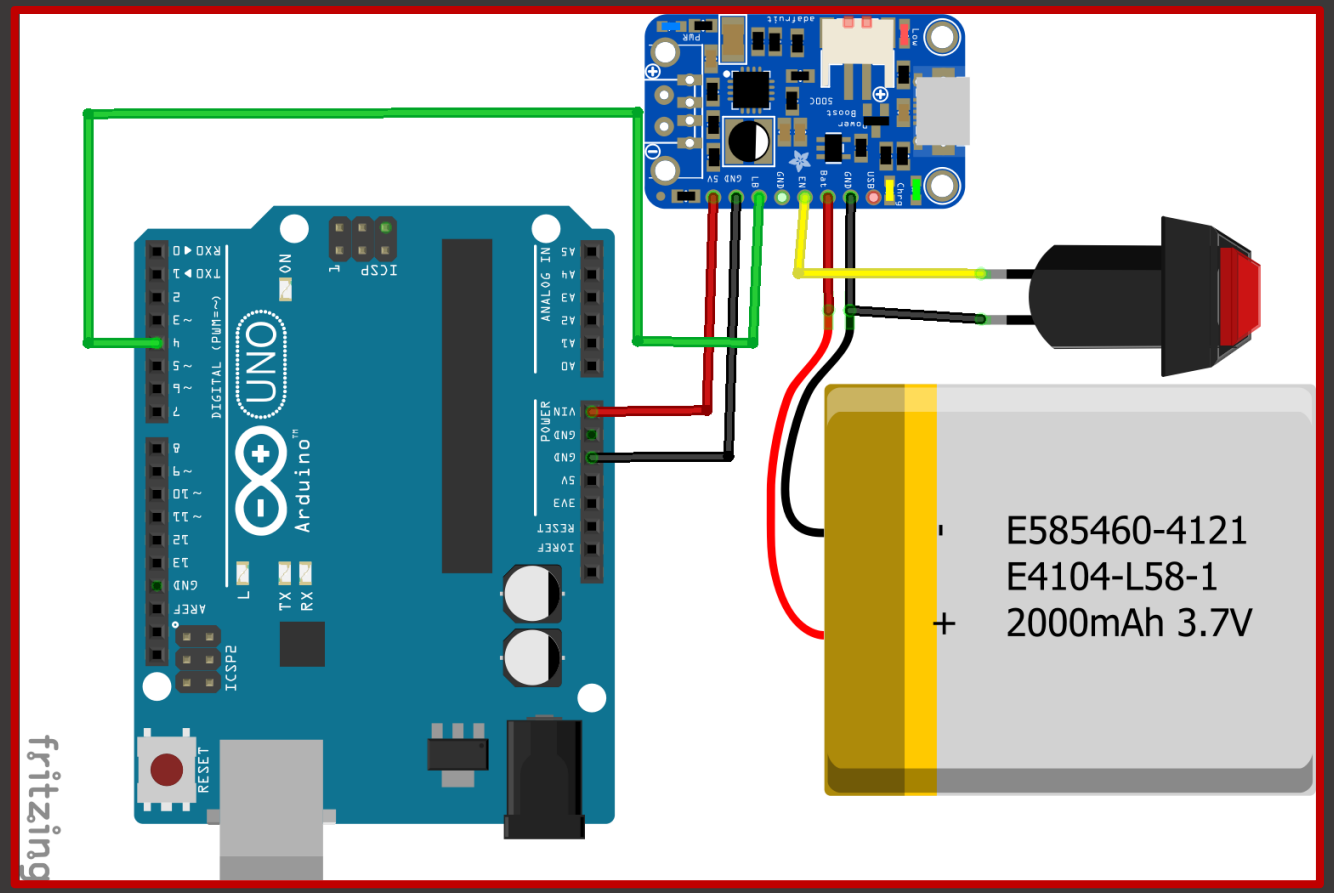
ELECTRICAL



HAPTIC FEEDBACK CIRCUIT:

- SERVO MOTOR FOR PRIMARY FEEDBACK
- ERM MOTOR FOR SECONDARY VIBRATIONAL FEEDBACK

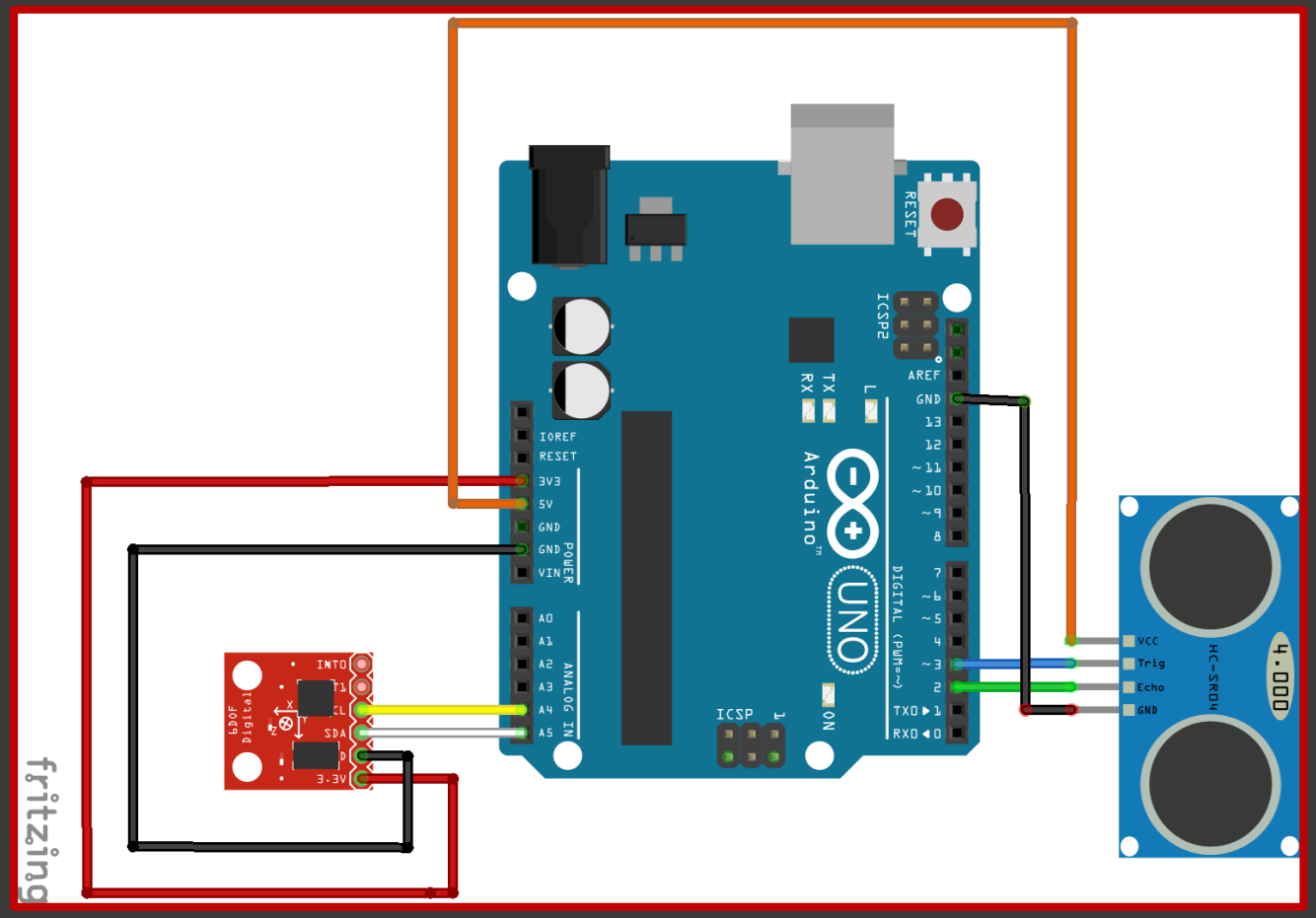
ELECTRICAL



POWER MANAGEMENT CIRCUIT:

- LI-ION BATTERY WHICH IS RATED FOR 3.7V, CAPACITY OF 2000MAH
- LI-POLYMER CHARGE MANAGEMENT CONTROLLER
- SYNCHRONOUS BOOST CONVERTER

ELECTRICAL



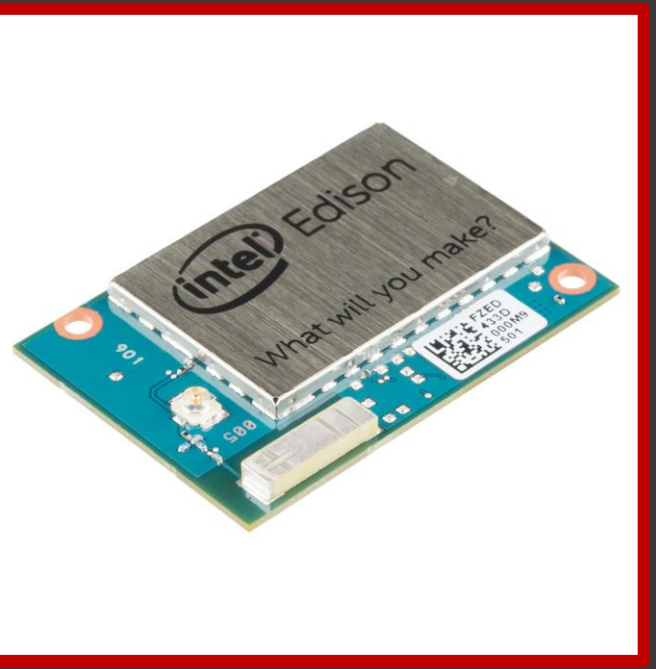
OBSTACLE DETECTION CIRCUIT:

