MaFaRo QuickStart Guide

Contents

Robot Head Assembly

* Exploded view does not include fasteners

Tools

1. Hot Glue Gun (HMA, Hot Melt Adhesive)
2. Small adjustable spanner
3. 4 x M3 Hex Screws
4. 1 x UNC 20 screw
5. 2 x M5 screws
6. 2 x M5 Hex bolts
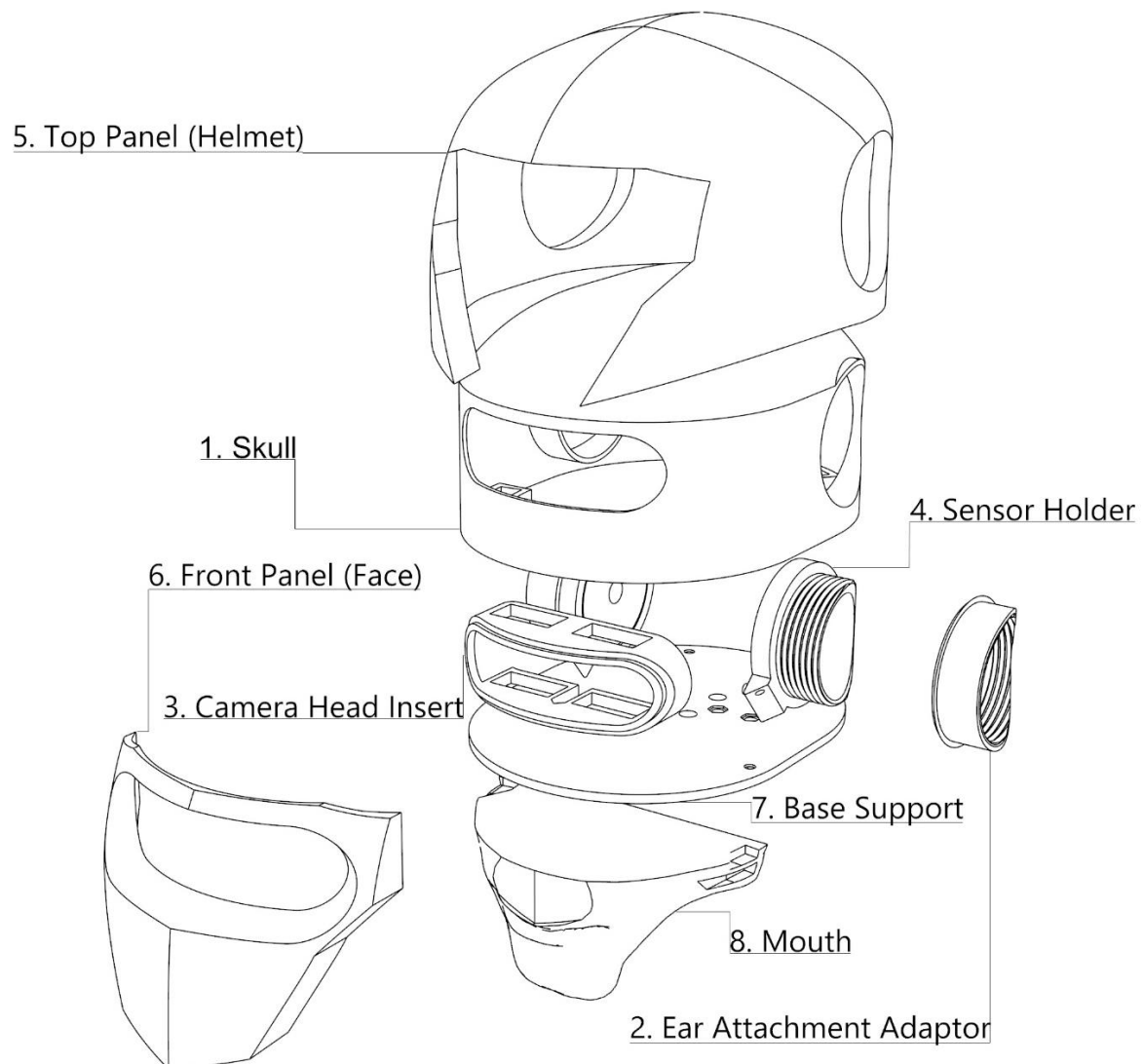7. 8 x Neodymium Magnets

