FLEXIBLE

SMALL

WATERPROOF

ACTUATORS

HEATER

Different ways to warm up something, from your gloves while skiing to boiling water to prepare a nice cup of tea!

DIFFICULTY RANGE

easy ●—●—●—○—○ hard

1 3

COST RANGE

cheap ●—●—●—●—● costly

1 5

FLEXIBLE HEATERS

Simple and easy to integrate flexible material with limited temperature range.

WATERPROOF HEATERS

Solutions ideal for outdoor spaces and naval applications.

SMALL HEATERS

Thermistors designed to efficiently propagate heat in an environment.

IN DETAIL

FLEXIBLE HEATERS

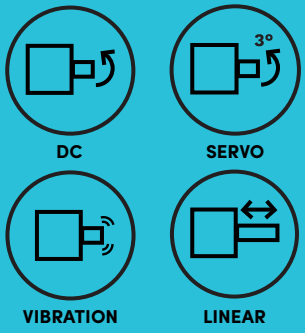
- Size: various
- Cost: various
- Flexible heaters basically electric wires bound inside rubber or leather treated to be moisture and chemically resistant. Can be easily self-made or acquired with highly customizable specifications.

SMALL HEATERS

- Size: various
- Cost: various
- Heater are finely-designed circuits with resistors specifically efficient in releasing warm. A simple configuration just turns on and off the circuit, while more complicated ones might involve thermostats, thermometer and diffusion system.

WATERPROOF HEATERS

- Size: various
- Cost: various
- Waterproof heaters are system engineered so to not be affected if soaked in liquid. They can be of critical usefulness in environmental-adverse situations (wing defrosting, naval constructions, satellite system).



ACTUATORS

MOTOR

Motors can rotate continuously, move and stay in a precise position, move linearly or even vibrate.

DIFFICULTY RANGE

easy — hard

2 4

COST RANGE

cheap — costly

1 5

DC MOTOR

Simple motors, ideal for power tools, toys and small vehicles.

VIBRATION MOTOR

Small actuators usually used for haptic feedback.

SERVOMOTOR

High-torque closed-loop motors for applications that require efficiency and performance.

LINEAR MOTOR

A motor producing a straight linear movement.

IN DETAIL

DC MOTOR

- Size: approx 20x20x40 mm
- Cost: 2 - 30 €
- Brushed motors easy to integrate and operate. Big, high-end DC motors offer good performances but are preferred in small packages for many consumer product involving motion or rotation.

SERVOMOTOR

- Size: approx 50x50x50 cm
- Cost: 10 - 70 €
- A servomotor is a closed-loop actuator with dedicated controller that offers rapid and precise movements with constant feedback of the position. Standard servomotors move always at max speed. They are often used in high-performance robotics and automation applications.

VIBRATION MOTOR

- Size: approx 10x10x10 mm
- Cost: 3 €
- Actuators in very small packages that creates controlled vibrations with an integrated unbalanced load. Used in haptic technologies.

LINEAR MOTOR

- Size: apprix 5x5x20 cm
- Cost: 30 - 300 €
- Special motor configuration that produce linear movement instead of rotation, removing belts, cogs and friction, and hence optimizing force and precision. Very useful for highly engineered projects.

LED

LASER

HIGH INTENSITY

ACTUATORS

LIGHTS

You can control light in different forms, small LEDs, powerful lights and even lasers (small or big!) Many of these sources can be dimmered, but not all of them!

DIFFICULTY RANGE

easy — hard

1 2

COST RANGE

cheap — costly

1 3

LED

General purpose low-consumption Light Emission Diode.

HIGH-INTENSITY LIGHT SOURCE

Various kind of light sources with more efficient and intense luminosity.

LASER

Light source with peculiar aesthetical properties and functionalities.

IN DETAIL

LED

- Size: approx 2x2x2 mm
- Cost: 0,10 - 1 €
- General purpose light sources, usually not expensive and easy to integrate. Often combined in strips for higher luminosity.

LASER

- Size: approx 20mmx20mmx50mm
- Cost: 5 - 15 €
- Low-power laser lights used for purposes such as installations, directional lights, barcode readers, medical appliances or in conjunction with light-sensors for enabling fast and reliable switches.

HIGH-INTENSITY LIGHT SOURCE

- Size: various
- Cost: 10 - 100 €
- Many technologies (incandescent, fluorescent, high-intensity discharge) that offer better performances than other sources, but with a higher consumption and environmental concerns.