- TOTAL OF FIVE HC-SR04 ULTRASONIC SENSORS.
- IMU (INERTIAL MEASUREMENT UNIT) HAS 9 DOF (DEGREES OF FREEDOM)

ELECTRICAL

USE AN INTEL EDISON AS OUR POST P.O.C MICROPROCESSOR

- DUAL CORE PROCESSOR CLOCKED AT 400 MHZ
- MICROCONTROLLER UNIT CLOCKED AT 100 MHZ
- INCLUDES BUILT-IN WI-FI AND BLUETOOTH
- WILL BE USED TO CONTROL THE HARDWARE CIRCUITS AND TO PROCESS THE DATA COLLECTED



HTTPS://CDN.SPARKFUN.COM//ASSETS/PARTS/1/0/0/1/1/SPARKFUN_EDISON_BOARDS-14.JPG

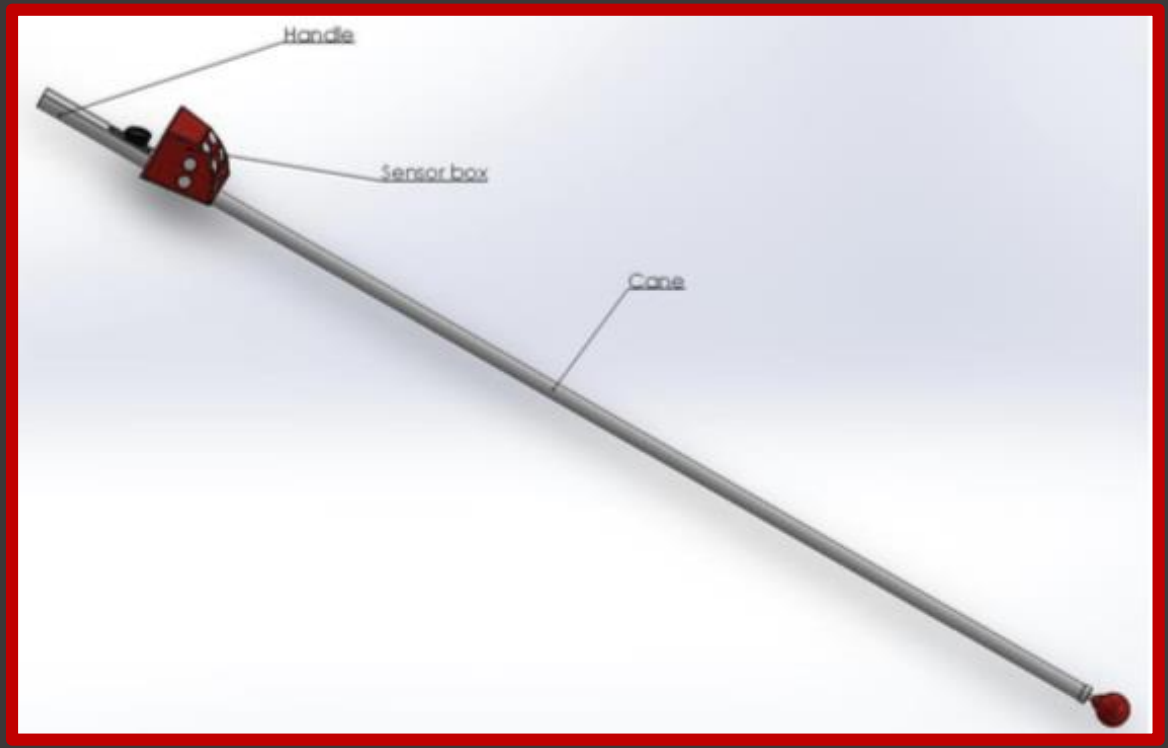
MECHANICAL DESIGN

A CONCEPTUAL DISCUSSION OF OUR PHYSICAL SYSTEM

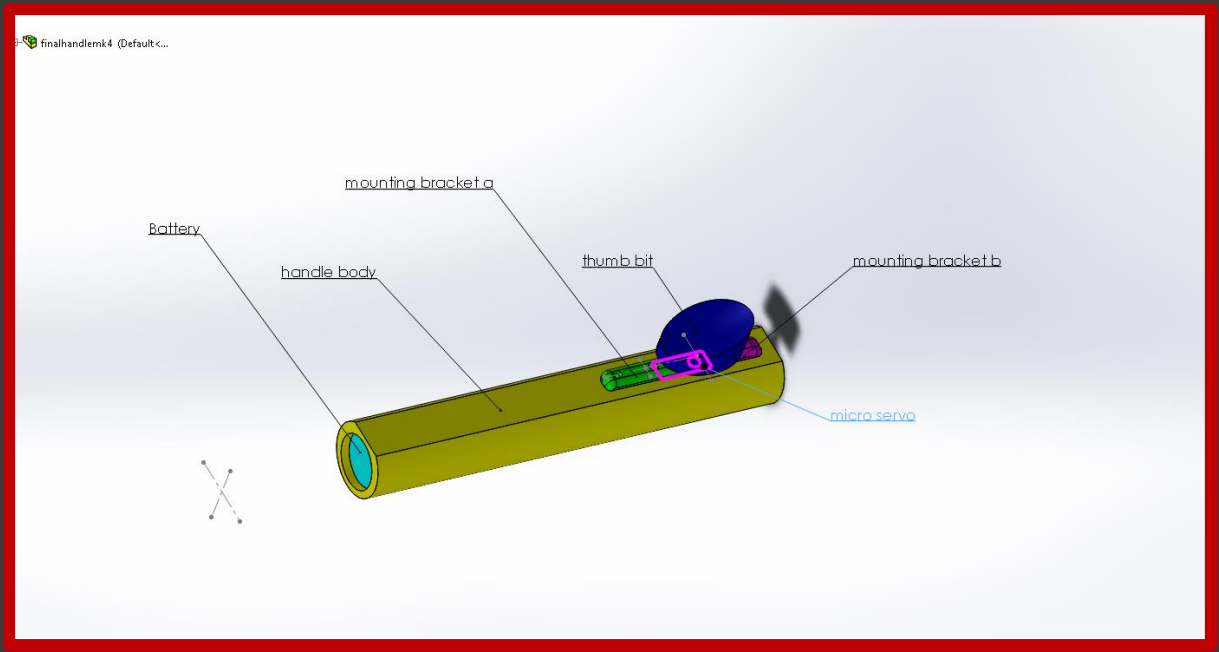
OVERVIEW

CONSISTS OF THREE SUB-SYSTEMS:

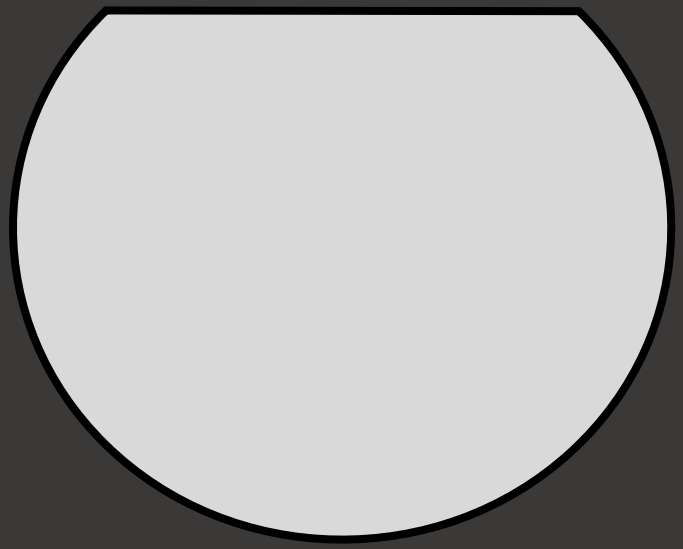
- HANDLE – ACCOMMODATES THE HAPTIC FEEDBACK SYSTEM AND BATTERY AND ALLOWS FOR CONNECTION TO SENSOR BOX
- SENSOR BOX – WILL HOLD ALL THE SENSORS AND THE MICROCONTROLLER
- CANE – STANDARD DESIGN TAKEN FROM THE MATERIALS AND DIMENSIONS OF STANDARD MOBILITY CANES ON THE MARKET TODAY.
- **TOTAL SYSTEM WILL BE EXPECTED TO WEIGH 688G**