Layout of the Robot Head

5. Top Panel (Helmet)

1. Skull

4. Sensor Holder

6. Front Panel (Face)

3. Camera Head Insert

7. Base Support

8. Mouth

2. Ear Attachment Adaptor

Figure 1. Exploded view of "MaFaRo" robot head.

Assembly of the Robot Head

*Roughen all interfacing components that require hot glue with sand paper.

*Ensure all 3D printed, threaded components match their side, failure to do so and tightening will result in cross-threading. Parts may get stuck and/or break.

Combine audio parts as top of (1.) Skull sub-assembly

1. Squeeze hot glue on the (2.) Ear Attachment Adaptor lip.
2. Match curvature from the inside and push (2.) Ear Attachment Adaptor into (1.) Skull.
3. Repeat steps 1 and 2 for the opposite side.
4. Optional. Use in case you want stereo audio
   a. Use adjustable wrench to self-thread ensure left and right
   b. Screw audio sensors into (4.) Sensor Holder standoffs using M3 screws.
   c. Repeat steps 4a for opposite side.
5. Screw (4.) Sensor Holders into (2.) Ear Attachment Adaptor.
6. Repeat step 5 for opposite side.
7. Squeeze hot glue on the (3.) Camera Head Insert lip.
8. Ensure the camera bolt retention slot on (3.) Camera Head Insert is facing the bottom of the (1.) Skull.
9. Push from the inside (3.) Camera Head Insert through (1.) Skull.
10. Squeeze hot glue on the edges of (6.) Front Panel Face.
11. Push (6.) Front Panel Face into (5.) Top Panel (Helmet) from the inside.
12. Slide (6.) Front Panel Face and (5.) Top Panel Helmet onto the Skull
13. Place and orient 1 magnet into the holder of (1.) Skull
14. Squeeze hot glue onto the magnet and wait for glue to set
15. Repeat steps 13 and 14 for all magnets

Prepare (7.) Base Support sub-assembly

16. Ensure 4 neodymium magnets are correctly placed and oriented in the bottom recesses of (7.) Base Support.
17. Squeeze hot glue on top of the magnets and (7.) Base Support, ensuring glue has cooled sufficiently to hold them in place
18. Place 2 x M5 nuts on top of the (7.) Base Support
19. Screw 2 x M5 bolts through the nuts.
20. Squeeze hot glue around the nuts, carefully as to not get it on the threads.
21. Remove the bolts when glue has set.

Combine (1.) Skull and (7.) Base Support sub-assemblies and mouth

22. Place and orient neodymium magnets in the bottom recesses of the (8.) Mouth.
23. Squeeze hot glue onto the magnets part of (8.) Mouth
24. Clean excess glue from (7.) Base Support.
25. Attach the bottom of the mouth to the (7.) Base Support

Disassembly notes

1. Use a hex key or any other thin and dull rod to push magnets that need to be removed from the skull. Poke them towards the top of the skull through the small holes of their holders.
2. A chisel is useful so as not to rip and tear your hands while removing glue
3. Be careful if using sharp objects to remove the hot glue, chip away only in direction opposite to your body.
4. Overtighten the Sensor Holders to dislodge the ear attachment adaptors

CAD Model

*Ensure dimensions make sense, if the Eye Centrepoint Height is placed above the cranial suture the model will likely fail to rebuild.

*Administering changes will take a long time as the majority of FreeCAD is written in python and is almost exclusively single threaded. A high frequency, low core count CPU would be best for recalculating changes.

*Due to the short deadlines of the project for the competition, many features will be implemented later.

