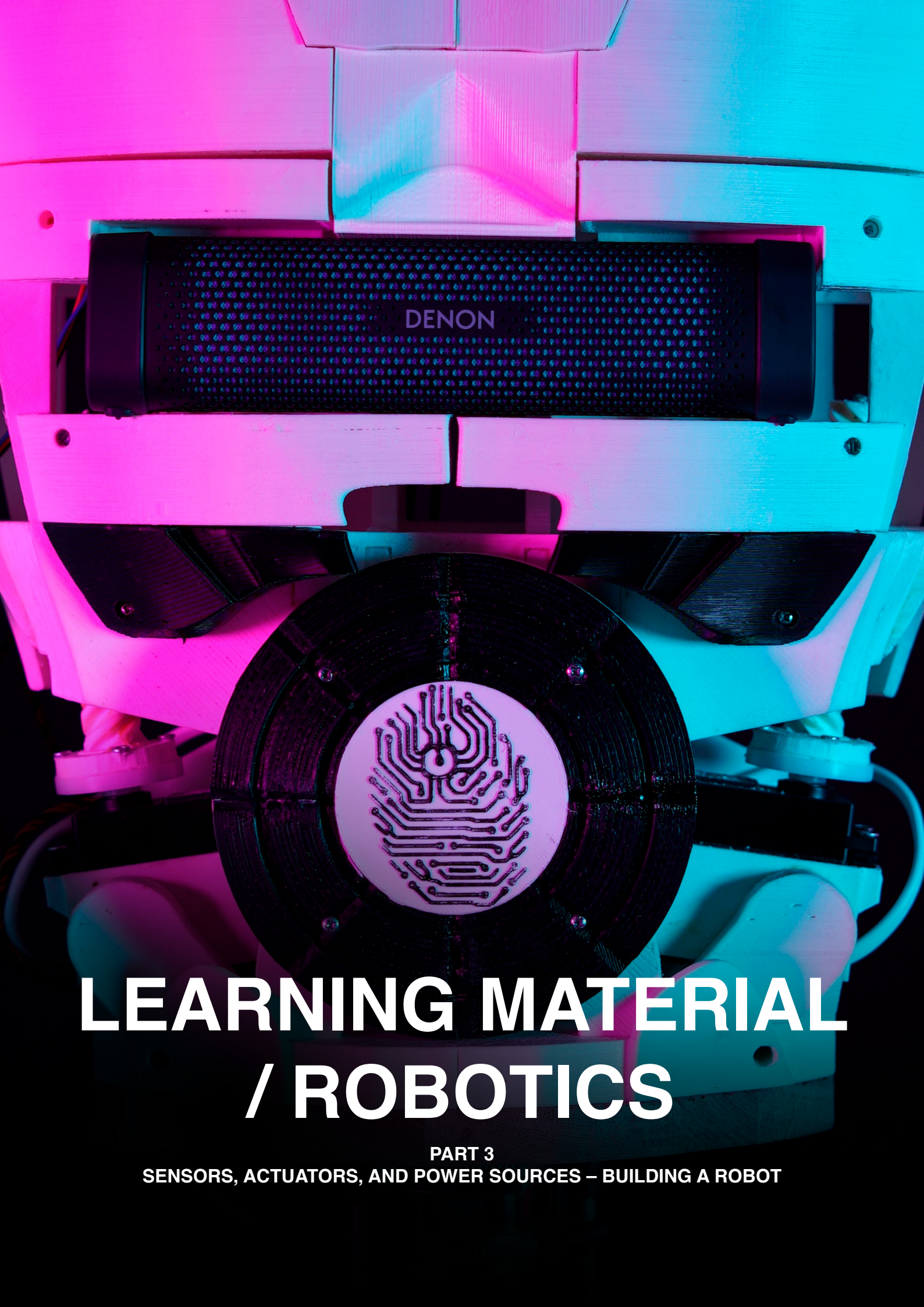

LEARNING MATERIAL / ROBOTICS

PART 3
SENSORS, ACTUATORS, AND POWER SOURCES – BUILDING A ROBOT

Target audience: high schools / secondary education institutions

The learning material will examine robotics from five different viewpoints:

1. Social Robots and Ethics
2. Social Robots and Emotions
3. Sensors, Actuators and Power Sources – Building a Robot
4. Robots and Programming
5. Robotics, Economics and Society

Teachers can utilize the learning material for different course contents and for developing an extensive know-how: thinking and learning to learn, cultural know-how, interaction and expression, multi-literacy, information and communication technology skills, working life skills and entrepreneurship, involvement and influence.