HANDLE CONCEPT



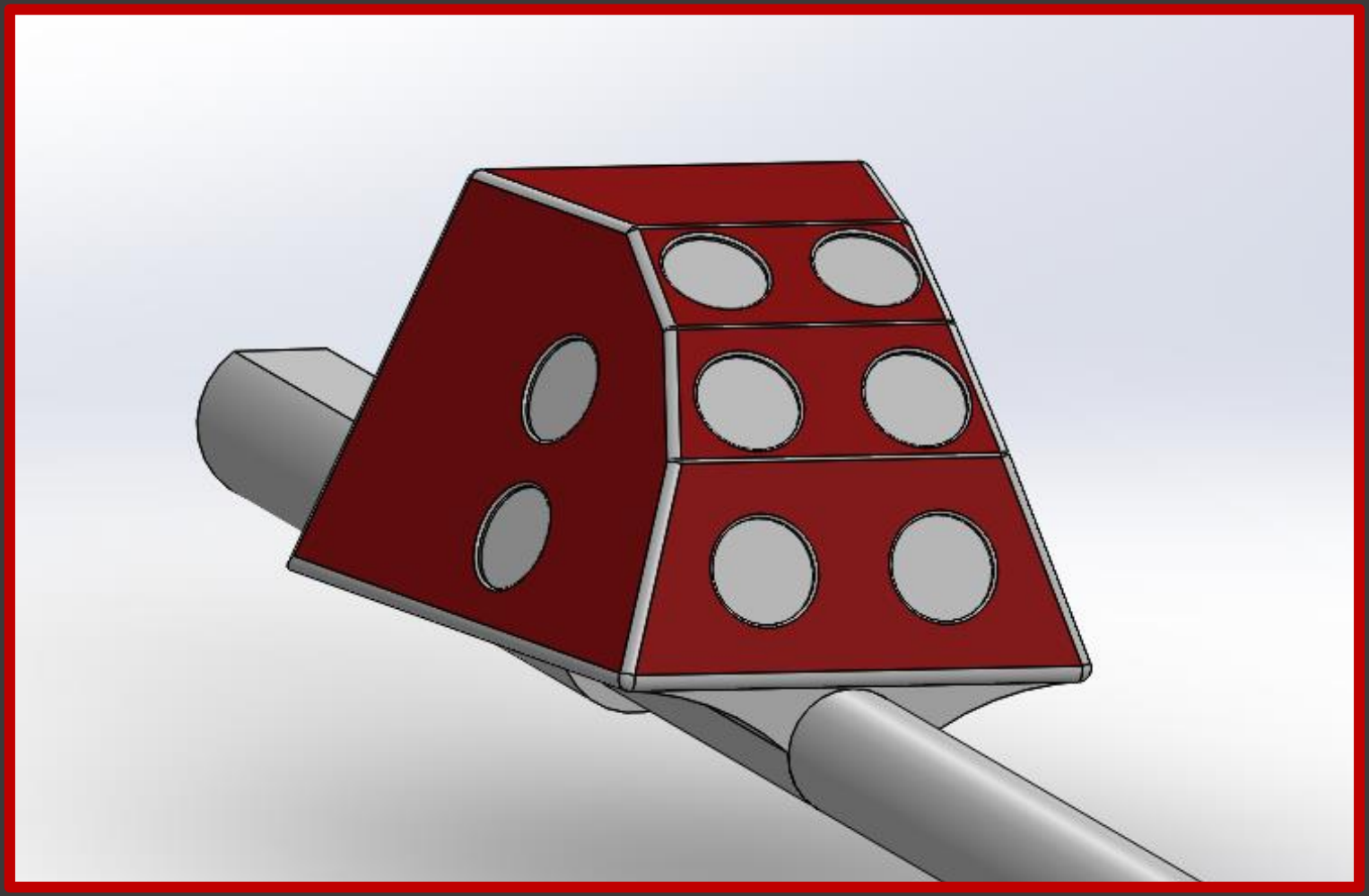
HANDLE SHAPE



PHYSICAL PROPERTIES OF HANDLE

- CASING BE MADE OUT OF ALUMINUM WITH A RUBBER SLEEVE FOR COMFORT
- TO WEIGH ABOUT 168G
- 15MM LONG AND 25.85 MM IN DIAMETER
- HANDLE SHAPE IS STANDARD MOBILITY CANE HANDLE SHAPED FOR FAMILIARITY

SENSOR BOX



- VOLUME OF CASE TO BE 110CM^3
- MADE OF PLA PLASTIC
- CONTAINS INTEL EDISON AND VARIOUS SENSORS RELATED TO OBSTACLE DETECTION
- ESTIMATED WEIGHT: 138G

CANE SHAFT

- MATERIAL: ALUMINUM
- DIAMETER: ¾ INCH
- LENGTH: 1.2 METERS LONG FOR PROTOTYPE
- WEIGHT: 282G
- HANDLE, SHAFT AND SENSOR BOX WILL BE CONNECTED TOGETHER FOR THE FINAL SYSTEM USING MECHANICAL COMPONENTS

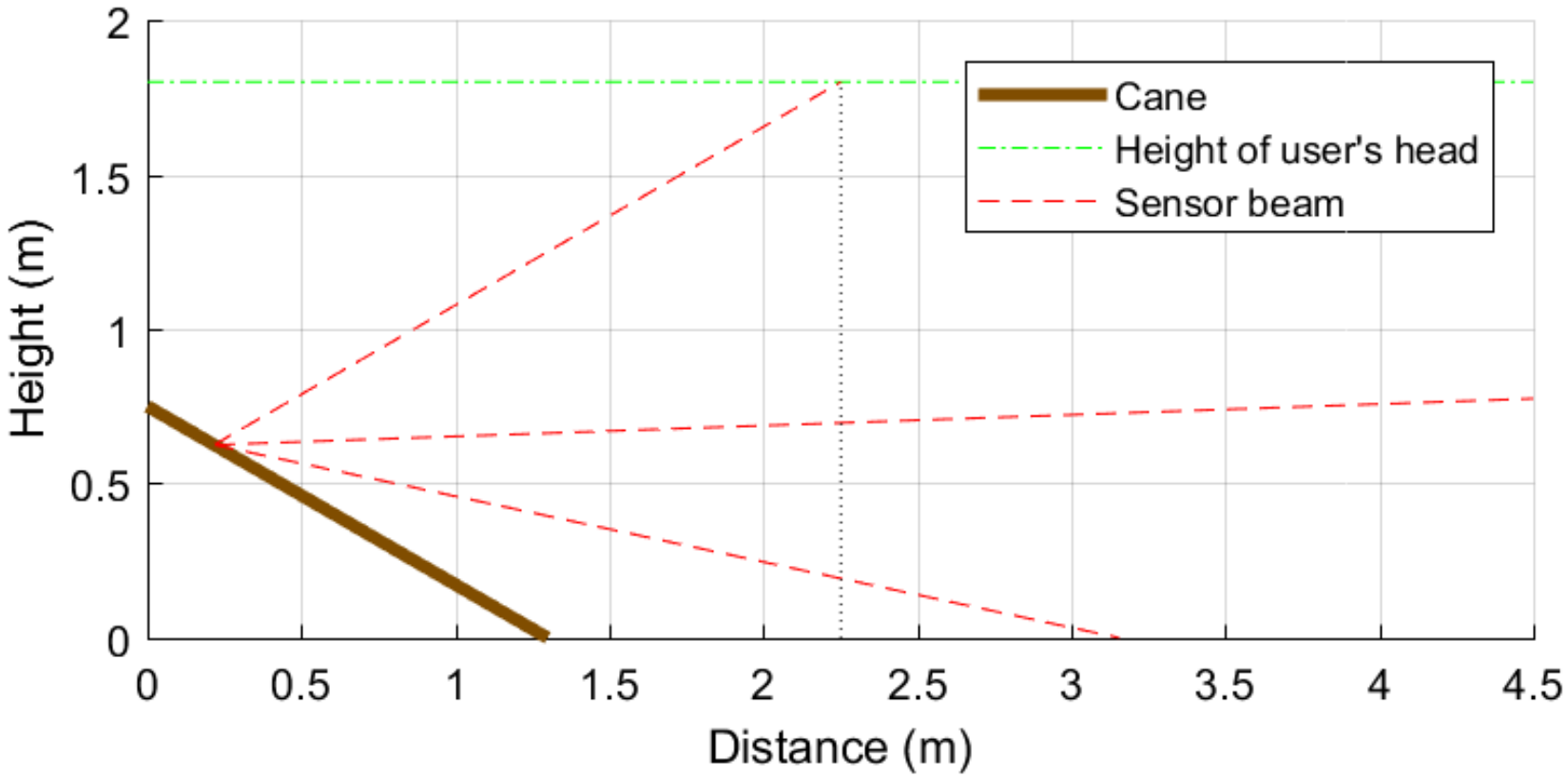
OBSTACLE DETECTION DESIGN

A COMPLETE BRAKE-DOWN OF OUR OBSTACLE DETECTION OBSTACLES

OBJECT SENSORS

- 5 ULTRASONIC SENSORS
  - ONE ANGLED UPWARDS TO DETECT LOW OVERHANGS
    - 1.75 TO 2.25 METER WARNING
  - ONE ANGLED DOWNWARDS TO DETECT LOW OBJECTS
    - 2 METER WARNING OF GROUND OBSTACLE
  - ONE POINTING STRAIGHT AHEAD TO DETECT INCOMING OBSTACLES & WALLS
    - 2 METER, LOWERED CANE
  - 2 SENSORS POINTING LEFT AND RIGHT TO DETECT LATERAL OBSTACLES
    - 90⁰ SWEEP IN FRONT OF USER

SENSOR ANGLES



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OBSTACLE DETECTION

- ULTRASONIC DATA IS BEING COLLECTED AND SAVED IN REAL TIME
  - UTILIZES USER SWEEPING MOTION TO INCREASE DETECTABLE RANGE
- ULTRASONIC DATA IS COMBINED WITH GYROSCOPIC MEASUREMENTS TO MAKE A POINT CLOUD OF READINGS
  - SCALAR DISTANCE READINGS ARE MATCHED WITH THE DIRECTION VECTOR
- FROM COMBINED MEASUREMENTS, OBSTACLES ARE INFERRED AND AVOIDANCE PATH IS RELAYED TO USER