*"Search contents" inside the spreadsheet part of the model. Search bar is found at the top of the spreadsheet

Parameters of Interest to HRI Researchers

As per "All Robots are Not Created Equal" (DiSalvo, et al., 2002). The following parameters are identified as important and can be altered similarly on the skull:
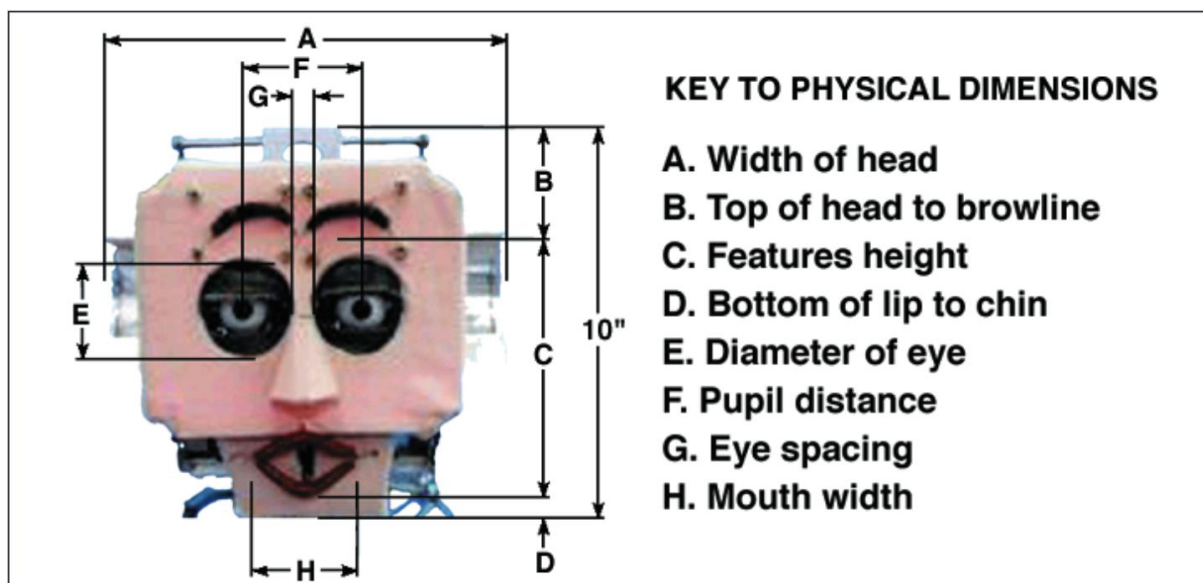

Figure 2. List and Diagram of parameters for use in Human Robo Interaction (DiSalvo, et al., 2002).