The learning material is based on the project of building and programming a social robot. It was funded by Futurice's social responsibility fund, The Chilicorn Fund, https://spiceprogram.org/chilicorn-fund/. The work group consisted of Olli Ohls, Maxim Slivinskiy, Paul Houghton, Teemu Turunen, Markus Paasovaara and Minja Axelsson.

Digitalents Helsinki acted as a partner in the project. The premise of the learning material is to share the knowledge obtained through the project. The InMoov-robot was 3D-printed according to the open source model of the French designer and visual artist Gaël Langevin. http://inmoov.fr

The material and the related content is downloadable for free from:
https://spiceprogram.org
License: CC BY 4.0. attribution Digitalents Helsinki/Futurice.

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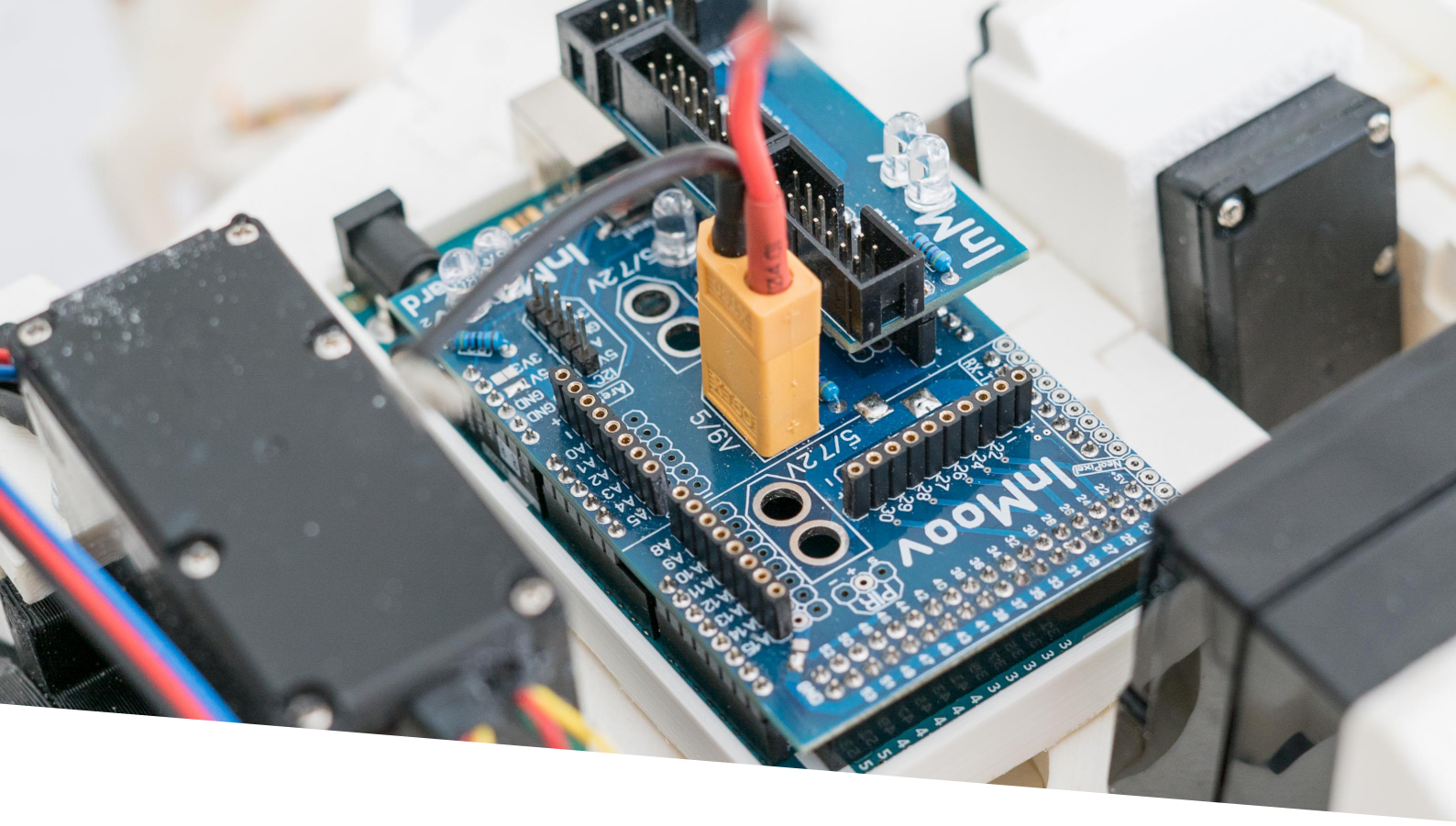
PART 3

