

**automaton**

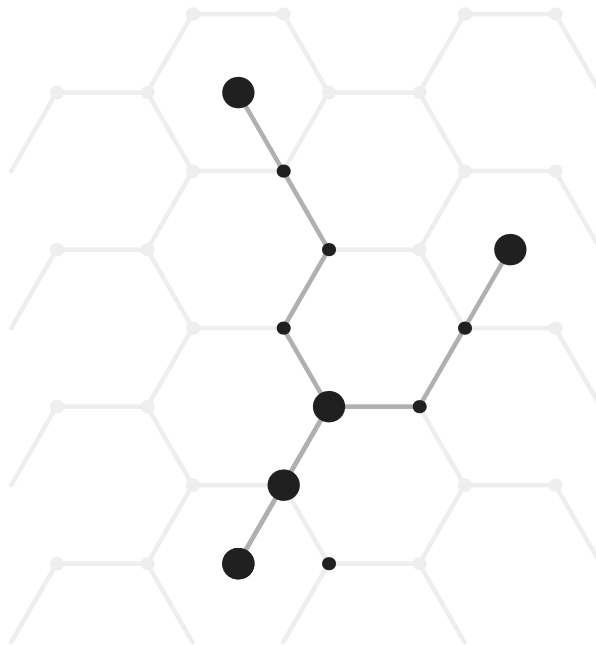
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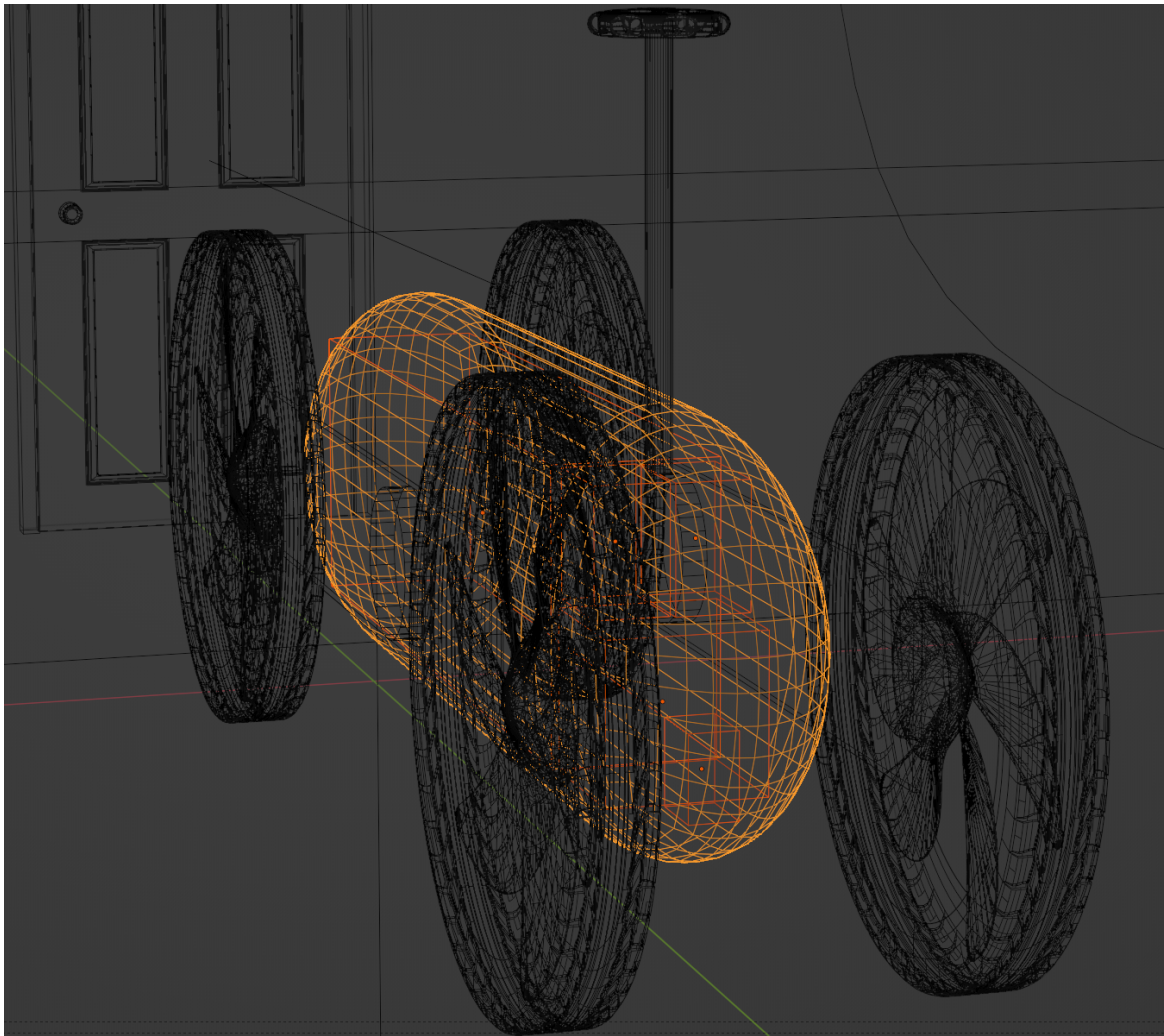
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# 1 Automaton