As per "Designing Robot Faces Suited to Specific Tasks that these Robots are Good at"(Komatsu & Kamide, 2017) The following Dimensions are identified as:
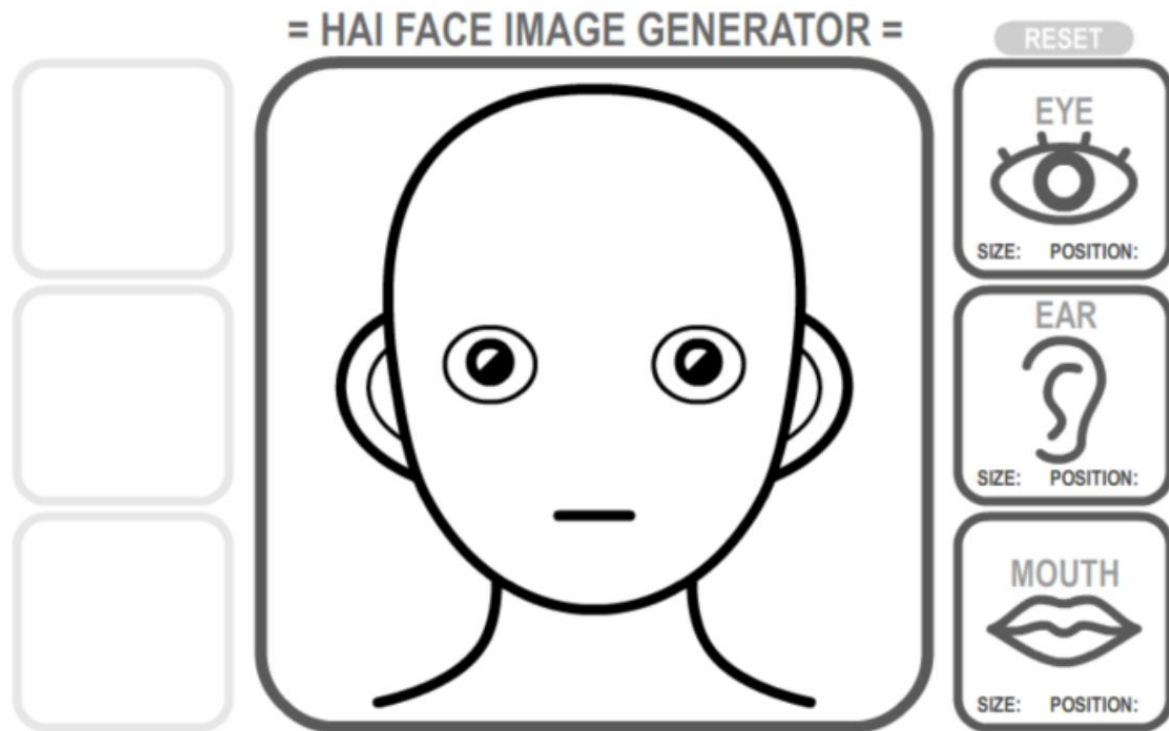

Figure 3. Diagram of 2D face geometry generator.

Location on Parametric Skull

You can find the corresponding to these two articles dimensions on the model through the following paths.

