ROFI – Next Generation Head – DAREL

by Mike Pluma

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Objectives For New Design

The ROFI model is the fifth robot prototype design by Jonathan Dowdall on ProjectBiped.com. It is primarily statically balanced. Static balance means that the robot's servo movements are pre-programmed and as such pre-balanced. Jonathan describes ROFI as semi-dynamically balanced because it also uses accelerometer feedback from the on board Android tablet to balance itself. Our goal with DAREL is to incorporate a more advanced Android device with more on board sensors. These additional sensors will be used to generate more positional feedback which can be used for more dynamic balance. The following is a breakdown of design objectives.

- Main objective: move toward Dynamic Balance
  - Raise center of gravity by moving the batteries out of the feet
  - Re-design the foot
    - To address lack of battery
    - Narrower foot-print
    - "Organic Curves"
- Secondary Objective: Incorporate internal phone sensors
  - Re-design "Body"
    - Re-orient phone to take advantage of back camera
    - Devise mount system to adapt to size of available phone (upgrade capable)
    - Make room for Batteries, Gyro, Ultrasonic/IR sensor
    - "Organic Curves"

Execution of Objectives

The ROFI model has the batteries in the feet. The batteries are somewhat heavy and having them in the feet gives inherent stability to the robot. Dynamic balance is not about inherent stability, so to add some instability we raise the center of gravity by incorporating the batteries into the body. Moving the Batteries means that we can redesign the foot aesthetically and address some structural issues at the same time.

The objective of using a more advanced Android device for its internal sensors brings a few issues. These more advanced devices are typically bigger than the tablet suggested in the ROFI design. To address this the DAREL head uses an adjustable bracket. It is adjustable because it is difficult to foresee the exact dimensions of the device that will suit the needs and the budget of the DAREL project. The phone brackets have rubber non-slip pads inside to secure the device as the robot will likely sway (if not fully fall over) during the development process as well as during normal walking.

Details for each of the new body parts and its assembly are described later in this document.

Parts List:

- Uniform Foot
- Body Riser
- Body Base
- Phone Bracket Left
- Phone Bracket Right
- Body Shell Sides
- Body Shell Top
- Body Shell Dome

Illustration 1: Exploded view of the DAREL Body

Illustration 2: DAREL Foot

The same **foot model** is used for both the left and right foot. The foot is the same height as the ROFI foot but uses the "hollow" design element from the FOBO foot. The bearing hole has a thicker wall around it and a raised surround. This is because in the previous versions of the feet, the wall surrounding the bearing hole would snap during bearing insertion. The wall around the servo horn socket is also thicker. This is because in previous designs the servo horn put strain on the socket and over-stressed the foot. The foot is as long as the ROFI foot and as narrow.

Illustration 3: DAREL Body Riser

The new **body riser** has a broader platform to mate with the new Body Base. They connect using more holes than the previous design. The new design still fits the old leg and hip parts from ROFI.

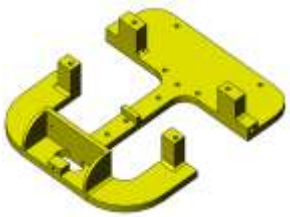


Illustration 4: DAREL Body Riser

The **Body Base** attaches to the next gen body riser. The Batteries sit freely in the head underneath the ardunio and behind the Midrange IR Sensor. The leads from the batteries run through the large access holes in the Body Base. The Arduino mounts to posts built into Body Base. The USB shield plugs into the arduino and is not mounted to the body directly. The Midrange IR Sensor mounts into the slot at the front of the Body Base. The gyro was not available at time of design, but could possibly be mounted onto a spare screw hole on the Body Riser.

The **phone brackets** attach at the back of the Body Base. The screws go through the slots on the brackets and the holes in the Body Base. The slots allow for the brackets to slide from side to side in order to adjust for the width of the phone. The high sides of the brackets support the phone in a vertical orientation. Some non-slip plastic or rubber pads are attached to the inside walls of the phone brackets for better grip onto the phone.