OBSTACLE AVOIDANCE PLANNING

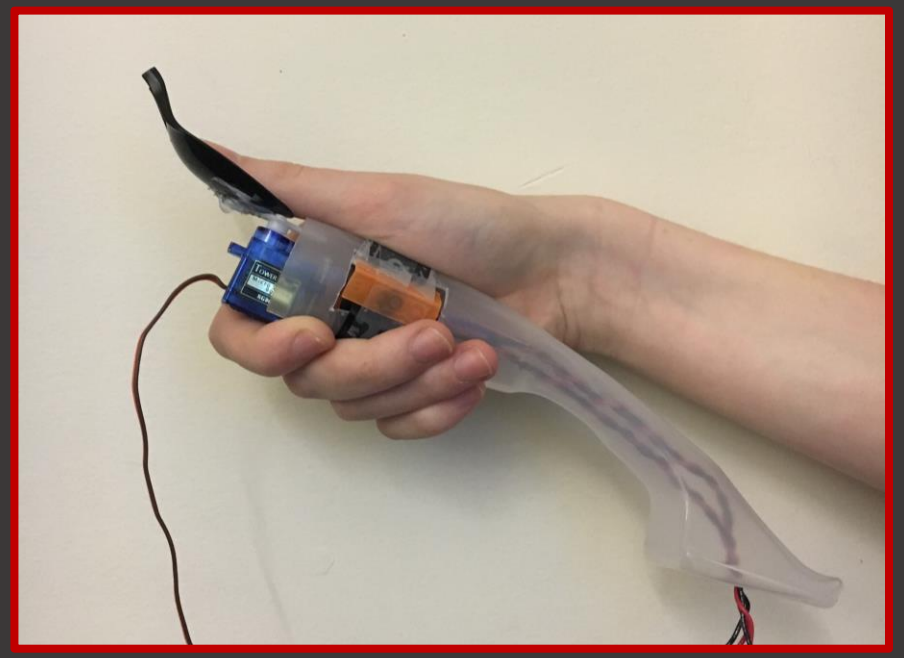
- FINDS RANGE OF ANGLES FROM COLLECTED POINTS
- SCANS THROUGH RANGE TO FIND A DIRECTION THAT HAS THE FURTHEST POINTS
- ANGLE WITH RESPECT TO CANES ORIENTATION IS CALCULATED AND GIVEN THE HAPTIC FEEDBACK SYSTEM
- IF POINTS ARE VERY CLOSE TO USER, SIGNAL GIVEN TO HAPTIC FEEDBACK TO ALERT USER

HAPTIC FEEDBACK DESIGN

A DISCUSSION ON HOW WE INTEND TO RELAY INFORMATION BACK TO OUR USERS

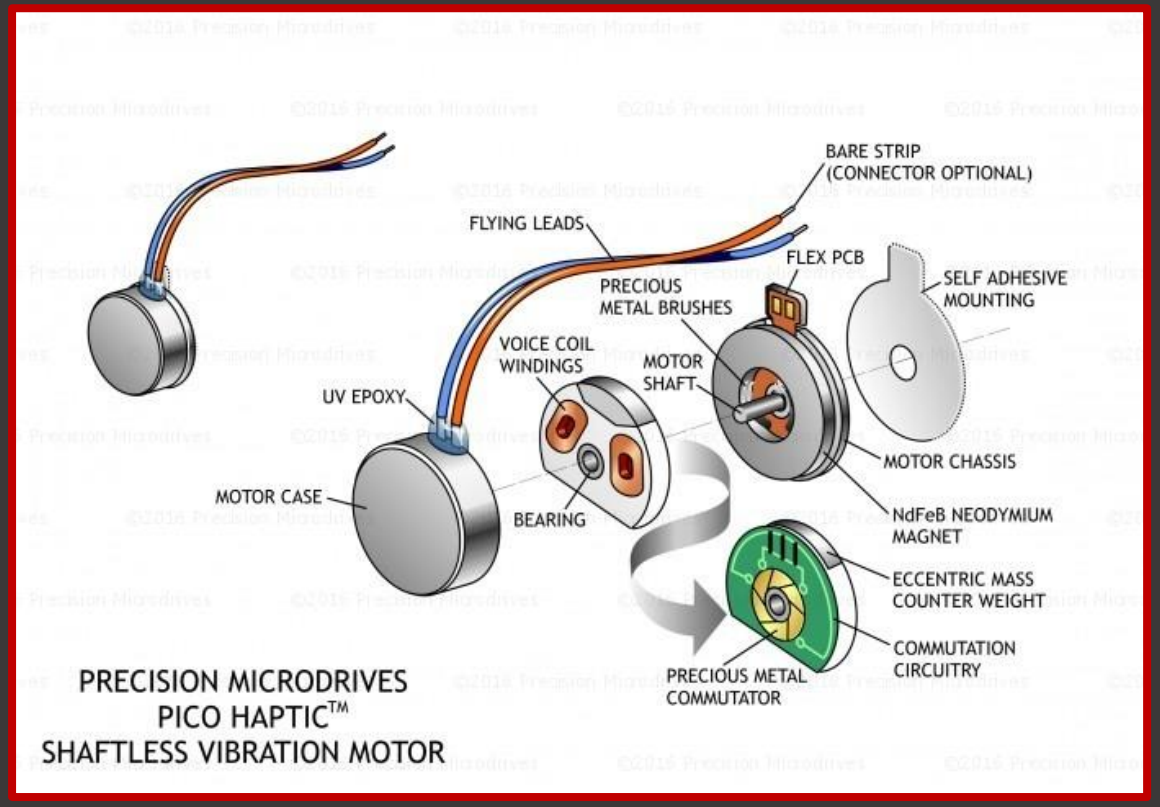
THE THUMB TOGGLE

- SPHERICAL RECESS ATTACHED TO A SERVO MOTOR
- USERS THUMB MOVED WITH A SPECIFIC ROTATION DIRECTION TO GUIDE THEM AROUND OBSTACLES
- DOES NOT ALTER STANDARD CANE GRIP
- GIVES THE USER CLEAR DIRECTIONAL INFORMATION
  - MOBILITY SPECIALIST PREFERRED THIS TO ALTERNATIVE DESIGNS



VIBRATION ERM

- ERM USED IN CONJUNCTION WITH MOTOR DRIVER TO GIVE USER A COUPLE DIFFERENT VIBRATION PATTERNS
- VIBRATIONAL PATTERNS WILL INDICATE:
  - EMERGENCY STOPS
  - OVERHEAD WARNING
  - DEVICE BEING TURNED ON AND OFF
    - THIS IN CONJUNCTION WITH A LATCHING PUSH BUTTON WILL INDICATE A DEVICE AS ON OR OFF
- PATTERNS WILL BE DIFFERENT ENOUGH THAT THEY ARE DISCERNABLE FROM EACH OTHER

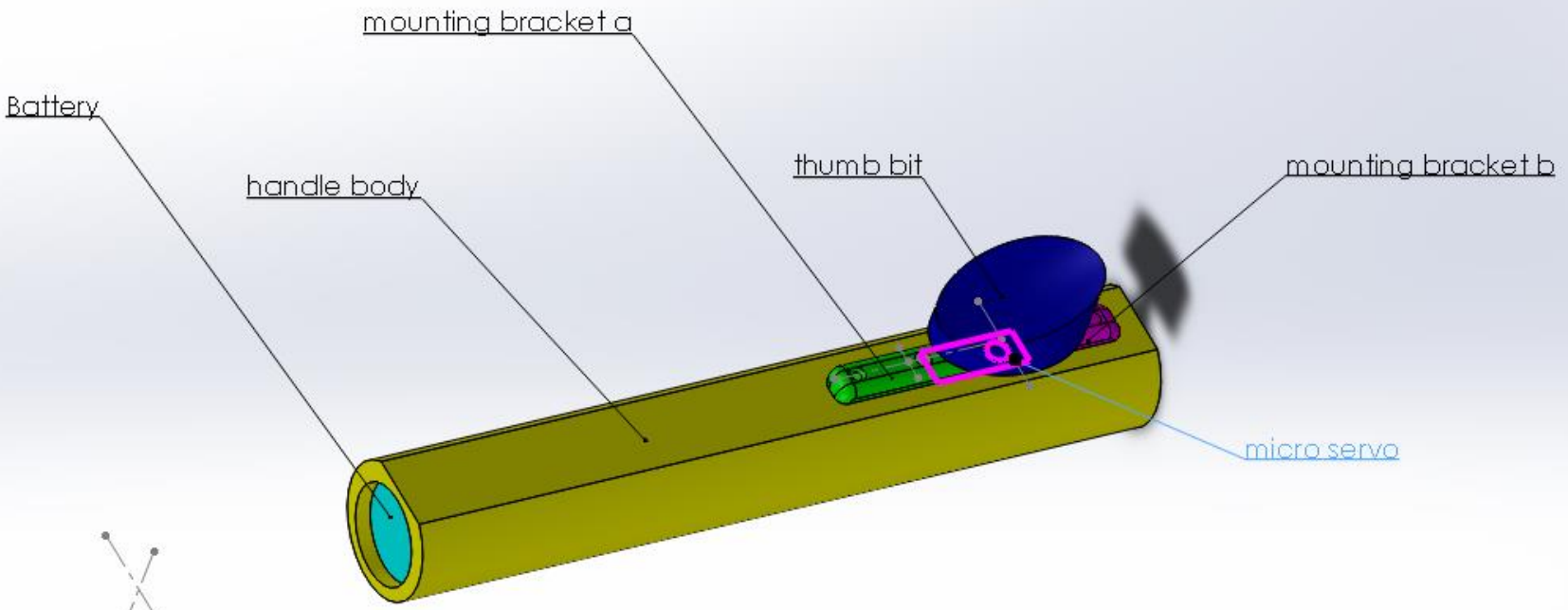


HTTPS://WWW.PRECISIONMICRODRIVES.COM/SITES/DEFAULT/FILES/STYLES/WATERMARKED_FULL_WIDTH/PUBLIC/INLINE-IMAGES/COIN-SHAFTLESS-VIBRATION-MOTOR-EXPLODED-VIEW.ORIGINAL.JPG?ITOK=PD3EG4TU