MONITOR

LED MATRIX

PROJECTOR

ACTUATORS

SCREEN

Different ways to visualize static images or graphics, or dynamic videos or animation.

DIFFICULTY RANGE

easy — hard

3 5

COST RANGE

cheap — costly

2 5

MONITOR

General purpose visual output device in a wide variety of size and price.

PROJECTOR

Apt for large surfaces and dark environments, offers mapping possibilities even for non-flat areas.

LED MATRIX

Ideal high-contrast output for tools and machines feedbacks. Generally low-consumption and low-resolution.

IN DETAIL

MONITOR

- Size: various
- Cost: 50 - 1.000 €
- Commercial monitors offers the easiest and fastest way to display content from a computer with bare minimum technical requirements. Usually they support either or both analog (VGA, RCA) and digital (DVI, HDMI) connections and offer various resolution settings and adjustments. Top notch monitors feature embedded operating system.

LED MATRIX

- Size: from 5x5x1 cm
- Cost: from 10 € up
- Conceptually simpler than other display solution, this technology offers results varying from bare bone 7 segment digit counters to high-resolution multi-color LED walls. Usually used in highly customized applications, LED matrixes offer a very technical yet inexpensive solutions when standard display are too generalized to fit.

PROJECTOR

- Size: approx 40x40x20 cm
- Cost: 400 - 2.500 €
- According to specifications, a projector requires a dark environment, minimum space and distance for optimal projection. It can be mounted over walls or under roofs, can be mirrored and easily adjusted for non-flat surface. Lamps have a limited lifetime.

RELAY

MOSFET/
TRANSISTOR

ACTUATORS

ELECTRONIC SWITCH

Components that allow to control big and powerful devices, such as light bulbs, big motors, and even your washing machine!

DIFFICULTY RANGE

easy — hard

2 5

COST RANGE

cheap — costly

1 2

RELAY

Electrically operated switches.

TRANSISTOR

A semiconductor device used to control current and power of signals.

MOSFET

A field-effect transistor whose conductivity is determined by the voltage applied to the gate pin.

IN DETAIL

RELAY

- Size: 20x20x20 mm
- Cost: 1 - 3 €
- Electromagnetic switches controlled by signals, used to electrically separate or activate circuits and systems. Relays are categorized according the unit of measurement they are activated with (volts, watts, amps, herz, etc).

MOSFET

- Size: 2x2x1 mm
- Cost: 0,10 - 1 €
- A type of transistor used to control the voltage passing in a circuit through a gate signal. This property allows a single low-voltage signal to amplify or switch even high flow circuits.

TRANSISTOR

- Size: 2x2x1 mm
- Cost: 0,10 - 1 €
- Transistors are the ubiquitous components that set the foundation of modern electronic applications, and can be found in the magnitude of millions inside a single microprocessor. Being made semi-conductive materials, they allow the switching and amplification of high-current signal from a low-current signal.

ACTUATORS

REMOTE CONTROLLER

Remote controller, like the one you use for TV or house gates, can be integrated in your projects.

DIFFICULTY RANGE

easy — hard

2 4

COST RANGE

cheap — costly

1 3

PROs

- Cheap
- Easily replicable
- Easily customizable

CONs

- Subject to interferences or jamming
- Physical limits of certain technologies (line of sight, range limit)
- Should work under local law prescriptions on the matter

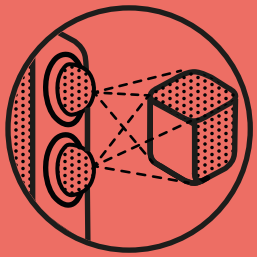
IN DETAIL

IR

- Size: approx 10x50x50 mm
- Cost: 1 - 20 €
- Usually found on home appliances controller, remotes based on infrared light signals are very common, easy to program and integrate. They need a clear line of sight and respect an operating angle with the receiver in order to work.

NFC

- Size: approx 10x50x50 mm
- Cost: 1 - 50 €
- These controllers use radio frequencies to communicate with automated system even when out of line of sight and at greater distances than IR signals. Different protocols exists in order to answer to different specific needs, such as complexity of commands, encryption, error-correction. While simple applications (such as gate openers or bluetooth headphones) may involve standard off-the-shelf systems, more advanced settings can count on more sophisticated and proprietary implementations.