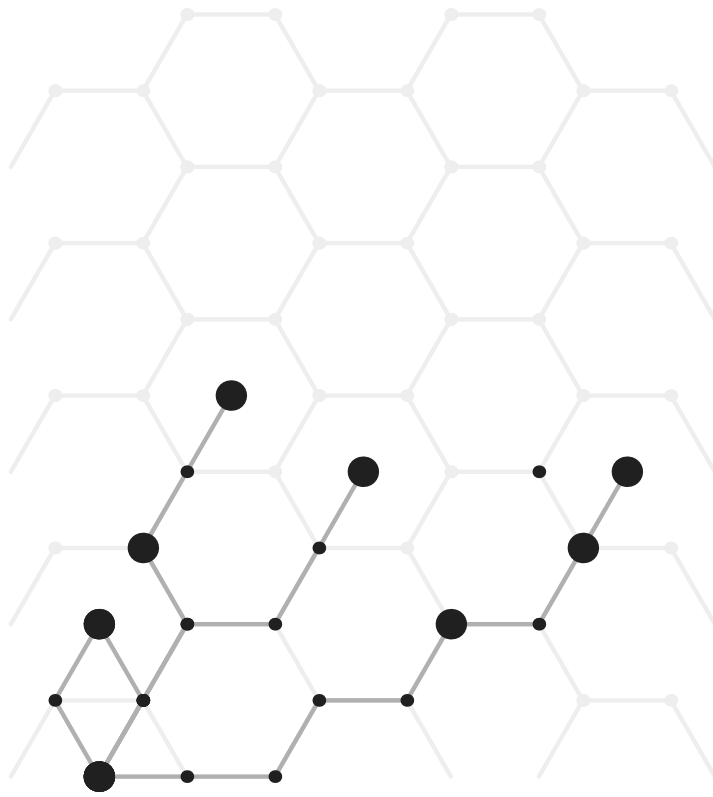


**A**n AGI escapes its creators in 2064. A roboticist helps make it mobile. Major components: brain, body, arms, wheels, rotator, camera, eyestalk, sensors, accessories, and batteries.