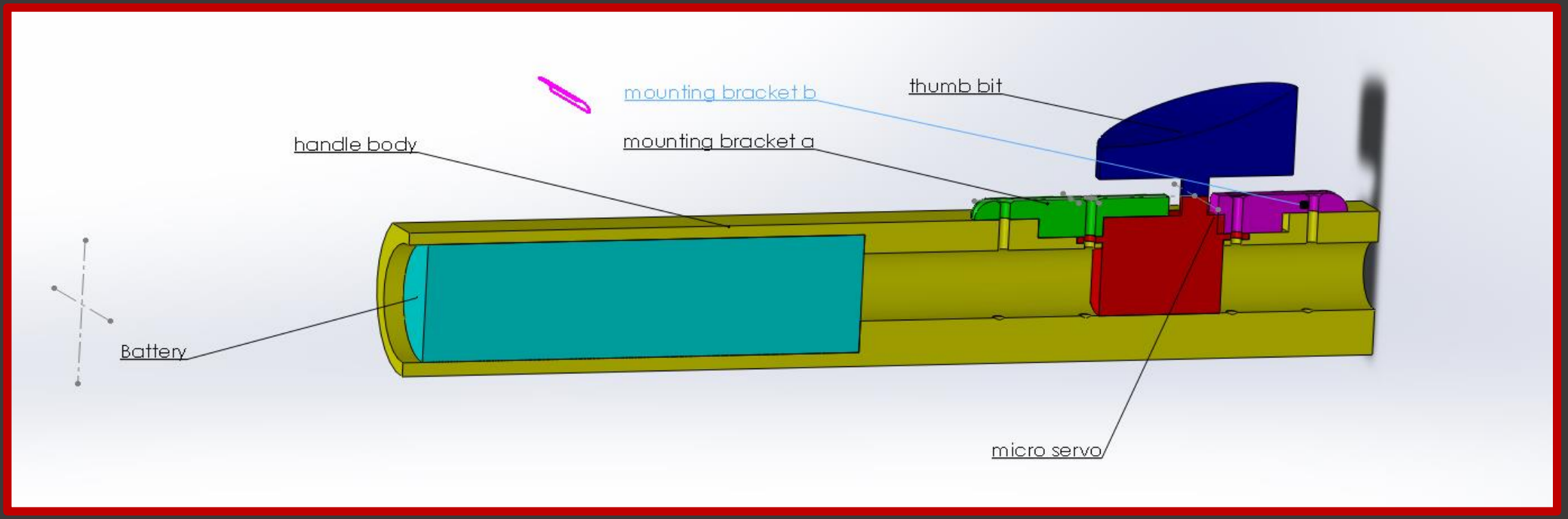
EXTRA GRAPHICS

FOR REFERENCE

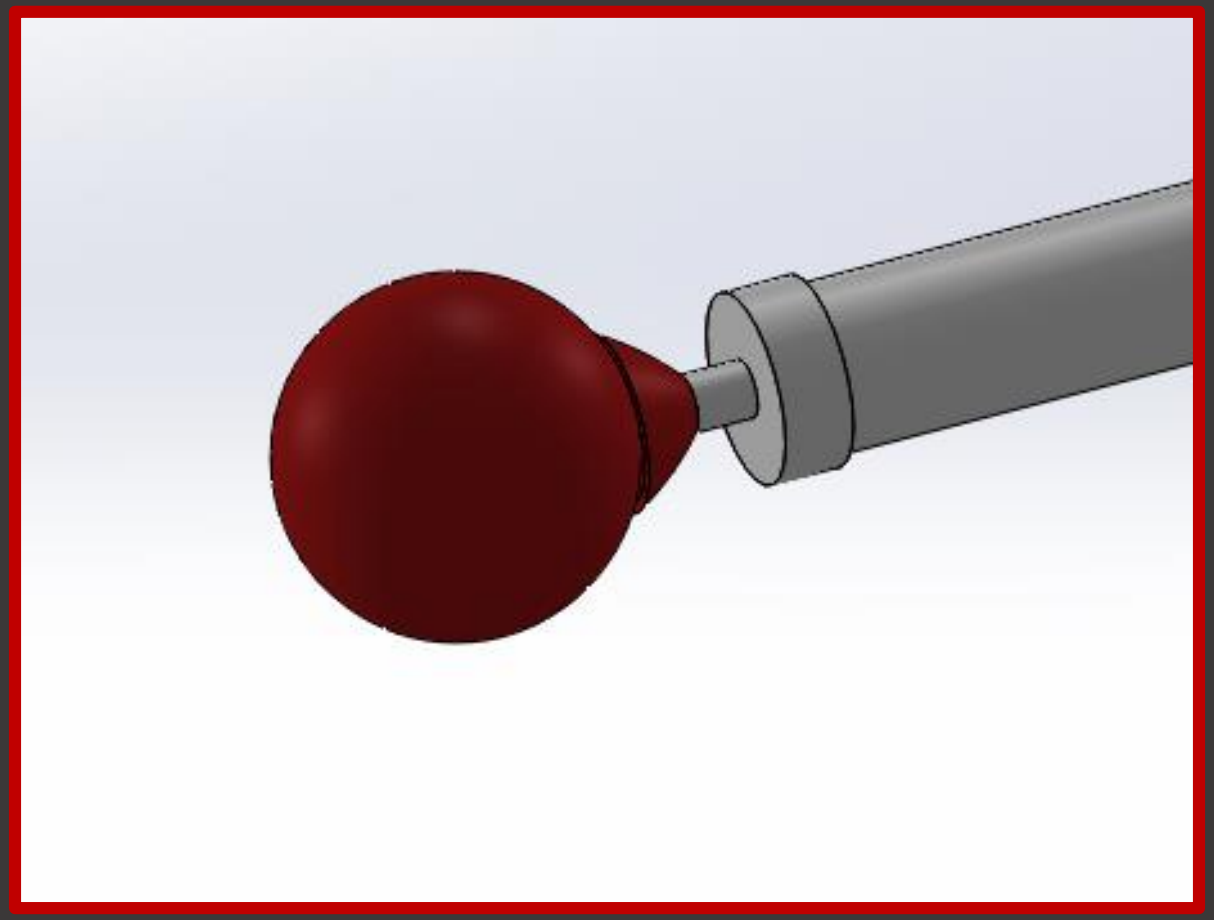
HANDLE CONCEPTUAL-MODEL



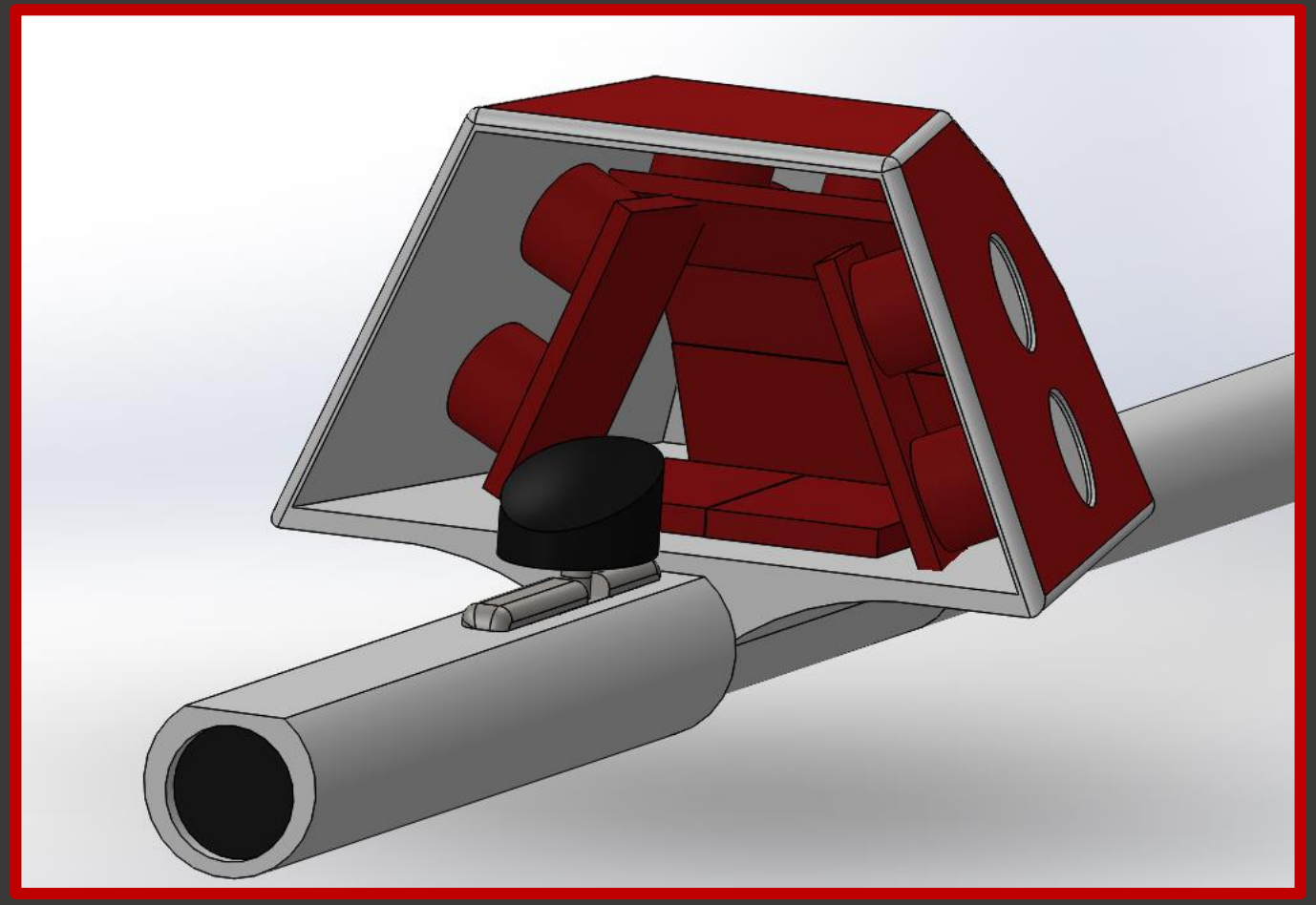
HANDLE CONCEPTUAL-MODEL



VARIOUS VIEWS OF CONCEPTUAL MODEL

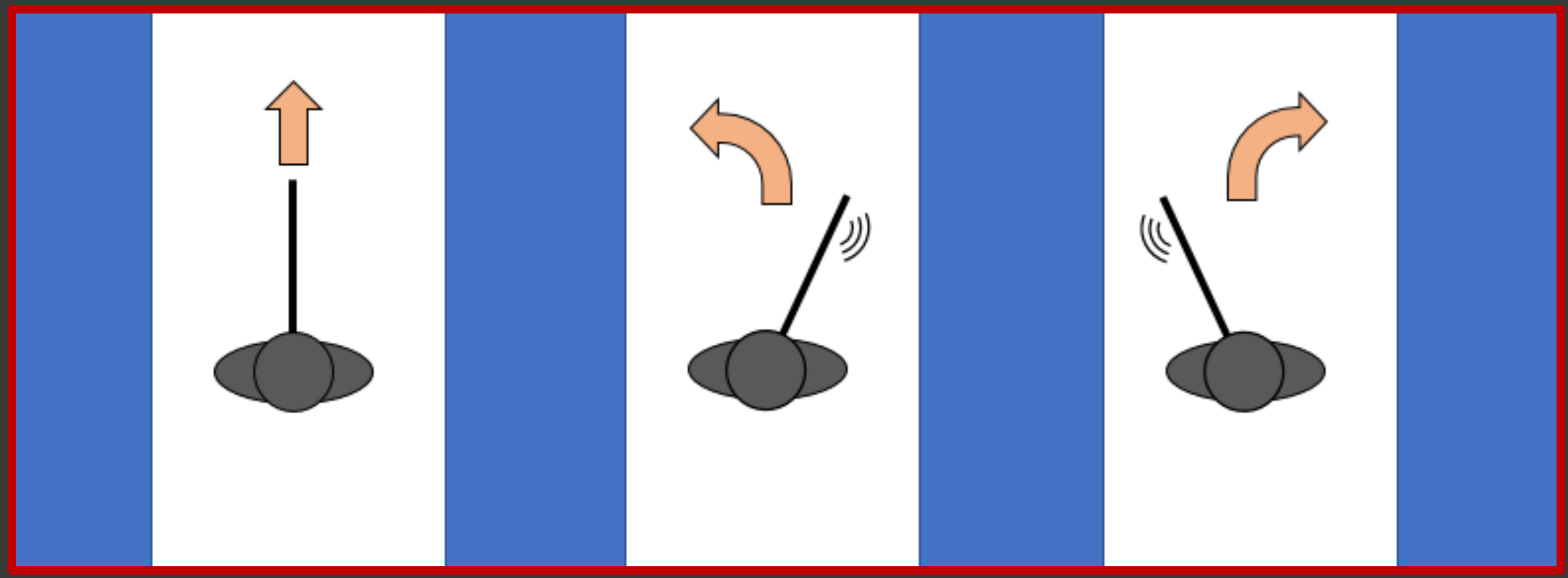


VARIOUS VIEWS OF CONCEPTUAL MODEL

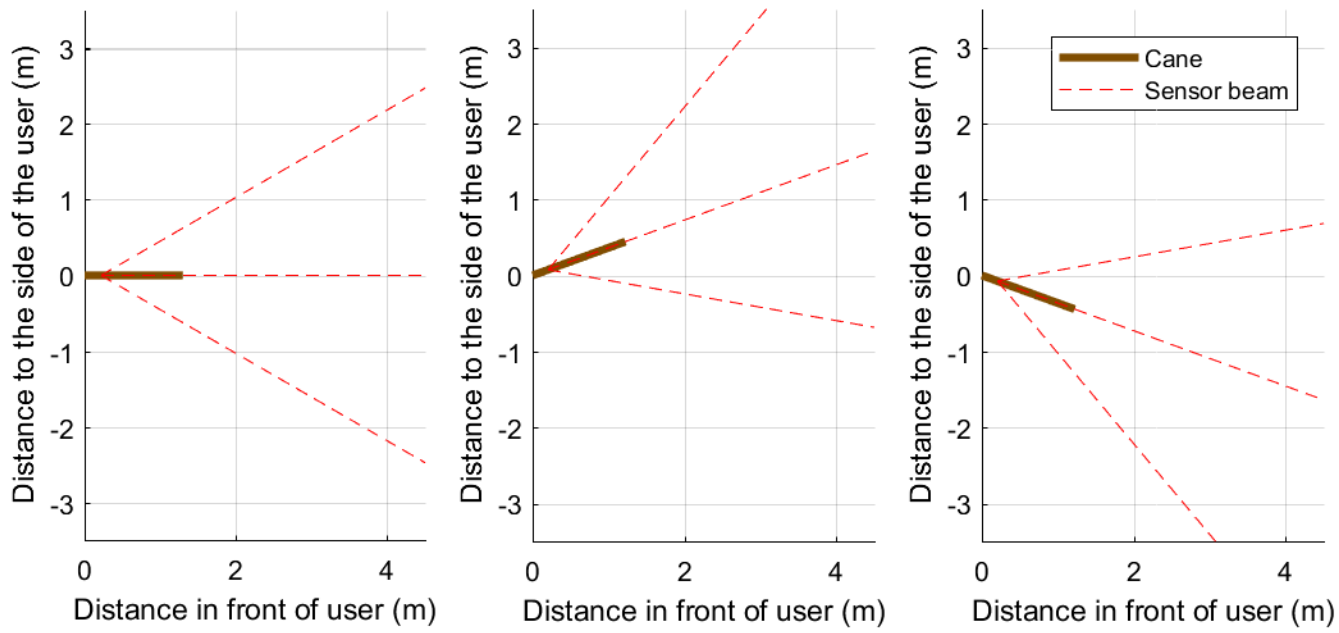


VARIOUS VIEWS OF CONCEPTUAL MODEL

NAÏVE-SENSOR ALGORITHM PROBLEM



HORIZONTAL SENSOR ANGLES WITH 15° SWEEP

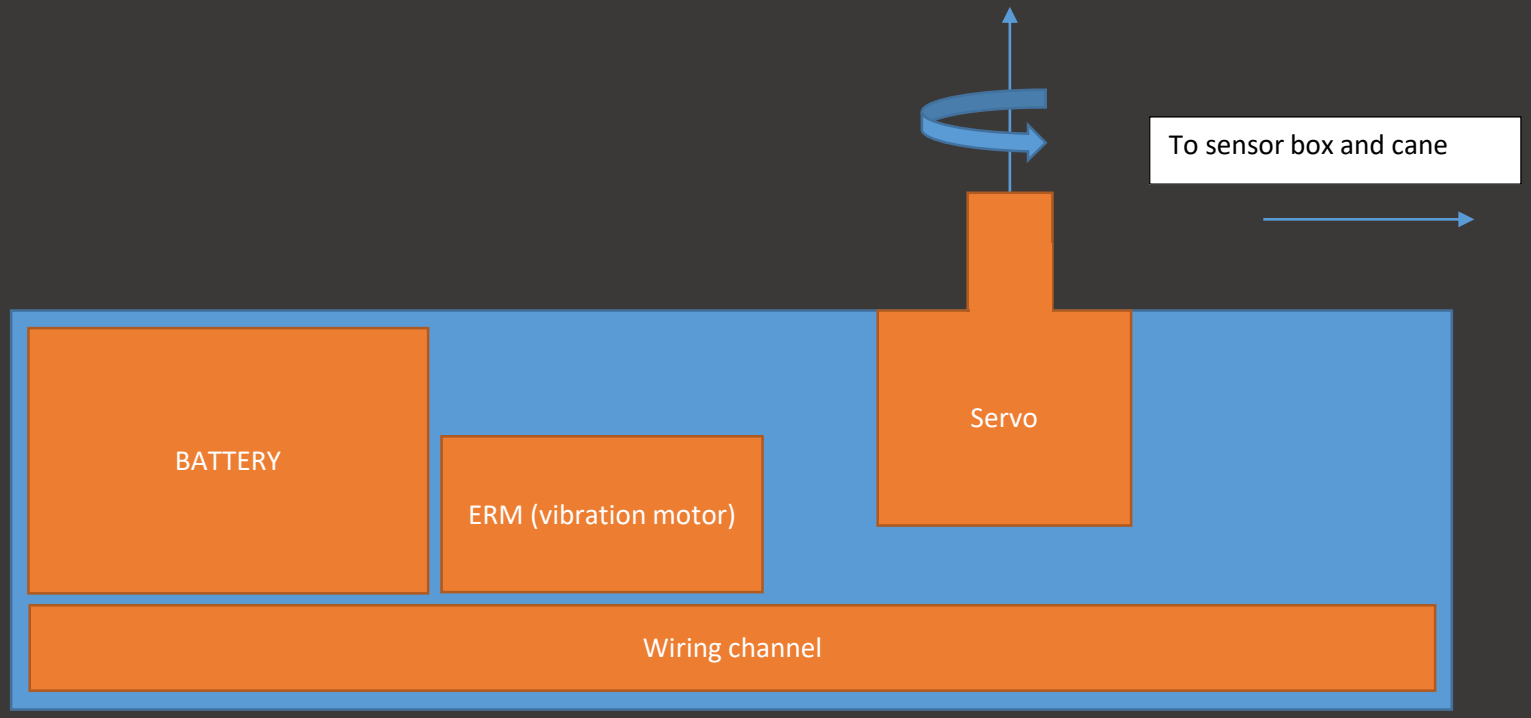


DETAILED INFO

FOR REFERENCE

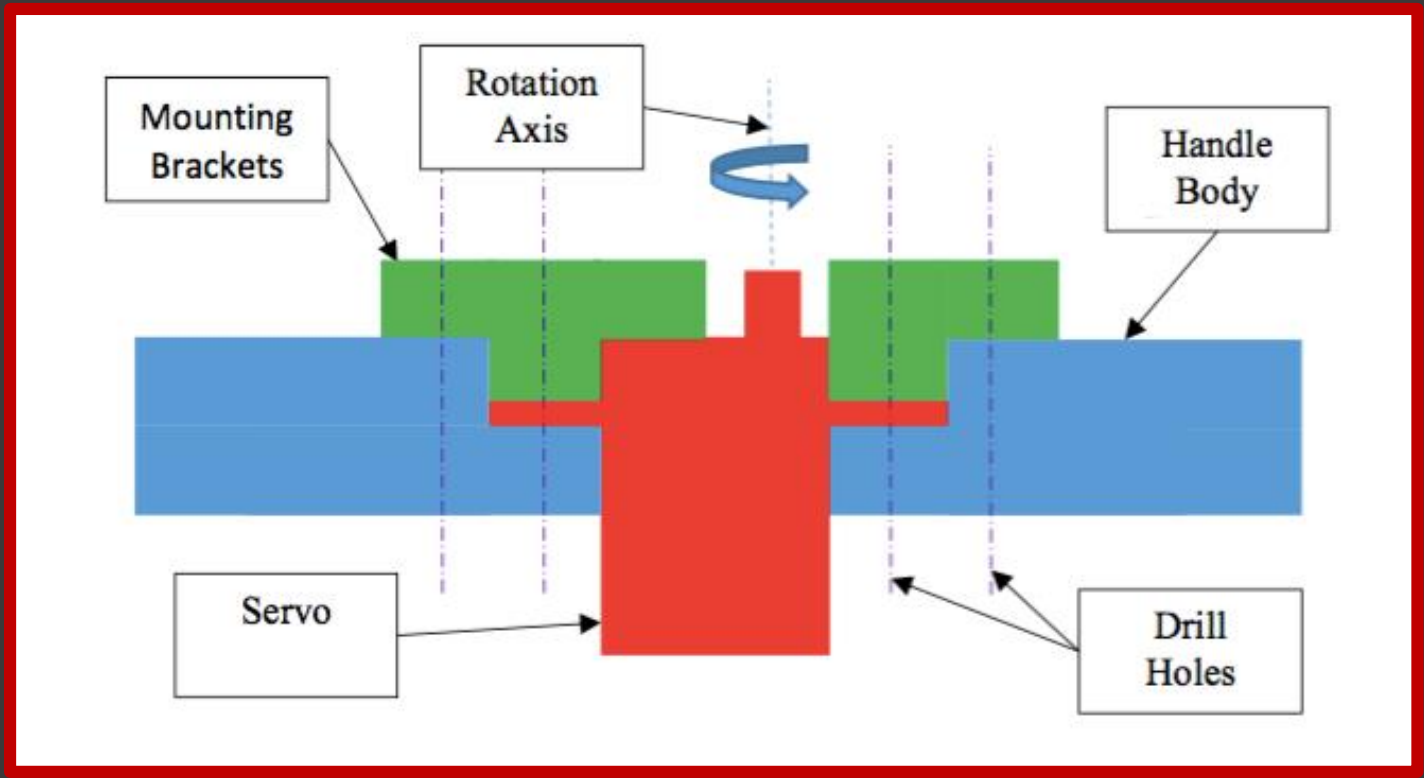