1. Width of head
   a. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x → Body_Robot_Head_2 → Sketch001_Top_View → **Head_Width**

Figure 4. Head_Width is at the top of the screenshot.

2. Top of head to brow line
    a. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
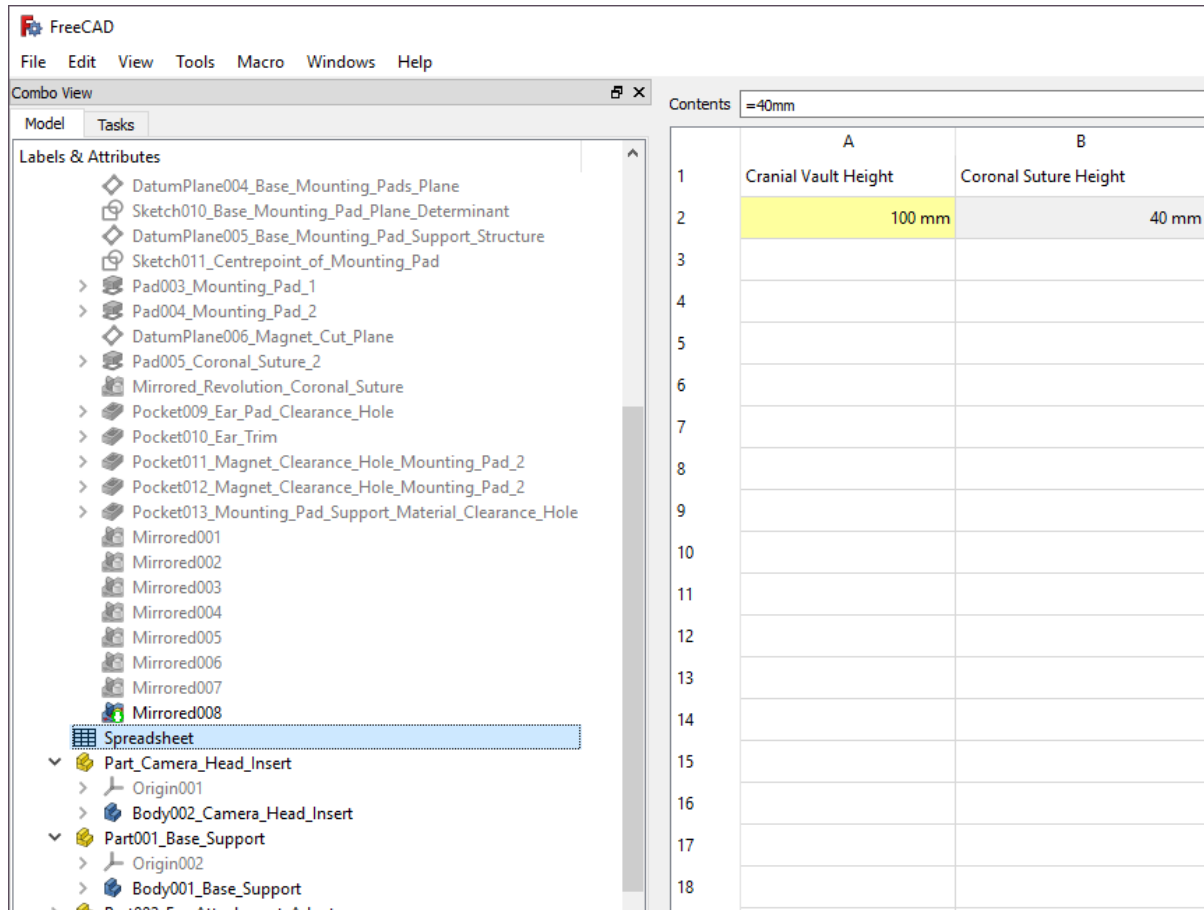   Body_Robot_Head_2 → Spreadsheet→ **Coronal Suture Height**