MACHINES

3D SCANNER

A 3D scanner is a camera capable to take “3D pictures”, recording not only the color of a pixel, but also its position in the space. It creates a 3D file, a digital representation of the object.

DIFFICULTY RANGE

easy — hard

3 — 5

COST RANGE

cheap — costly

1 — 5

PROs

- Capture existing objects
- Capture body parts and measurements
- Can be used to create personalized items

CONs

- Not easy to use
- Expensive if you need a high-resolution, large format or fast capturing
- The file needs to be edited

IN DETAIL

A 3D scanner is a camera capable to take “3D pictures”, recording not only the color of a pixel, but also its position in the space. Sometimes a single 3D picture is not enough to reconstruct the entire model, so it’s possible to take multiple pictures and merge them into a single complete 3D file, more or less in the same way a lot of frames create a video.

PHOTOGRAMMETRY

- It uses a lot of pictures to reconstruct the 3D model
- Slow process, high resolution, full-color model

STRUCTURED LIGHT SCANNER

- Small object, few seconds per scan, good resolution
- Not to be used in full sunlight

HAND SCANNER

- Flexible, cheap and easy to use, low quality
- Not always reliable with the dimensions

MACHINES

3D PRINTER

It's a machine that creates objects stacking layers together, the same way a thick book is made by a lot of thin pages.

DIFFICULTY RANGE

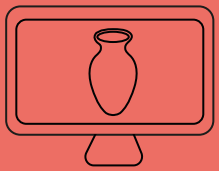
easy — hard

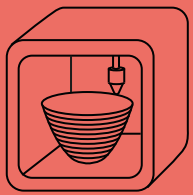
1 — 3

COST RANGE

cheap — costly

1 — 5





PROs

- Wide range of materials
- Easy to use and learn
- Complex geometries
- Robust parts
- Colorful

CONs

- Quite slow
- In average, interesting for small parts (less than 15x15x15cm)
- Expensive for some materials

IN DETAIL

The machine creates a physical version of a 3D virtual model. In the process, the model is sliced in thin layers and the machine draws these layers with some sort of solid material. Layer by layer the entire object is created. It allows creating complex geometries in different materials.

DIY (FFF)

- Cheap, easy to use
- Small plastic objects (around 20x20x20cm)

PROFESSIONAL (SLS, SLA, FDM)

- Higher resolution, resistant parts
- Wide range of material (plastics, resins, metals)
- More expensive

LARGE FORMAT

- Larger volume (up to 1m3)
- Plastic, ceramic, or concrete

MACHINES

LARGE CNC MILL

It's like a big, very precise, automatic saw, that cuts different materials using a spinning blade, similar to a drill tip.

DIFFICULTY RANGE

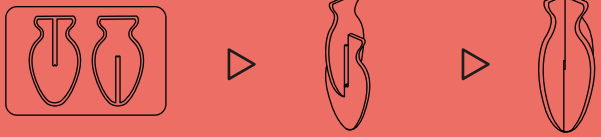
easy — hard

3 4

COST RANGE

cheap — costly

1 4



PROs

- Can make big object
- One of the cheapest way to make big objects
- Can make resistant object
- Work with different materials
- Working area up to 2,5x1,5 meters

CONs

- Cheap machine works with wood and plastic only
- Making something complex is expensive
- Some design modification are required due to tech limitation

IN DETAIL

A CNC milling machine is a 3 axis machine (can move along X, Y, Z or a combination of these) that moves along a path with a spinning cutting tool. It allows to cut in every direction, including vertically (drilling a hole). It's commonly used to make furniture and works with wooden panels. The cut parts are assembled together to create a solid, stable, 3D object.

2D DESIGN

- The easier and cheaper way to mill: the machine cuts the outline of parts, holes and pockets
- The pars are snapped, interlocked, screwed or glued together to assemble the final design

3D DESIGN

- More similar to sculpting, the machine removes the excess material to make a 3D object out of a larger block
- It takes longer and it's more expensive

MILLING METAL

- Metal can be milled as well, but the milling machine must be very stiff and resistant. It's more expensive, complex and slow
- Easier with aluminum alloys, brass, and soft metals

MACHINES

LASER CUTTER

It makes very very precise fretworks. It cuts not-too-thick slabs of different materials, from leather to plexiglass.