MECH INFO

HANDLE EQUIPMENT POSTIONING



- BATTERY IN HANDLE BUTT AS IT IS HEAVY AND IT MOVES THE CENTER OF GRAVITY AS FUR

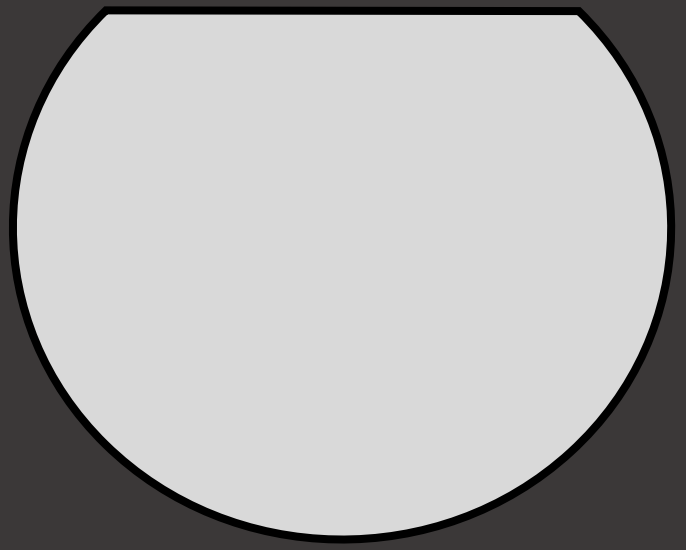
SERVO MOUNT DIAGRAM



- DESIGNED SUCH THAT THE BULK OF THE SERVO CAN BE PLACED INTERNALLY IN THE HANDLE
- THE MOUNTING BRACKETS WHEN TIGHTENED WILL ALLOW FOR A GASKET LIKE SEAL OF THE SERVO TO THE CANE SO IT IS MORE WATERPROOF

HANDLE SHAPE

- CHOSEN SUCH THAT IT MIMICS COMMON MOBILITY CANE HANDLES
- THE VISUALLY IMPAIRED ARE TAUGHT TO PLACE THEIR THUMB ON THE FLAT SIDE OF A MOBILITY CANE HANDLE
