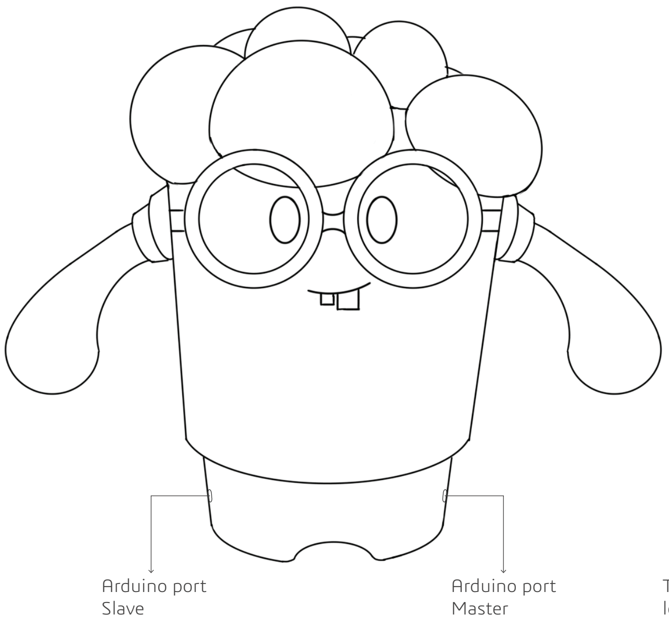
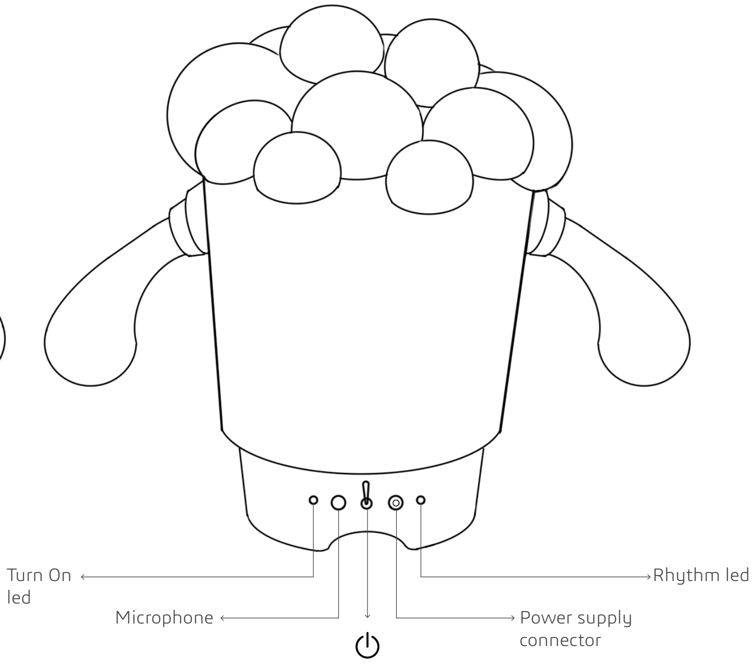
DAN

CREATIVE
ENGINEERING

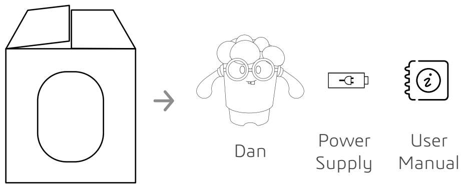
USER MANUAL



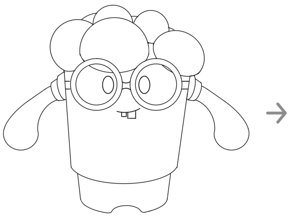


COMPONENTS

Inside box:



Inside Robot:



4 Servo motors
2 Arduino microcontroller
1 Integrated equalizer
1 Microphone
1 Driver Board for LEDs
1 Switch-mode buck regulator
LEDs (cold-white color)
Cables and connectors
Screws and bolts