DIFFICULTY RANGE

easy ●—●—●—○—○ hard

1 3

COST RANGE

cheap ●—●—●—○—○ costly

1 3

PROs

- Simple to use and fast
- Works on different materials
- Easy to design connections and joints

CONs

- Limited size and thicknesses
- Round, “soft” shapes are not easy to make
- Expensive for metals
- Some materials aren’t recommended because it produce toxic smoke

IN DETAIL

A laser cutter uses a highly focused light to melt or burn away a small amount of material, to divide the part from the rest of the slab. These parts must be assembled to create the final piece. It is one of the easier machine to use and faster to prototype, it works well for final products as well.

JOINTS

- Easy to design interlocking part to make more resistant parts
- Can be glued or snapped together

T-SLOTS

- A way to cut parts that can be assembled with screws (google “t-slot laser cut”)

FLEXIBLE PARTS

- A way to cut parts to make them flexible but less resistant (google “flexible pattern laser cut”)

MACHINES

VINYL CUTTER

A practical and fast plotter for cutting sheet-like surfaces.
Mainly used for stickers, painting, masks and textiles.

DIFFICULTY RANGE

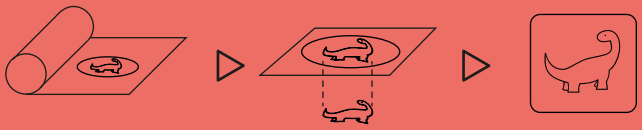
easy — hard

1 2

COST RANGE

cheap — costly

1 2



PROs

- Simple to use and fast
- Materials are often cheap
- Perfect for making transfer stickers

CONs

- Limited material range
- Small details are difficult to render
- Composite works requires a bit of manuality

IN DETAIL

A vinyl cutter uses a sharp blade mounted over the moving head of a plotter machine. In this way, it can cut over sheet-like materials re-creating a vector image in very little time.
Useful for early stages of prototyping and product customizations, vinyl cutter are cheap and easy to maintain, and materials can be easily bought in bulk.

TRANSFER STICKERS

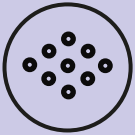
- Vinyl sheets and thermal transfer papers are easy to work with materials, yelding professional results with minimum training.

COPPER SHEETS

- Fine-tuning the cutting parameters, it's possible to cut over tin foil and copper sheets, making simple circuits without the need of acid baths or CNC.

PAPER ENGINEERING

- Trimming, scoring and creasing are easy to obtain even over lengthy surfaces of paper rolls



SENSORS

AMBIENT

Group of sensor that measure environmental values.
They can detect light, temperature, moisture, some specific gasses, or thin dust (PM2.5, PM10, etc.)

DIFFICULTY RANGE

easy — hard

1 3

COST RANGE

cheap — costly

1 4

LIGHT

From complete darkness to very bright environment.

GAS

Can measure a specific gas, such as NOx, CO, CO2, etc.

DUST

Measure the particles in the air, usually dangerous thin particles. It has a limited lifespan.

TEMPERATURE

Different ranges, large range sensors have lower resolution.

MOISTURE

Some are for soil (solid), some for air (gasses).

IN DETAIL

LIGHT

- Size: approx 5x5x2 mm
- Cost: less than 1 €
- Easy to use but not precise if it's too bright (it saturates)

TEMPERATURE

- Size: from few millimeter to 1 or 2 centimeter
- Cost: few €
- From -50°C to 150°C has a 0,1°C resolution, but there are sensors that reach 1200°C (less precise)

GAS

- Size: approx 3x2x1 cm
- Cost: around 5 € (for cheap and easy to use one)
- Can detect the concentration of a specific gas, the value is not absolute (like PPM), but it gives an idea of a relative concentration (more than before, twice as much, etc).

MOISTURE

- Size: approx 1x1x2 cm
- Cost: around 5 €
- "Digital sensors" have a high resolution but are a bit more complex to be used, while "analog sensors" are cheaper and less precise.

DISTANCE

SENSORS

DISTANCE

Sensors that measure the distance between the source and the first object in front of them. They are basically a sort of invisible tape measure.

DIFFICULTY RANGE

easy — hard

2 5

COST RANGE

cheap — costly

2 5

TOF

Emits a laser impulse and measure how long it takes to go, get reflected by the object and come back.