Illustration 5: DARELs Adjustable phone brackets

The **Body Shell Sides** attach to the Body Base at the front and rear sides. The Midrange IR Sensor "eyes" go through the holes in the front. Holes on the right (DAREL's perspective) accomodate the USB and power jacks of the arduino, and fuse. The servo power switch is on his left.

Illustration 6: DAREL Body Shell Sides

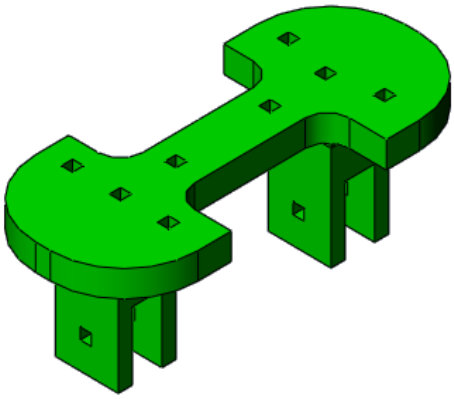
The **Body Shell Top** attaches to the Body Shell Sides on the sides via the interlocking tabs and screws. The notch is to accomodate the USB cable that runs from the USB shield to the Arduino.

Illustration 7: DAREL Body Shell Top

The **Body Shell Dome** joins the Body Shell Top and Body Shell Sides via the interlocking tabs and screws.

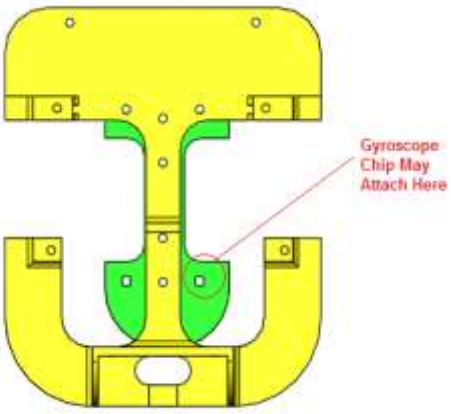
Illustration 8: DAREL Body Shell Dome

Assembly Instructions

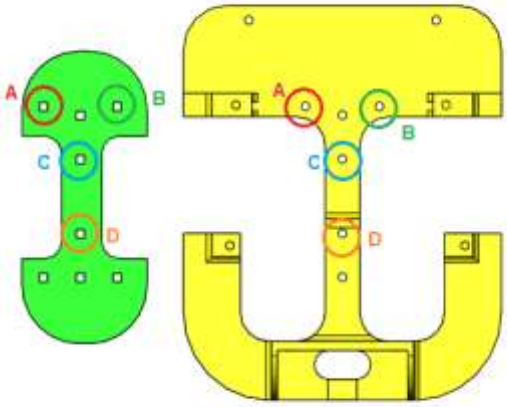


Step 0: Build The Legs in the manner following the ROFI instructions by Jonathan Dowdall on ProjectBiped.com

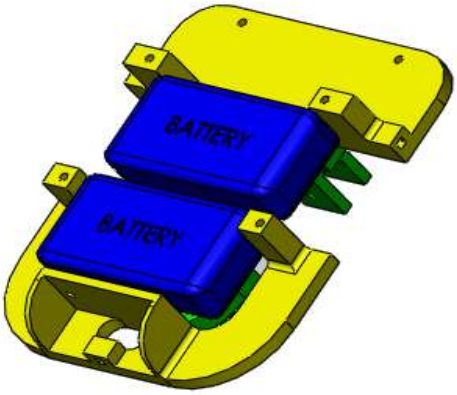
Step 1: Begin with the Body Riser.