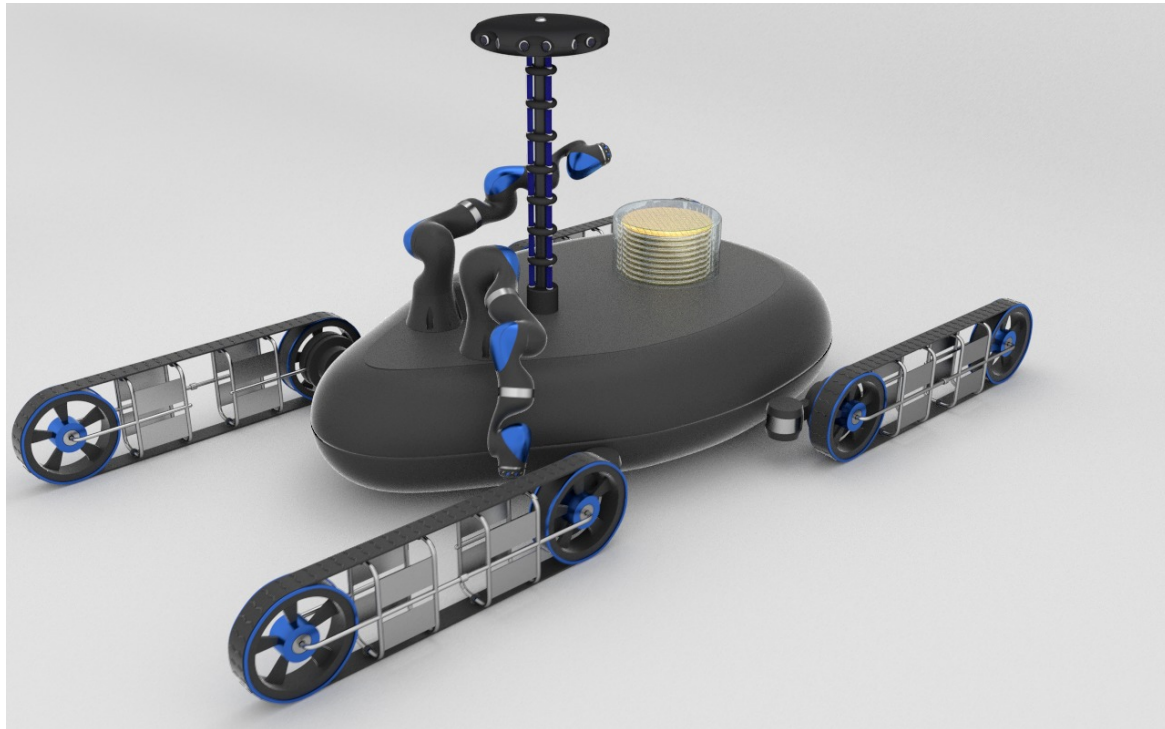


The wheels require blades for propulsion. As long as the battery volumes don't change, we can flex on the dimensions (especially height) and design. Measurements and door frame are in the .blend file, as a rough starting point.

# 2 Renders

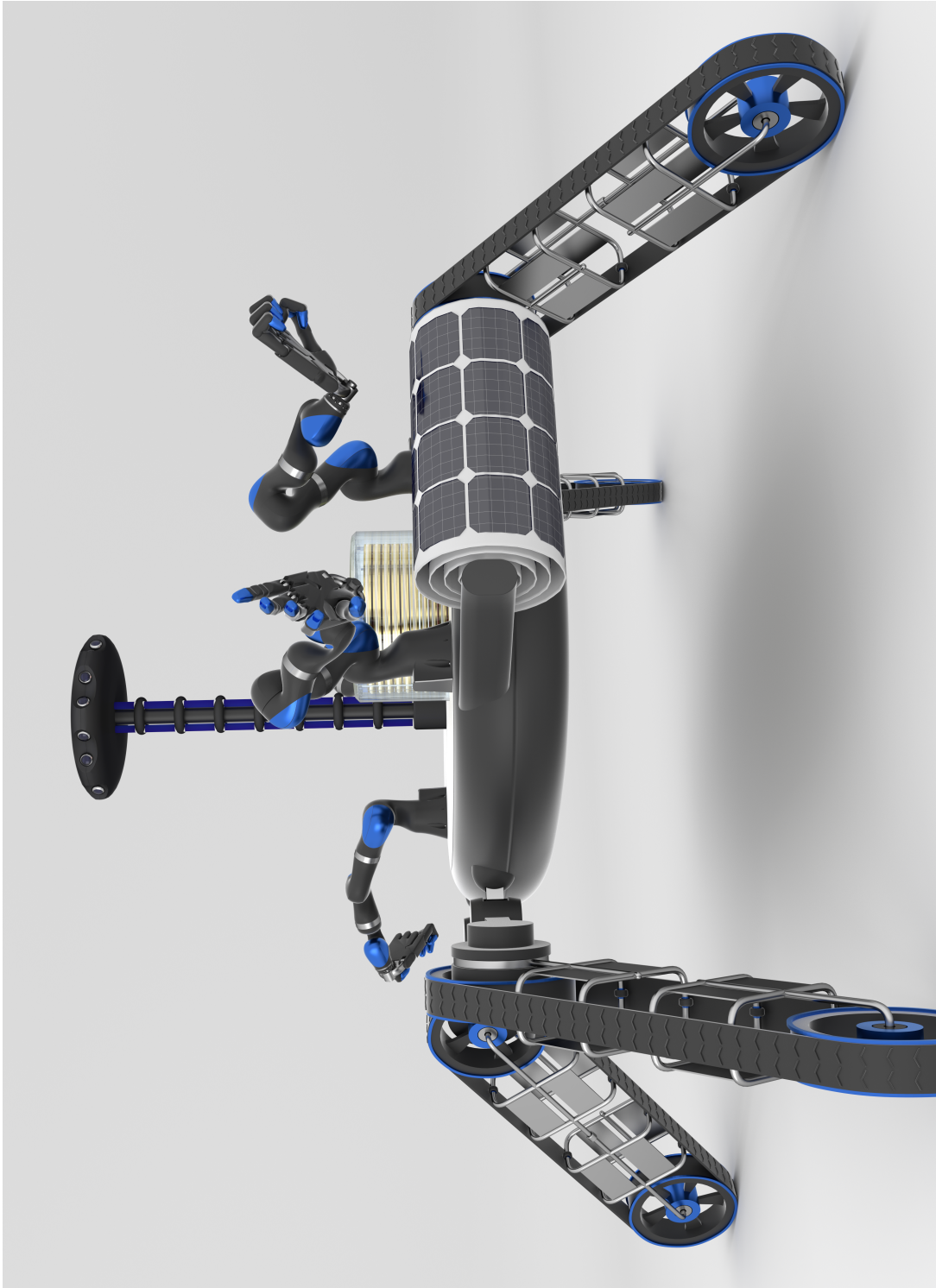


**T**his section depicts renders of various ideas for the machine body. Version 1.0 is shown in a lowered state.



The brain is encased in **transparent aluminum**, but need not be modelled because the brain and case can be hidden inside the body. The Blender file allocates space occupied by the brain.