- THE FLAT SIDE IS WHERE WE PLACED OUR HAPTIC TOGGLE



HANDLE MATERIALS AND DIMENSIONS

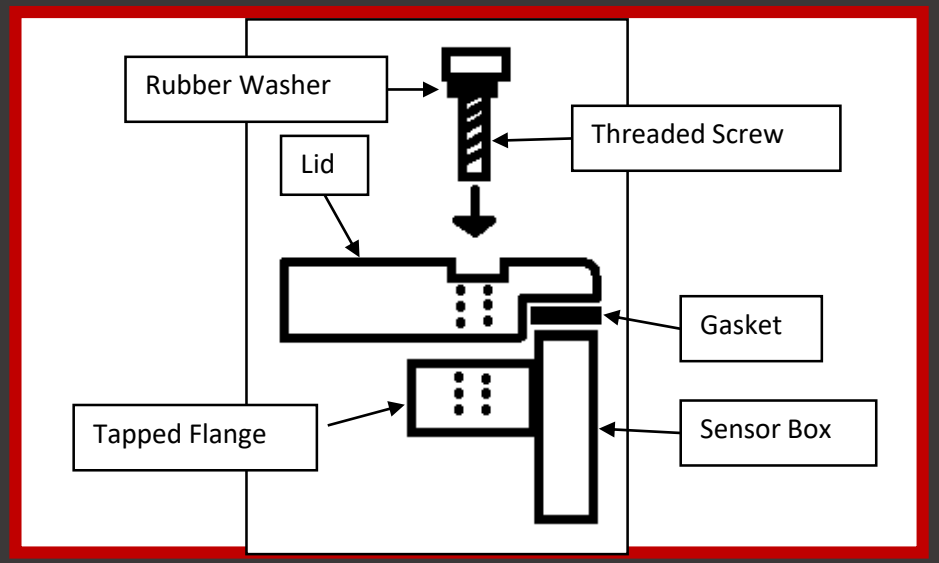
- HANDLE IS INTENDED TO BE MADE OUT OF ALUMINUM
  - NON-TOXIC AND RECYCLABLE
  - LIGHT
  - GREAT HEAT CONDUCTOR
  - SOME BETTER STRUCTURAL PROPERTIES THEN PLASTIC.
- A RUBBER SLEEVE IS EXPECTED TO GO OVER THE RAW ALUMINUM FOR COMFORT
- DIMENSIONS OF CASING
  - 15MM LONG AND 25.85 MM IN DIAMETER
  - SHOULD ACCOMMODATE MOST HAND SIZES COMFORTABLY
- TAKING INTO ACCOUNT ALL THE MATERIALS AND COMPONENTS HOUSED IN THE HANDLE IT WILL WEIGH AN ESTIMATED 168G