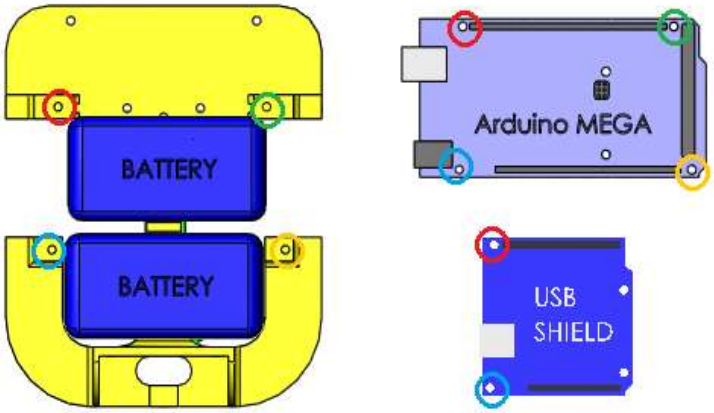
Step 2: It Should Line Up Like This.



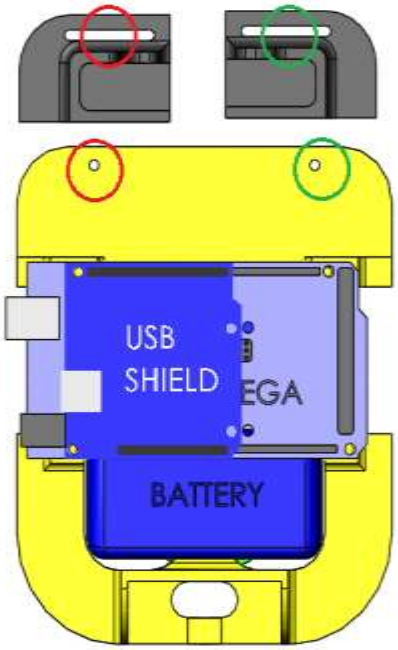
Step 2: Mate the holes and attach using M3x16mm bolts
(or whatever may fit better)



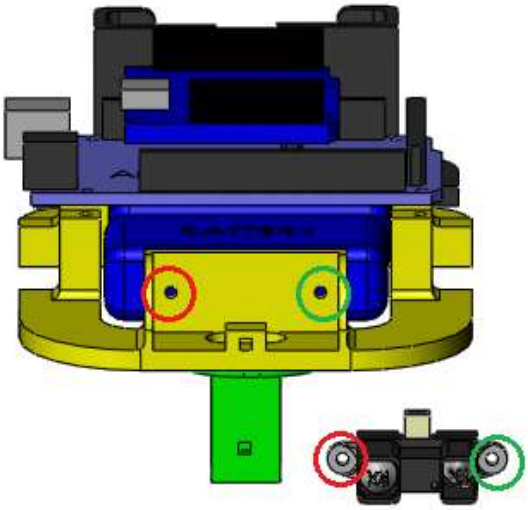
Step 3: Batteries cram in like this.



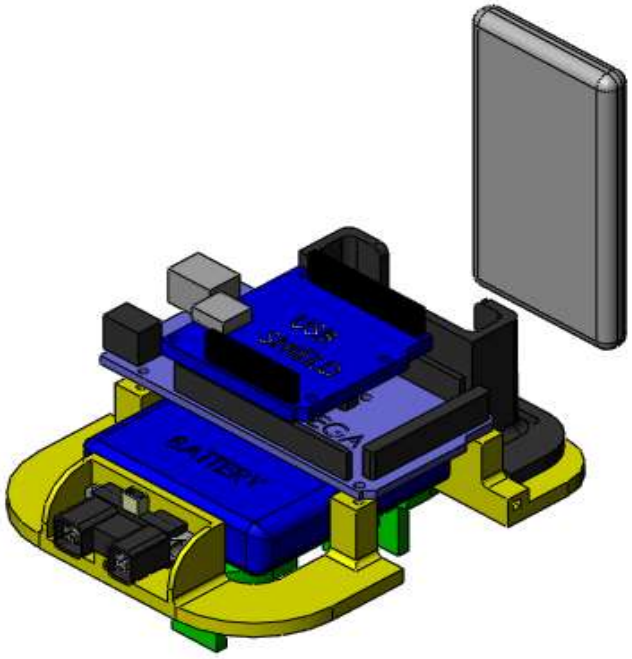
Step 4: Screw in the Arduino at the Circled Holes
using M3x8mm Bolts (or whatever fits best)