IR

Emits an IR light pattern and measure how long it takes to go, get reflected by the object and come back.

ULTRASOUND

Emits an ultrasound impulse and measure how long it takes to go, get reflected by the object and come back.

IN DETAIL

TOF

- Size: approx 15x20x2 mm
- Cost: around 15 - 25 €
- Not easy to use but quite precise, range up to few meters, but it depends on how much the target absorb light

ULTRASOUND

- Size: approx 3x1x1 cm
- Cost: few €
- Less precise than the ToF, is not influenced by the environment's brightness. It measures from few centimeters to 4-5 meters

IR

- Size: approx 15x15x30 mm
- Cost: around 10 - 15 €
- Sensitive to too bright environments, quite precise and easy to use, short range (less than a meter)

ROTATION

ACCELERATION

ENTRANCE
EXIT

PRESENCE
MOVEMENT

SENSORS

MOTION

These sensors detect movements and accelerations. If the movement is simple (rotation, linear movement, etc), it's easy and cheap. It becomes expensive and difficult if the movements are combined, fast or complex (like a leaf flying in the wind).

DIFFICULTY RANGE

easy — hard

1 — 5

COST RANGE

cheap — costly

1 — 5

ROTATION

Can measure within a certain range, or an endless number of rotation. Quite cheap and easy to use.

ENTRANCE/EXIT

It checks if something is passing by. It's used to count the number of people passing by a door, or to stop automatic gate to close if there is something in the way.

ACCELERATION

It is the same kind of sensors you have in your phone to measure the inclination or if you're shaking it.

PRESENCE/MOVEMENT

Check if someone\something moved, similar to the automatic doors or lights.

IN DETAIL

ROTATION

- Size: approx 5x5x15 mm
- Cost: few €
- Can measure a fix range (from 0° to 180°) or a continuous rotation (different sensors have different precisions)

ACCELERATION

- Size: approx 10x10x2 mm
- Cost: around 5 - 10€
- It usually measures the angle of inclination (compared to X, Y, Z) and the acceleration. Not so useful to measure the velocity.

PRESENCE/MOVEMENT

- Size: approx 3x3x3 cm
- Cost: around 5 - 10€
- Measure if someone or something moves in front of it, in the range of few meters (up to 7)

ENTRANCE/EXIT

- Size: approx 2x2x5 cm (but you need something on the other side of the gate)
- Cost: around 15 €
- It checks if someone interrupts the ray emitted by the sensor, useful to check gates, doors, etc, to count people or objects passing by.

DIGITAL COMPASS

GPS MODULE

SENSORS

OUTDOOR/ NAVIGATION

It helps to navigate outdoor. It can tell you or record your position, or indicate where the North is.

DIFFICULTY RANGE

easy — hard

3 5

COST RANGE

cheap — costly

1 3

DIGITAL COMPASS

Indicates the orientation and magnitude differential of the sensor in relation to external magnetic fields.

GPS MODULE

Retrieves sensor position in the world through satellite-based communication.

IN DETAIL

DIGITAL COMPASS

- Size: approx 20x20x10 mm
- Cost: 5 - 15 €
- Based on accelerometer and magnetic sensors, (it communicate through I2C Protocol to microcontrollers). Should stay over a flat surface and not close to magnetic interferences.

GPS MODULE

- Size: approx 40x40x20 mm
- Cost: 35 - 50 €
- Using the Global Positioning System satellite network, this sensor can calculate real-time position and other navigation data in the form of coordinates.

BUTTON

SENSOR

AREA

MAGNET

SENSORS

TOUCH/ PRESENCE

They can detect clicks, touches, movement on the surface (like a trackpad in your PC) or the presence of a small magnet (it's like a button that clicks only if you use a magnet).

DIFFICULTY RANGE

easy ●—●—○—○—○ hard

1 2

COST RANGE

cheap ●—●—●—●—○ costly

1 4

BUTTON

Simple switch that emits or interrupts a signal when activated.

TOUCH AREAS/PAD/ SCREEN

Arrays of switches that renders the user's movements over the sensitive area.

TOUCH SENSOR

Switch that are activated by the human touch.

MAGNETIC FIELD SENSOR

Sensor that activates when a magnetic field is introduced.

IN DETAIL

BUTTON

- Size: approx 10x10 mm
- Cost: 0,10 - 2 €
- Buttons can differ a lot in size, shape, price, etc.