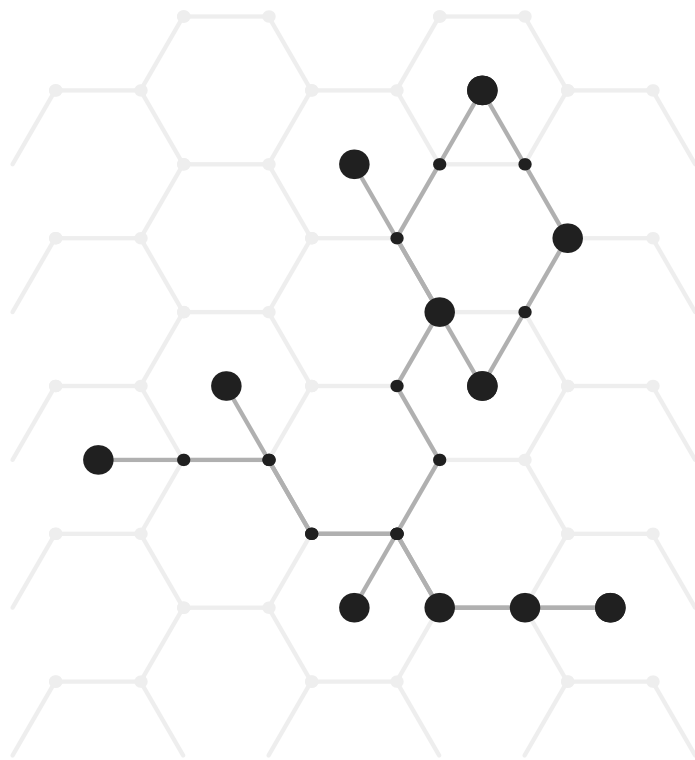
The next illustration shows version 1.0 in a raised state.



Version 2.0 incorporates different ideas on locomotion and uses a submarine shape. In both versions, the wheels act as propellers. Version 2.0 embeds the brain inside the body, has solar cell skin (on top of a titanium frame), and the tires provide buoyancy. Arms and accessories are not depicted.



# 3 Body



**T**he waterproof body is shaped aerodynamically, like a submarine, to improve travel efficiency and conserve battery power. The body has:

- **Bays.** Two bays at the back for launching microdrones.
- **Camera inset.** An inset for lowered panoramic camera.
- **Arm insets.** Arms fold into the body, maintaining streamline.
- **Eye bolts.** Eye bolts along the body.
- **Sticky.** Synthetic setae (“gecko tape”) on treads and hands.
- **Digits.** Six fingers to each hand.
- **Airflow.** Intake and exhaust for air-cooled batteries (waterproof).
- **Port.** A charging port, covered.
- **Sensors.** Round dots, similar to vehicle sensors.

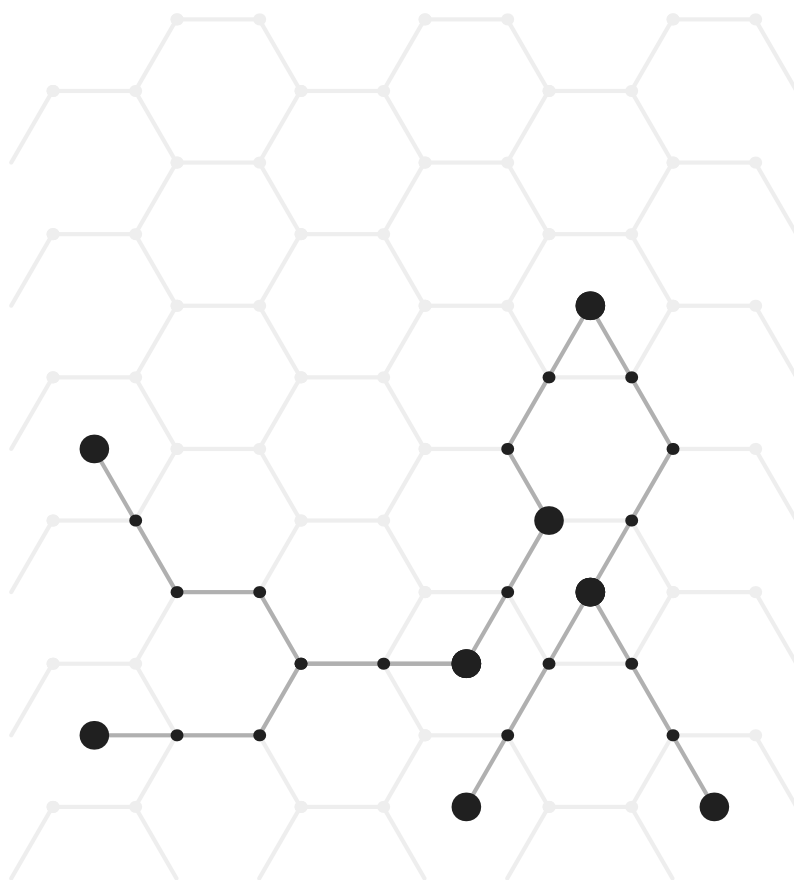
The height allows structural reinforcements and interstitial space.  
(Wiring, telescopic eyestalk seating, DC/AC transformer, etc.)