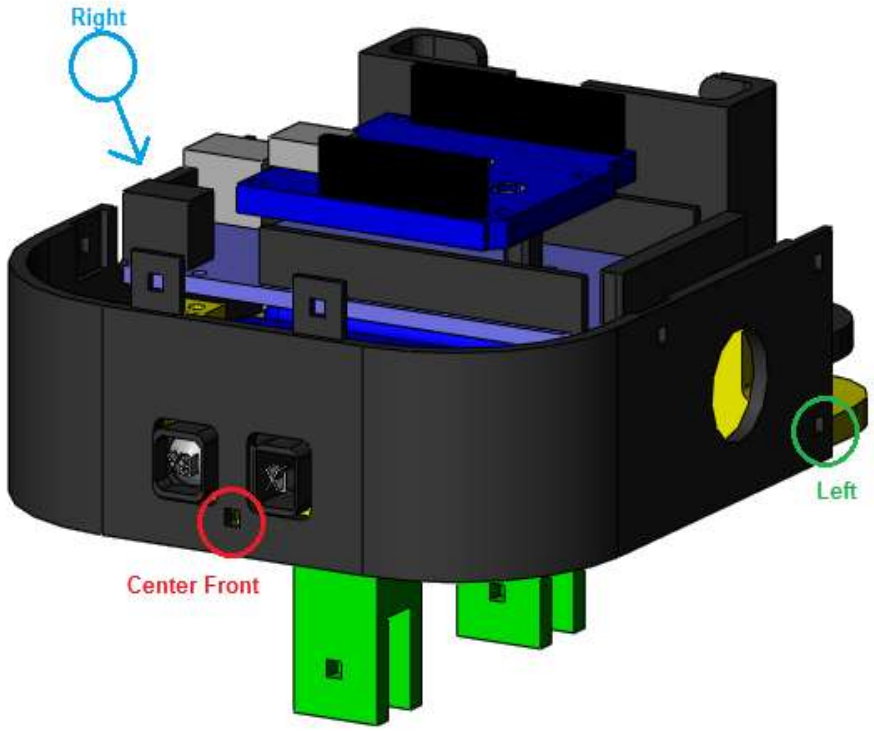
Step 5: Attach the Phone Brackets to the Body Base using M3x12mm bolts (or whatever fits) through the top slots and into the body base. Use washers between the parts and nuts on the underside of the body base. The Phone Brackets should slide side-to-side unless the bolts/nuts are fully tight.



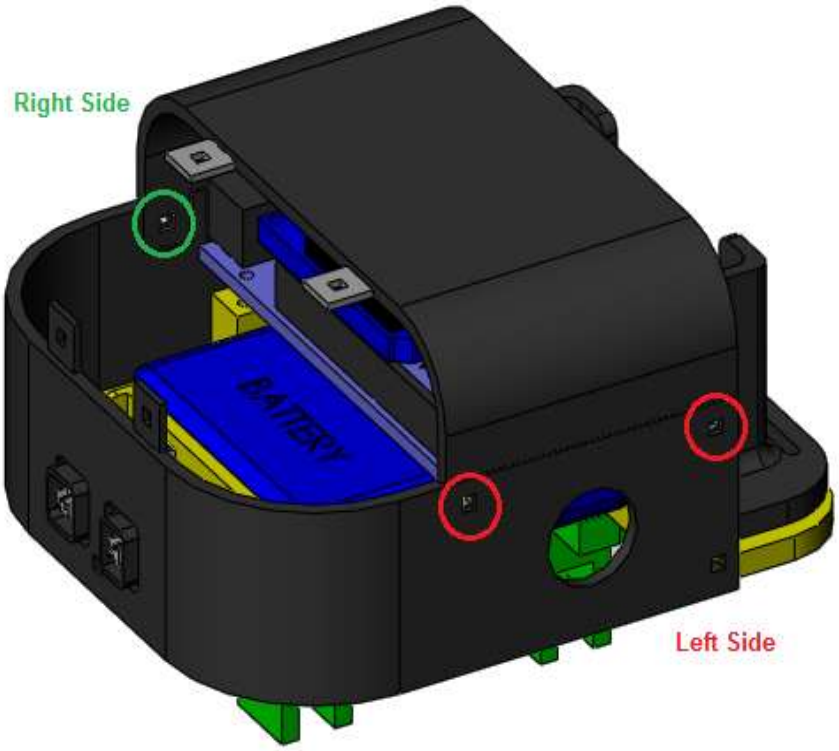
Step 6: Attach the Mid-Range IR Sensor the Body Base with the I/O jack pointing UP. It screws to the holes indicated.