SENSORS, ACTUATORS, AND POWER SOURCES - BUILDING A ROBOT



Background

Robots are built for all sorts of purposes. There are robots for housekeeping, caretaking, industry, warfare, medicine, entertainment, and comfort. Robotics is a rapidly growing industry, but it's possible to build a robot from scratch yourself. Apart from their usage, robots differ in appearance as well. Most robots are designed for industrial work, so their appearance doesn't carry much meaning, but social robots, for example, are built to serve humans. A robot that looks like a person or has other human-like features is called a humanoid robot. Even though the robot resembles a person, it's still a machine that has, for instance, sensors for collecting data, actuators to move its parts and a power source that maintains its functions.

A robot's sensors are similar to the senses of humans. Using them, a robot collects information about its surroundings. Typical sensors used in navigation are an ultrasound sensor, camera, and in more expensive robots, LiDar, an optical radar. The information that the sensors collect is called data. Data can be temperature, sound waves or the distance between the robot and an object in front of it. The data that the sensor collects is often transferred to a computer for interpretation. The process is similar to the way a human's eye works. The eye collects information, codes it into nerve impulses, and sends these impulses to the brain to be interpreted.

The power source can be an alternating current, which gives the robot its power straight from the electricity network. This won't work if the robot should be allowed to roam freely. Instead of using direct power, the robot can be equipped with a battery. The battery in the electric car Tesla is made up of tiny 18650 cells, of which there are thousands in one Tesla car. Storing the required amount of energy in the batteries has been challenging, but with the development of battery technology, it's already possible to drive over 800 kilometres with an electric car.

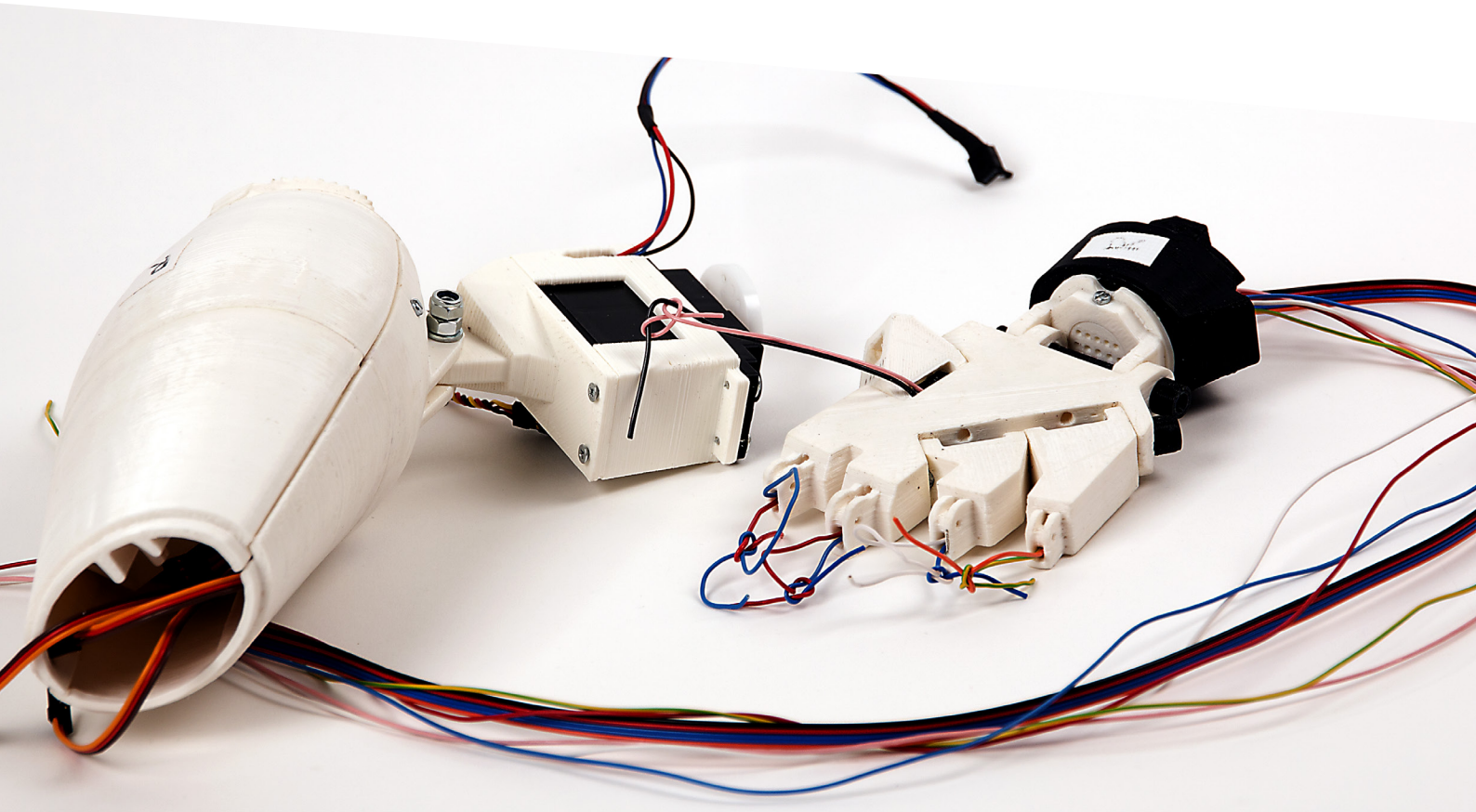
Some robots have inbuilt solar panels or another type of system for recharging its battery. For instance, solar power is used to charge the batteries of robots working in space.