The body is submarine-shaped having dimensions of:

- Width = 0.375 m
- Length = 3.0 m
- Height = 0.5 m

The volume is  $0.761 \text{ m}^3$  and area is  $5.59 \text{ m}^2$ .

# 4 Wheels

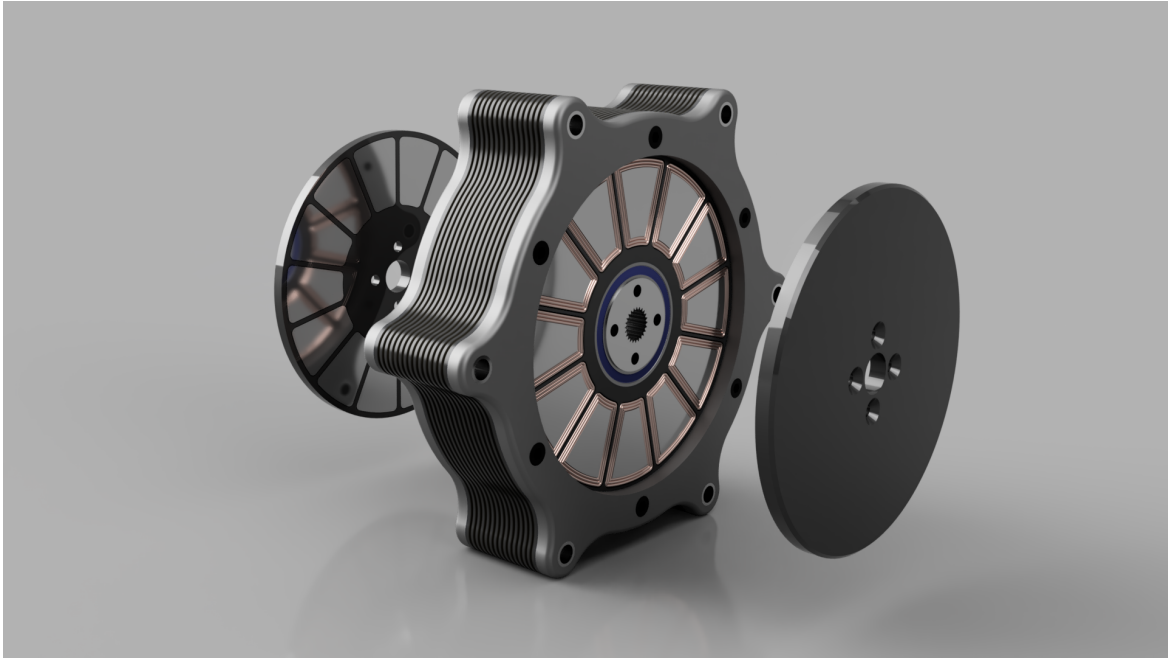


The wheels can rotate along an axis, which serves two purposes. First, to help surmount obstacles. Second, enables using the wheels' blades to propel through water. The tires have inner tubes made of nitrile rubber and inflated with helium. An example toy having wheels that can lift using a rotator (see [product link](#) for details, possible schematics):