Step 6b: Prior to assembling the Body Shell Pieces, be sure to connect all wiring to and from the sensors/Arduino/phone. Check all connections and function BEFORE AND AFTER Shell Assembly.



Step 7: Fit the Body Shell Sides around the Body Base. Prior to screwing it down (using M3x12mm Bolts) you may want to attach the Servo Switch and Fuse (not shown). The Body Shell Sides mount to the Body Base at 3 points. (center front, left and right).



Step 8: After CAREFULLY trimming away the support structure between the tabs, attach the Body Shell Top to the Body Shell Sides using M3x8mm (or shorter) bolts at the 4 tab holes (2 holes on each Right and Left).

Step 9: After carefully removing any support structures. Attach the Body Shell Dome to the Body Shell Sides and Body Shell Top at the 4 tab holes (indicated) using M3x8mm (or shorter) bolts.

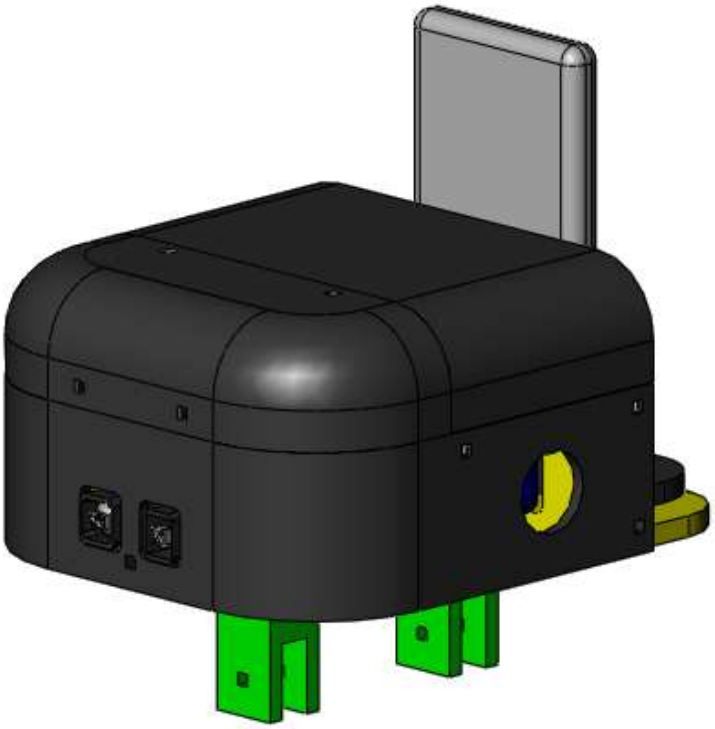


Illustration 9: Fully Assembled DAREL Body

Looking Forward

The phone bracket system was concieved to address the issue of various dimensions between phones. The ideal was to have a phone that has an internal Gyro and a front (screenside) camera. The same mounting brackets could be used in this case. The major difference is the placement/use of the IR RF. In the long view, the sensor package would use the device camera as the range finder, so the Midrange IR RF would be extraneous. If this is the case, the head as a whole could be mounted at 180 degrees and have the phone facing forward and use the front camera as the RF. Re-design of the head would be minimal.