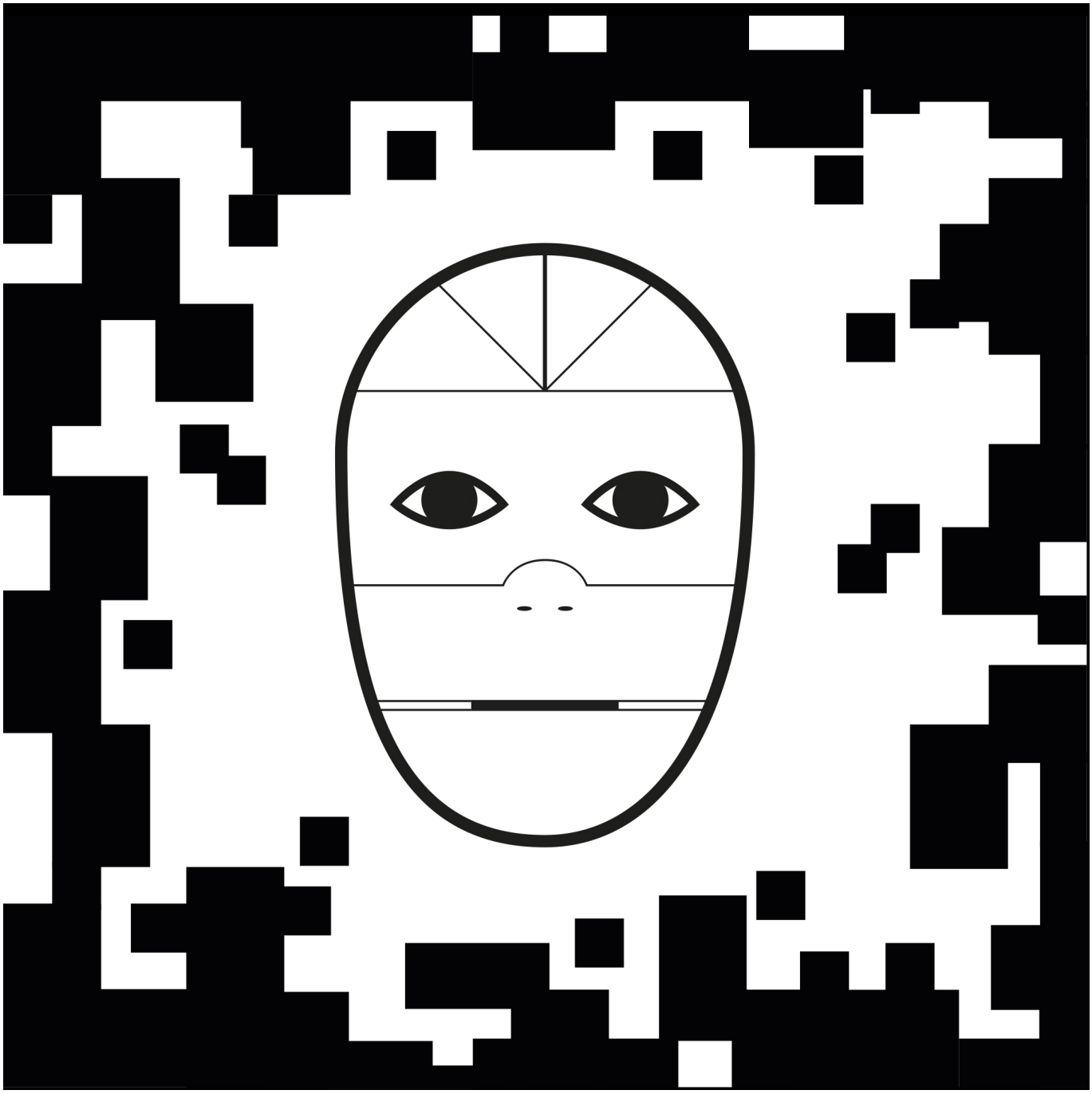
Mechanical devices that move or control a mechanism are called actuators. An electric motor is one example of an actuator that converts electric current into mechanical movement. Among others, there are actuators that are hydraulic, pneumatic, mechanical or ones that use electricity or thermal energy. The actuators of most modern robots are controlled by programming.