Figure 5.Coronal Suture Height refers to the top part of the human skull.

3. Features height
    a. A composite dimension that is not yet integrated into the design.
4. Bottom of lip to chin
    a. Not yet implemented parametric dimension.

5. Diameter of eye
   a. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
      Body_Robot_Head_2 → Sketch003_Front_View →
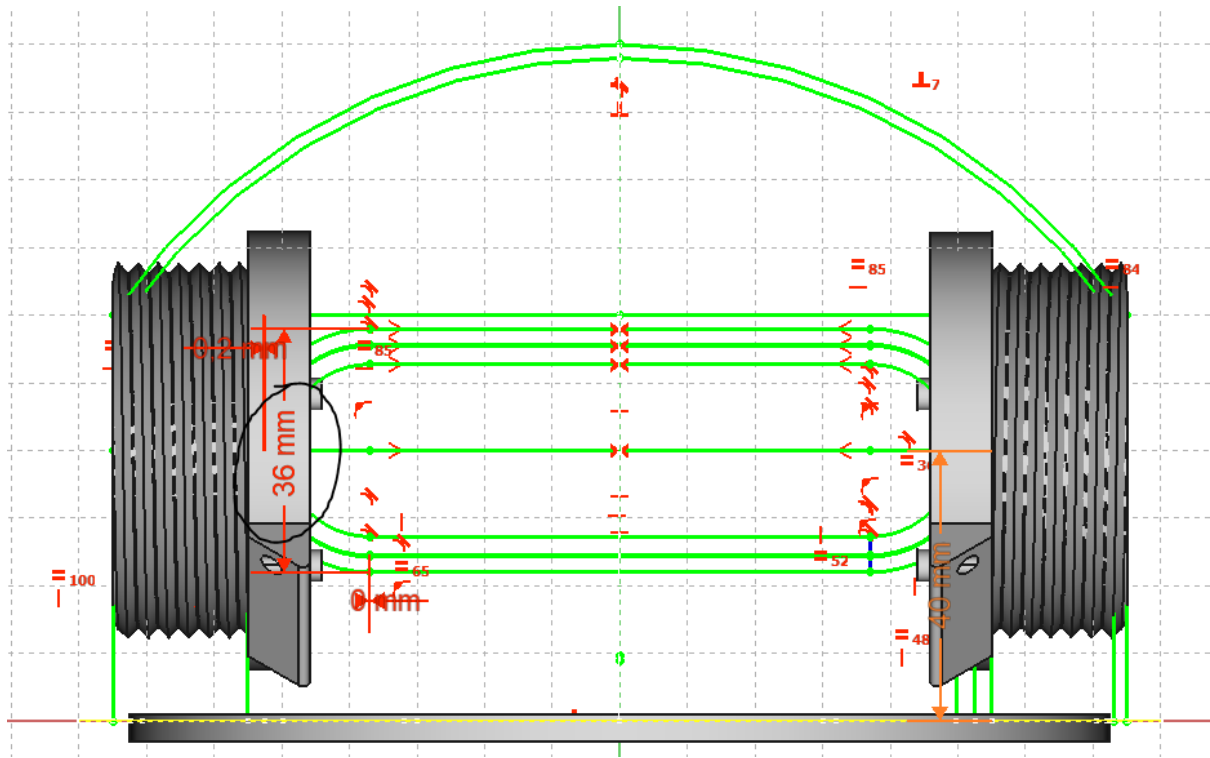   **Camera_Head_Insert_Mounting_Lip_Height**