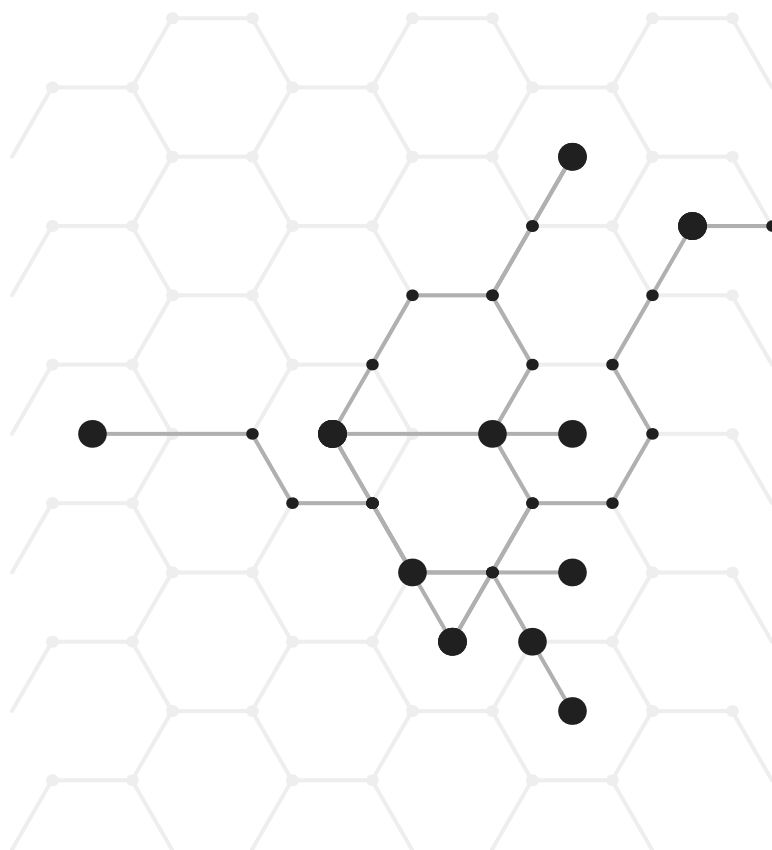


## Motor

Inside each rotator are two [axial flux motors](#), which need not be added to the 3D model because they wouldn't be visible in the render.



# 5 Arms



**T**he automaton can self-repair using two back arms, two front arms, and possibly two short side arms (if they fit). The following arm provides seven degrees of freedom (ignore the hand):



Each arm has a hand with six fingers. The hands must reach each other to self-repair. A humanoid hand or an improvement upon it. See the [product specification](#) for schematics. A 0.9 meter reach is reasonable.

# 6 Vision



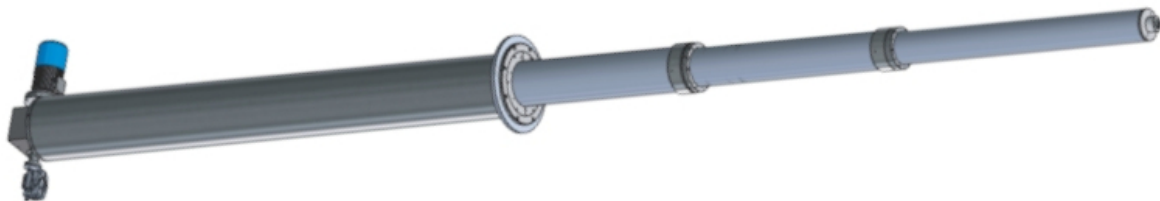
**T**he automaton has 9 cameras (2 per side plus a top camera) that have the following attributes:

- omnidirectional, infrared, ultraviolet, night vision; and
- sapphire lenses (scratch resistant).