Building a robot can teach various skills, such as electronics, mechatronics, as well as 3D design and printing. Initially a virtual 3D model is made of the robot to test the compatibility of parts and mechanical properties, such as the durability of parts under stress. When the model reaches the criteria set for it, it's time to make the first prototype, using 3D printing, for example. The internet is full of other people's models that can be fully or partially used in one's own robot project.

Experience

The InMoov robot's FaceTrack feature uses footage taken by a camera, after which an algorithm that has been taught to recognise people's facial features draws a green box around the face using coordinates. The coordinates are given to another algorithm that moves the servomotors controlling the robot's head so that the green box around a person's face stays as close to the center of the camera footage as possible. Using this feature, the robot's face turns towards the person talking to it.

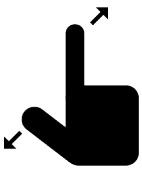




You can use the image above to open the InMoov robot's 3D model for viewing on a mobile device. Download the InMoov robot's app from Google Play Store to inspect the model used in 3D printing. When you open the app on your device and hold the camera up to the image, the robot's model will open.

Disassemble and reassemble the robot by swiping with one finger

Move the robot using two fingers



Scale the robot by moving two fingers in opposing directions

Download

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InMoov AR

Tap the robot's head or arms to see an animation

Double tap the robot's body to play a disassembly animation

Rotate the robot

Reset the robot's position

Gaël Langevin's model of the InMoov robot

The French designer and visual artist Gaël Langevin, whose clients have included the world's largest brands for over 25 years, designed the InMoov robot as his own personal project.Langevin's motive is to share knowledge with robotics enthusiasts and make building a social robot possible for those who want to. There are robots being built all over the world.
https://inmoov.fr/

Tasks

1/ Look up information on different types of actuators online. Write down what pneumatic, hydraulic, and electromechanical actuators are used for.

2/ Go to https://thingiverse.com/ and inspect various robot models made by others. You can narrow down the search by describing what kind of robot you're looking for. Try the following: "drone" "quadropod" "hexapod" "rover". Choose one that you'd want to build and explain why.

3/ Find out and draw how an ultrasound sensor, touch sensor and LiDar work.

4/ Try out the 3D design program at https://www.tinkercad.com/ and design a robot or a part of one.

5/ Degrees of freedom (DoF) mean the defined modes in which an object can move. An object on a two-dimensional plane has five degrees of freedom. An object moving freely in three-dimensional space has six degrees of freedom. When building a robot, the degrees of freedom in the mechanical parts must be given thought. Consider how you'd design the movement of a robot's head. How many degrees of freedom would a robot need to copy the positions of a human head? How should this be implemented with servomotors that each move in two directions? Next consider the movement of a robot's hand. How many degrees of freedom does a human's arm and hand have? Building a walking humanoid robot is an extremely large and expensive task. Can you explain why?

Sources

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