SENSOR CASE MATERIALS AND DIMENSIONS

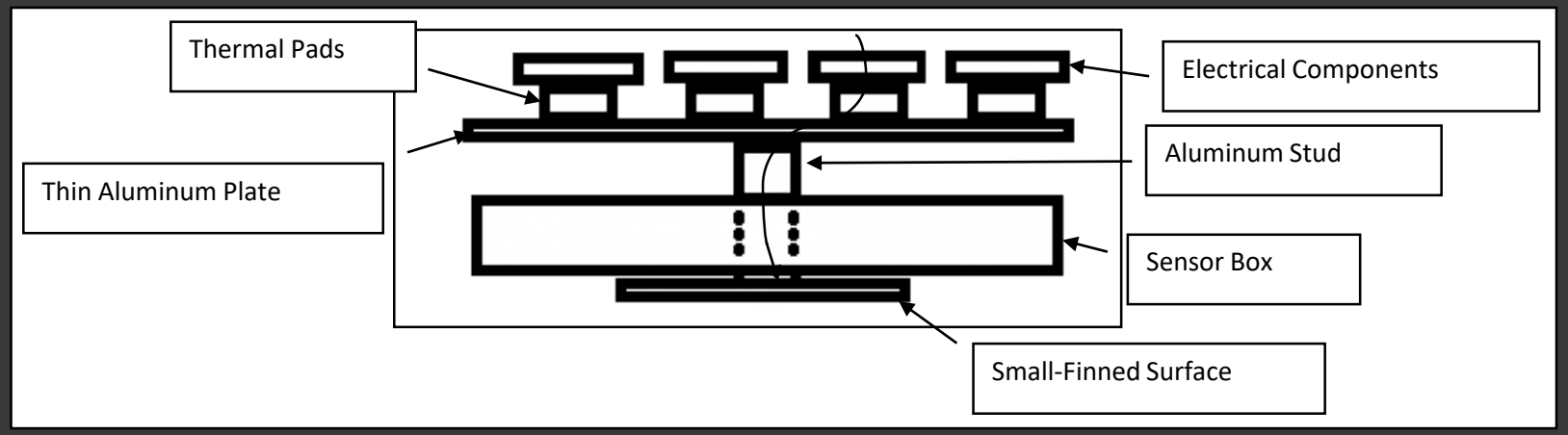
- FOR THE SENSOR CASE IT IS INTENDED THAT WE WILL USE PLA PLASTIC.
  - IT IS NON-TOXIC AND ECO-FRIENDLY
  - IT IS RECYCLABLE AND COMPOSTABLE
- FROM OUR MODEL CALCULATIONS THE VOLUME OF THE BOX STRUCTURE WAS DETERMINED TO BE 110.31CM^3
- TAKING INTO ACCOUNT ALL THE SENSORS CONTAINED AND THE WEIGHT OF THE BOX ITSELF WE CALCULATED A WEIGHT OF 138G FOR THE SENSOR BOX

SENSOR BOX WATERPROOFING

- VERY IMPORTANT TO CONSIDER AS THIS WILL BE USED OUTSIDE AND EXPOSED TO ELEMENTS
- A FORMFITTING LID TO THE BOX WILL BE SCREWED TIGHT WITH A RUBBER GASKET PLACED BETWEEN THE LID AND THE BOX
- ALL SCREWS INTO THE BOX WILL HAVE A RUBBER WASHER



SENSOR BOX THERMAL DISSIPATION



- PLA IS A POOR HEAT CONDUCTOR.
- A THIN ALUMINUM PLATE WILL BE CONNECTED VIA THERMAL PADS.
  - THIS WILL IN TURN BE CONNECTED TO A ALUMINUM SURFACE ON THE OUTSIDE OF THE BOX VIA A ALUMINUM CHANNEL.
  - WE EXPECT THIS WILL HELP MANAGE THE INTERNAL HEAT OF THE SENSOR BOX.

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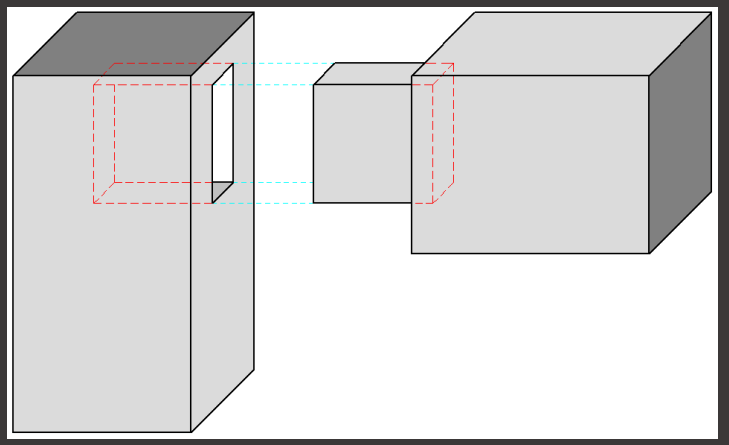
CANE-SHAFT DESIGN

- TO BE ¾ INCH ALUMINUM TUBING
  - THE THICKNESS WILL BE 1/16 INCH
  - THIS TUBING SIZE IS COMMON WITH STANDARD MOBILITY CANES
  - THE ALUMINUM IS LIGHT, AND RELATIVELY CHEAP COMPARED TO OTHER LIGHT MATERIALS ON THE MARKET WITH SIMILAR STRUCTURAL PROPERTIES.
- THE SHAFT HAVE INTEGRABILITY WITH CUSTOM CANE TIPS
  - A COMMON FEATURE OF MOBILITY CANES
- THE SHAFT WILL BE SOLID AND NON-COLLAPSIBLE FOR THE PROTOTYPE
  - TO SIMPLIFY THE DESIGN
- THE LENGTH WILL BE ABOUT 1.2 METERS FOR THE PROTOTYPE
  - THE FINAL PRODUCT WILL HAVE TO OFFER DIFFERENT SIZES TO ACCOMMODATE DIFFERENT PEOPLE SIZES
- THE ESTIMATED WEIGHT IS CALCULATED TO BE 282G

OVERALL SYSTEM

- 50G ASSUMED FOR MISC WEIGHT(WIRING, ECT..), TALLYING THE OTHER COMPONENT WEIGHTS WE ARE ESTIMATING THE ENTIRE ASSEMBLY TO WEIGH 688G.
- THE HANDLE WILL CONNECT TO THE CANE AND SENSOR BOX USING A MORTISE STYLE JOINT.
- A CUSTOM MOUNT WILL BE MADE TO CONNECT THE SENSOR BOX TO THE CANE SHAFT.

Mortise joint



By GreyCat - self-made SVG, loosely based on idea of work Image:Mortise_and_Tenon.png by Luigi Zanasi, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2118241

PROXIMITY SENSING INFO

SENSORS

- SENSOR 1 – ANGLED UPWARDS TO DETECT LOW OVERHANDS THAT THE USER IS IN DANGER OF HITTING THEIR HEAD ON
- SENSOR 2 – ANGLED DOWNWARDS TO DETECT OBJECTS BELOW WAIST LEVEL
- SENSOR 3 – ORIENTED STRAIGHT AHEAD OF THE USER TO DETECT ONCOMING WALLS AND OBSTACLES FROM A DISTANCE
- SENSOR 4 AND 5 – POINTED TO THE LEFT AND RIGHT TO DETECT LATERAL WALLS AND OBJECTS

SENSOR ANGLES

- MOBILITY CANES ARE APPROX. THE SAME HEIGHT AS THE USERS ARMPIT WHEN STOOD ON END
- HELD WITH THE HANDLE OF THE CANE ROUGHLY AT HALF THAT HEIGHT, NEAR THE WAIST OF THE USER.
- THIS RESULTS IN AN ESTIMATED 30° ANGLE OF THE CANE WITH RESPECT TO THE GROUND, AND A REACH OF ROUGHLY 1.25M
- OUR TOP SENSOR WILL BE MOUNTED AT AN ANGLE OF 60° WITH RESPECT TO THE CANE, GIVING AN ESTIMATED ANGLE OF 30° ABOVE THE HORIZONTAL AT REST
- OUR LOWER SENSOR WILL BE MOUNTED AT AN ANGLE OF 18° WITH RESPECT TO THE CANE, GIVING AN ESTIMATED ANGLE OF 12O BELOW THE HORIZONTAL AT REST
- THE THIRD SENSOR WILL BE MOUNTED AT AN ANGLE OF 32° WITH RESPECT TO THE CANE, GIVING A SLIGHT ANGLE OF 2° ABOVE THE HORIZONTAL AT REST

OBSTACLE DETECTION ALGORITHM

- DATA WILL BE CONTINUOUSLY COLLECTED AND FEEDBACK WILL BE CONTINUOUSLY UPDATED
- FOR EVERY MEASUREMENT TICK, EACH SENSOR RETURNS A DISTANCE
- USING THE IMU AND SENSOR DATA A POINT CLOUD WILL BE CREATED
- POINTS WILL BE PROCESSED TO FIND FACES AND OBJECTS
- FEEDBACK WILL BE RETURNED TO THE USER VIA HAPTIC FEEDBACK MODULE

HAPTIC INFO

HAPTIC DESIGN

- OUR DESIGN GOALS WERE TO CREATE VERY SIMPLE AND EASY TO UNDERSTAND SIGNALS THAT WILL MINIMIZE THE TIME BEFORE A NEW USER CAN EFFECTIVELY USE THE NAVCANE
- MADE SURE THAT WE GAVE THE USER ENOUGH INFORMATION SO THAT THEY WERE SAFE, BUT WERE NOT BOMBARDED WITH TOO MUCH INFORMATION
- COMFORTABLE TO USE FOR EXTENDED PERIODS OF TIME

THE 'THUMB TOGGLE'

- SPHERICAL RECESS ATTACHED TO A SERVO MOTOR SO WE CAN MOVE THE USERS THUMB WITH A SPECIFIC ROTATION TO GUIDE THEM AROUND OBSTACLES
- DOESN'T ALTER STANDARD CANE GRIP
- WELL DEFINED FEEDBACK WITH FEW AMBIGUITIES
- VIBRATING MOTORS WITH DIFFERENT PATTERNS TO WARN USERS OF IMMEDIATE OBSTACLES, OVERHANGS AND LOW BATTERY

UI INFO