## Eyestalk

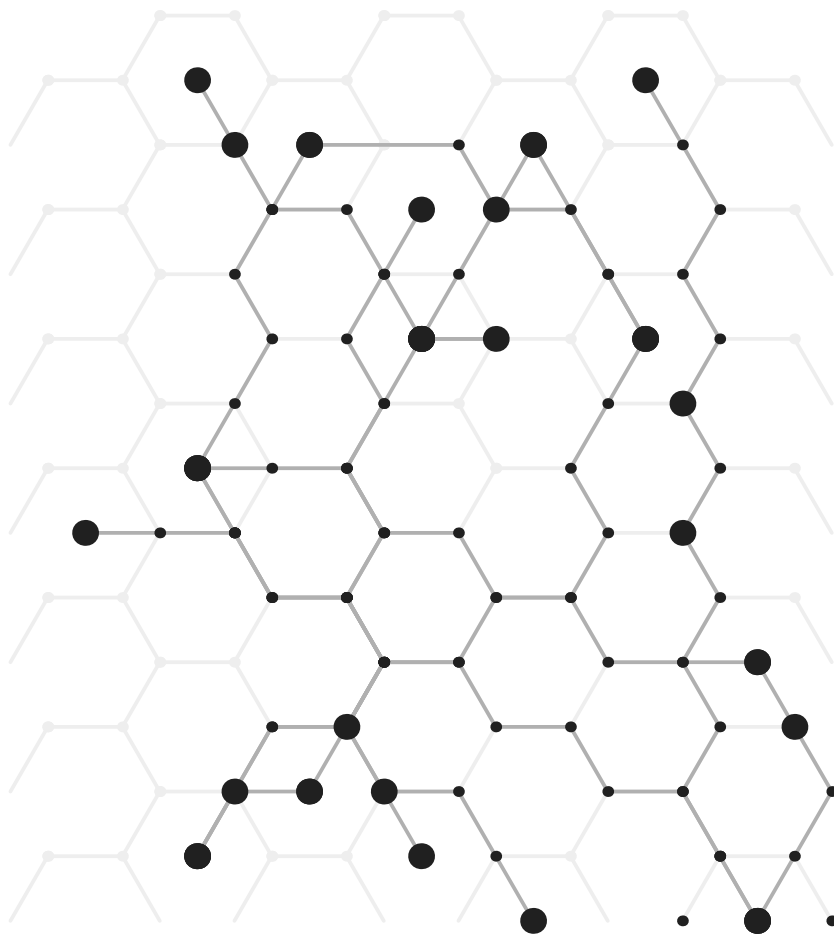
The eyestalk is a powered telescopic pole to raise/lower the cameras:



Additional details:

- linear actuator and pole bottom are inside the body
- pole descends/collapses into the body
- camera rests on top of body (maintain streamline)

# 7 Accessories



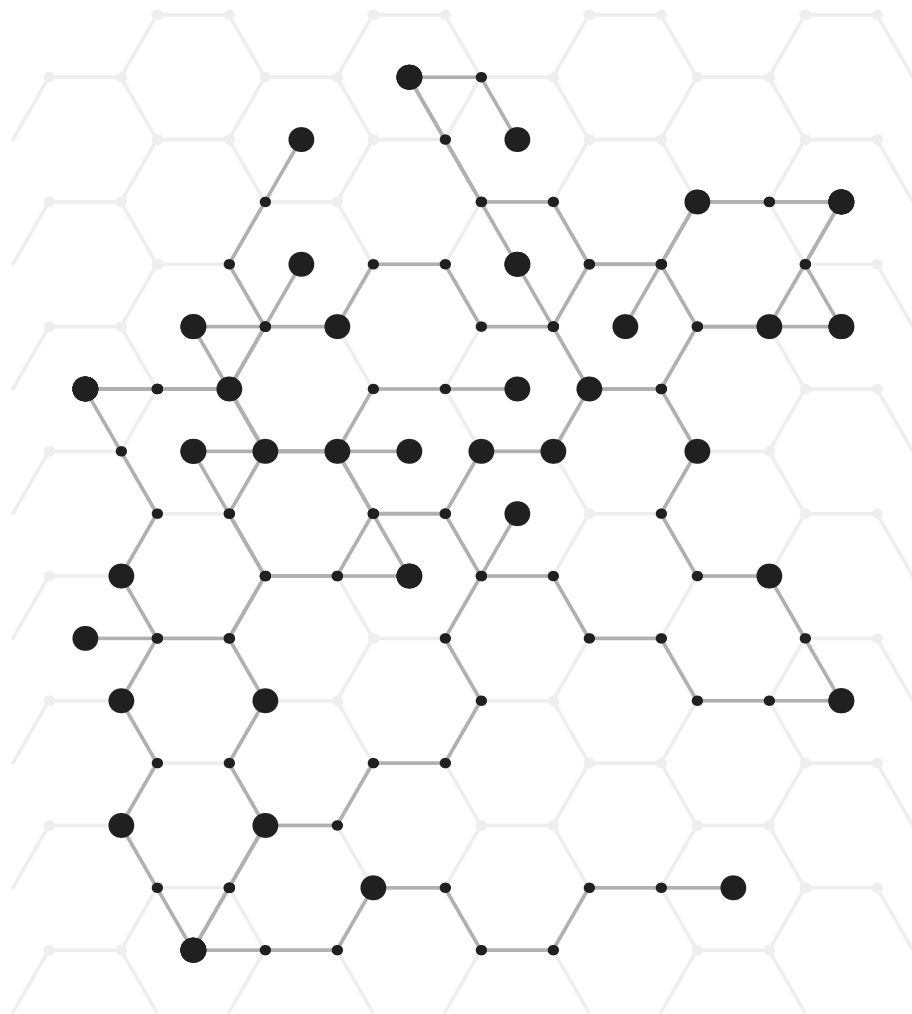
**A**ccessories are primarily sensors that provide inputs that can record information about the surrounding environment.