TOUCH SENSOR

- Size: approx 20mmx30mm
- Cost: 5 - 10 €
- These sensors have capacitive properties to switch state with bare touches. Often given in already soldered breakouts.

TOUCH AREAS/PAD/SCREEN

- Size: highly variable
- Cost: highly variable
- Composed of arrays of capacitive sensors, touch areas are very common as interfaces for devices and interactive appliances. Costs and dimensions can very differ according to the purpose of use and quality of the materials (from small phone screen to wide interactive multi-touch monitors).

MAGNETIC FIELD SENSOR

- Size: approx 10x10 mm
- Cost: 1 - 3 €
- Often used for mechanical applications (limits, proximity sensing, angular detection) these sensors offer an efficient way of communicating states among different devices but can suffer significantly from environmental interferences.

MICROPHONE

TRIGGER

SENSORS

SOUND

Sound can be measured in its intensity (using a microphone) or transformed in a button (have you ever seen a light turning on when you clap your hands? That's it!)

DIFFICULTY RANGE

easy ●—●—○—○—○ hard

1 2

COST RANGE

cheap ●—●—●—●—● costly

1 5

MICROPHONE

Sensor used to detect and record sounds.

TRIGGER

Sensor acting as a sound-activated switch.

IN DETAIL

MICROPHONE

- Size: approx 100x50x50 mm
- Cost: 4 - 35 €
- Based on different technologies and materials, the cost of these sensors can highly impact on the quality of the measurements. For sophisticated tasks, such as high-quality recording or audio analysis, several microphones are often necessary as well as other tools (filters, current regulators, noise reducers).

TRIGGER

- Size: approx 20x50 mm
- Cost: 1 - 5 €
- Simple microphone used to detect the sound intensity of the environment. Generally used as trigger to activate controllers, it's of no use for situations involving any audio quality.

AIR

WEIGHT

FLEXOMETER

SENSORS

PRESSURE

A group of sensors appropriate for the measurement of force applied to specific surfaces.

DIFFICULTY RANGE

easy ●—●—●—○—○ hard

1 3

COST RANGE

cheap ●—●—●—●—○ costly

1 4

AIR PRESSURE

Sensor measuring the barometric pressure of an environment.

FLEXOMETER

A tool for measuring the flexibility of a body.

WEIGHT/PRESSURE

Used to calculate the amount force applied to a surface.

IN DETAIL

AIR PRESSURE

- Size: approx 30x30x60 mm
- Cost: 10 - 20 €
- Family of sensors used to measure gas or liquid pressure in a closed environment. Relative to the technology underlying the sensor, it can greatly differ in quality and scope.

WEIGHT/PRESSURE

- Size: approx 40x40x10 mm
- Cost: 5 - 100 €
- Used to measure the direct force applied on them, these sensors are divided according to their range of load and multiple ones are often used to obtain reliable measurements.

FLEXOMETER

- Size: 10x80x2 mm
- Cost: 2 - 5 €
- It's a particular thin film that changes the resistance when you bend it.

RFID/NFC

BEACON

SENSORS

TAG

It's a way to attach a label (tag), readable by electronic boards. It's a way to recognise things or info associated with those objects (if I find that label, do this operation). Same tech used for your office badge or coffee key.

DIFFICULTY RANGE

easy — 2 — 4 — hard

COST RANGE

cheap — 1 — 2 — costly

RFID

Uses radio frequency to read data from a tag.

BEACON

Enables interactions with objects and locations through app-based interfaces.

NFC

Uses high-frequency radio signal and can act both as a reader and a tag.

IN DETAIL

RFID

- Size: approx 30x20 mm
- Cost: 0,50 - 10 €
- RFID technology comprises a thin metal label storing information (generally, 2KB) that can be retrieved by a reader. Cheap and reliable, it's often used in storage and tracking applications.

NFC

- Size: approx 30x20 mm
- Cost: 0,50 - 10 €
- Functionally similar to High Frequency RFID technology, NFC tags can also be rendered on electronic devices allowing interactive reading and file sharing (especially useful on smartphones).

BEACON

- Size: approx 40x40x40 mm
- Cost: 10 - 50 €
- These standalone smart objects exploit bluetooth and WiFi networks to provide metadata or feedback from the environment they’re in. Widely used in augmented reality scenarios and Internet of Things applications.