Figure 6. Camera Head Insert Mounting Lip Height refers to the vertical distance of the mounting lip, not to its distance from the origin.

6. Pupil distance
   a. Calculate the following way:
      i. Outer_Camera_Mount_Lip_Width –
         Camera_Head_Insert_Mounting_Lip_Height = Pupil Distance
   b. The dimensions can be found using the following paths
      i. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
         Body_Robot_Head_2 → Sketch001_Top_View →
         Outer_Camera_Mount_Lip_Width
      ii. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
          Body_Robot_Head_2 → Sketch003_Front_View →
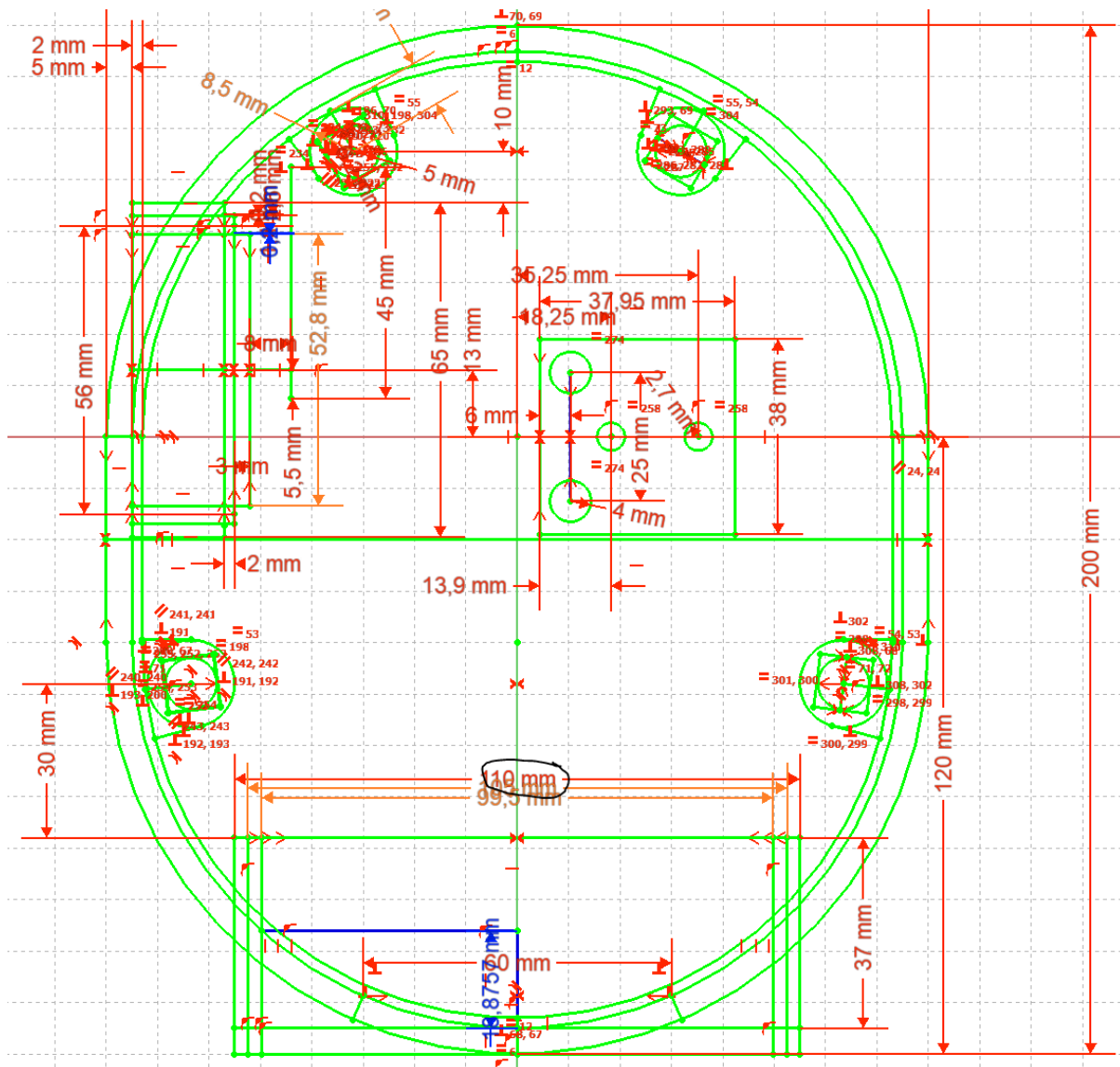   **Camera_Head_Insert_Mounting_Lip_Height**