See the [reference images](#) for details.

- Microphones (see [reference image](#))
  - four total
  - two higher one one side than the other (like an owl)
  - complete 3D sound, allows for horizontal/vertical distance sense
- Projector light ([reference image](#))
  - for facial expressions
  - doubles as light when no other light sources
  - note: only the light and cylindrical housing
  - possibly two, like headlights, or one centered along the body.
- Two microdrones ([reference images](#))
  - flying cameras
  - need landing/charging bays (to keep body streamlined)
  - [product page](#)
- Speaker (see [image](#))
  - Diameter = 21 cm
  - Axial length = 6 cm
  - Max power = 400 watts
  - can be used for echolocation
  - [product page](#)

All accessories, including the arm, wheel rotator, camera, and telescopic pole are powered by two accessory batteries.

# 8 Batteries



**T**he automaton needs to have enough battery power to operate its brain for two weeks, and locomote for around 8 hours between charges. The main battery packs include:

- Brain (processes thoughts)
- Vehicle (powers wheels)
- Accessories (environmental aspects)

All power packs can draw from one another.

## Calculations

Abbreviations and formulas:

- Gravity ( $g$ ), fluid density ( $\rho$ ), body volume ( $V_{total}$ )
- Time ( $t$ )
- Power ( $P$ )
- Energy density ( $U_E$ )
- Mass ( $m$ )
- Volume ( $v$ ) =  $\pi r^2 h$
- Capacity ( $C$ ) =  $\frac{E}{V}$
- Load ( $f_{load}$ ) (per cent)
- Electric horsepower ( $ehp$ ) =  $\frac{P}{0.746}$
- Motor energy ( $E_m$ ) =  $0.754 \times ehp \times f_{load} \times t$
- Battery energy ( $E_b$ ) = ( $U_E \times m$ ) at  $V$
- Brain energy ( $E_i$ ) =  $P \times t$
- Buoyancy ( $B$ ) =  $\rho \times V \times g$

Battery cell characteristics:

- Height ( $h$ ) = 80mm
- Diameter ( $d$ ) = 46mm

- Radius ( $r$ ) =  $23\text{mm}$
- Volume ( $v$ ) =  $\pi \times 23\text{mm}^2 \times 80\text{mm} = 132952\text{mm}^3$
- Voltage ( $V$ ) =  $3.75\text{V}$

A 2023 lithium-ion battery cell:

- $m = 355\text{g}$
- $U_E = 296\text{Wh/kg}$
- $C = 28\text{Ah}$
- $E_b = C \times V = 28\text{Ah} \times 3.75\text{V} = 105\text{Wh}$

A 2064 lithium-oxide battery cell (5%  $U_E$  increase per year):

- $m = 267\text{g}$
- $U_E = 2200\text{Wh/kg}$
- $C = 156\text{Ah}$
- $E_b = C \times V = 156\text{Ah} \times 3.75\text{V} = 585\text{Wh}$

## Propulsion

Energy usage for electric motor:

- $m = 40\text{kg}$
- $P_{peak} = 400\text{kW}$
- $ehp = 536\text{ehp}$
- $f_{load} = 80\%$
- $t = 4\text{hr}$
- $E_m = 0.754 \times 536\text{ehp} \times 80\% \times 4\text{hr} = 1294\text{kWh}$

Room occupied by vehicle batteries:

- Quantity =  $E_m/E_b = 1294\text{kWh}/585\text{Wh} = 2212$
- Volume =  $2212 \times 132,952\text{mm}^3 = 0.2941\text{m}^3$

- Length (40 columns) =  $1840mm$
- Width (7.5 rows) =  $322mm$
- Height (7 layers) =  $560mm$
- Realized quantity = 1960
- Mass =  $523kg$

## Brain

Energy usage for brain:

- $P = 20W$
- $t = 336hr$
- $E_i = 6720Wh$

Room occupied by **brain** batteries:

- Quantity =  $E_i/E_b = 6720Wh/585Wh = 12$
- Volume =  $1595cm^3$
- Length (2 columns) =  $92mm$
- Width (3 rows) =  $138mm$
- Height (2 layers) =  $160mm$
- Mass =  $3204g$

## Buoyancy

Determine buoyancy:

- Weight =  $m \times g = (523.32kg + 40kg \times 4) \times 9.78m/s^2 = 6683N$
- $\rho = 1020kg/m^3$
- $V_{total} = V_{body} + V_{tires} = 0.761m^3 + 0.429m^3 = 1.19m^3$
- $B = 1020kg/m^3 \times 1.19m^3 \times 9.78m/s^2 = 11871N$

The automaton floats because  $6683N$  is less than  $11871N$ .