Figure 7. Outer Camera Mount Lip Width, for mounting lip heigh refer to previous figure.

7. Eye spacing
    a. Not implemented yet, depends on camera module or eye modules
8. Mouth width
    a. Not implemented in FreeCAD yet

9. Ear Size and position
   a. Outermost radius of ear assembly
      i. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
         Body_Robot_Head_2 → Sketch001_Top_View →
         Head_Ear_Hole_Outer_Boss_Diameter
   b. Ear distance from forward rotating centre of base
      i. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
         Body_Robot_Head_2 → Sketch001_Top_View →
         Distance_from_Origin_for_Ear_Centrepoint
   c. Ear centrepoint height
      i. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x →
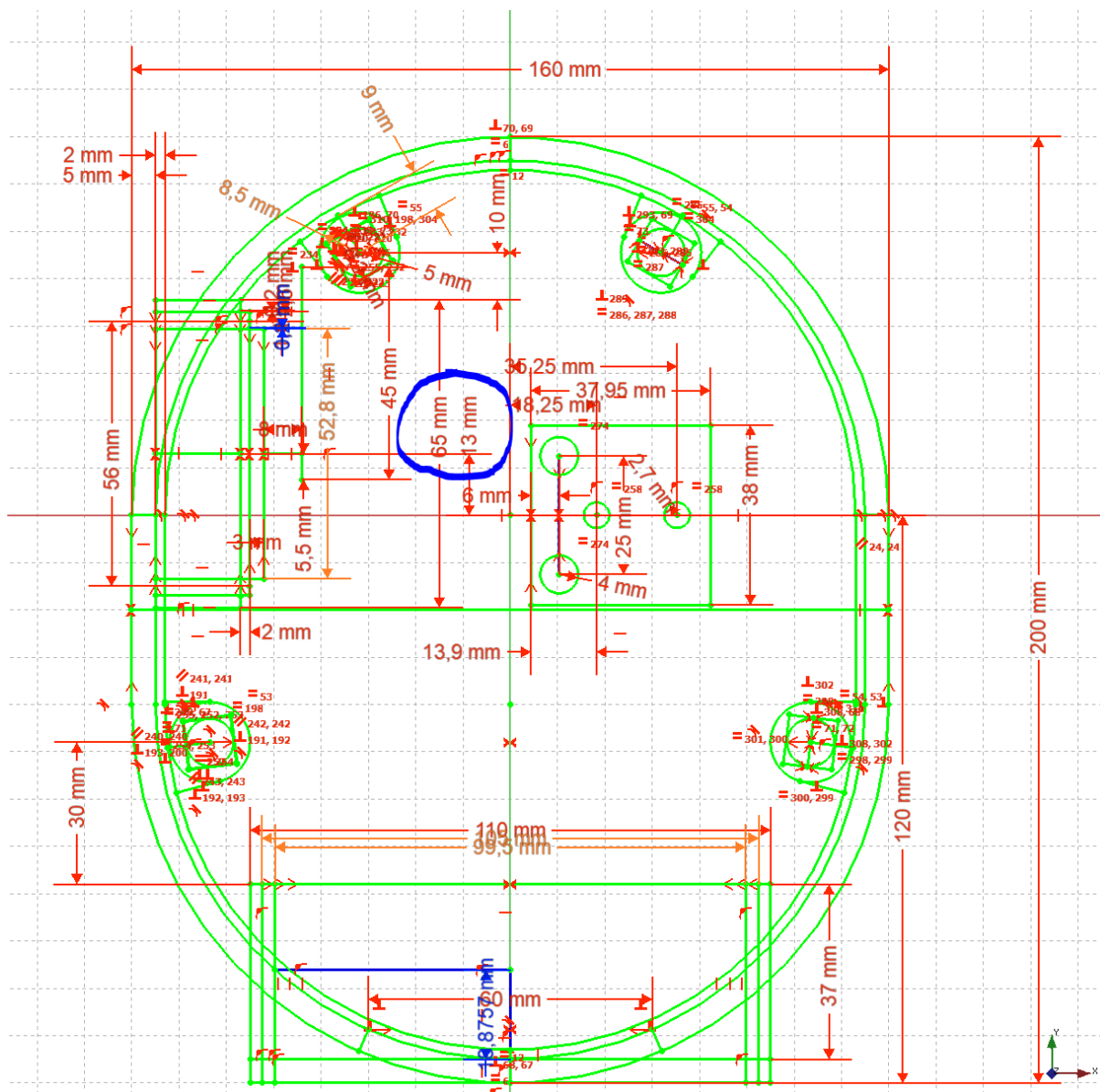   Body_Robot_Head_2 → Spreadsheet→ **Ear_Centrepoint_Height**

Figure 8. Distance from origin for ear centrepoint. Defines how close to the pivot point and which side the ear hole is on along the Y axes

Other Useful Dimensions

1. To adjust how deep the mounting point of the skull is inside the head use the following dimensions from the spreadsheet
   a. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x → Body_Robot_Head_2 → Spreadsheet→…
      i. Magnet Depth
      ii. Magnet_Pad_Depth
      iii. Total Magnet Distance Between Head and Support Base
      iv. Mounting Pad Depth Inside Head
      v. Base Plate Thickness
      vi. Nut Recess Thickness (Base Plate)
2. To avoid magnets interfering with audio drivers
   a. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x → Body_Robot_Head_2 → Sketch001_Top_View → Mounting_Point_Distance_From_Rear_of_Camera
   b. Open CAD File → Combo View → Labels &Attributes → Robot_Head_x → Body_Robot_Head_2 → Sketch001_Top_View → Mounting_Point_Distance_From_Rear_of_Audio_Cavity
3.

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Bibliography

DiSalvo, C., Gemperle, F., Forlizzi, J. & Kiesler, S., 2002. *All Robots Are Not Created Equal:.* London, ACM.

Komatsu, T. & Kamide, M., 2017. *Designing robot faces.* Lisbon, s.n.