PRECAUTIONS

Not waterproof

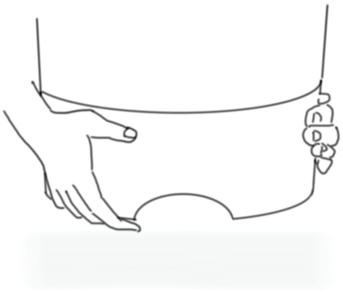
Keep the robot away from heat sources

Keep away from fragile objects

In case of outdoor usage, cover the robot if it starts raining

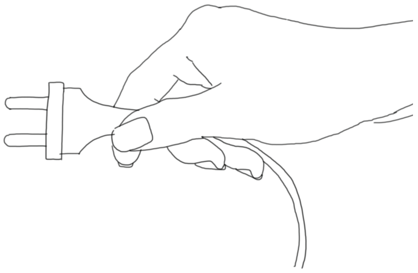
Do not attempt to open the robot

INSTRUCTIONS

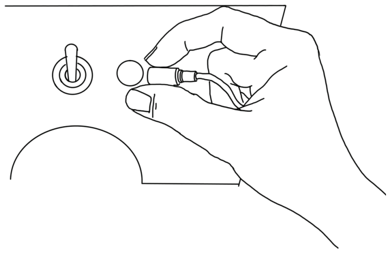


1. Place the robot DanCE on a table.

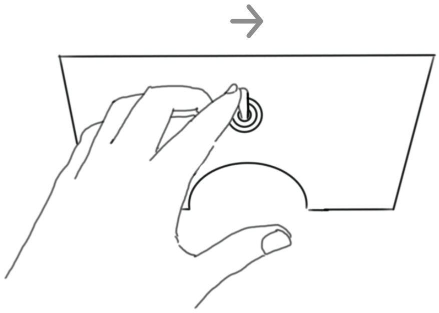
⚠ Ensure that there are no near fragile objects and/or overthrowable items filled with fluid; the robot is not waterproof



2. Plug the power supply 12V in a normal socket.

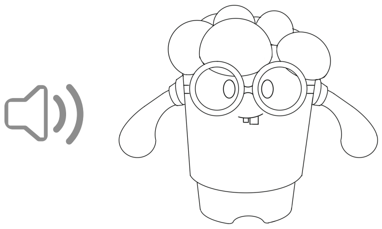


3. Plug the power supply to the port on the rear of the base.



4. Put the switch placed in the base in the “on” position.

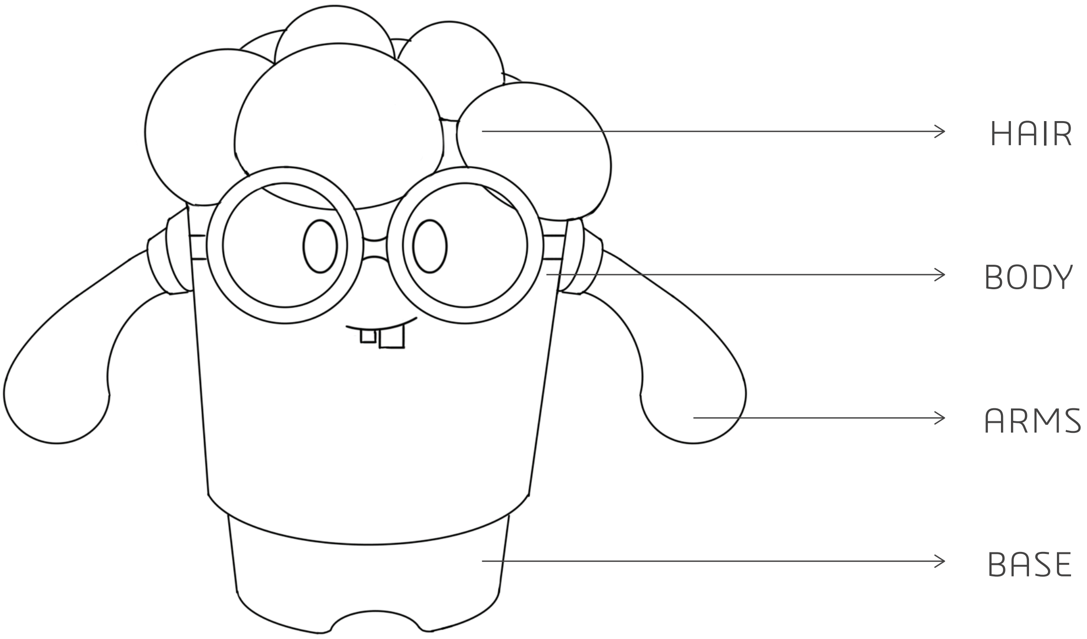
⚠ Warning! The robot when switched on can perform some adjustment movement.



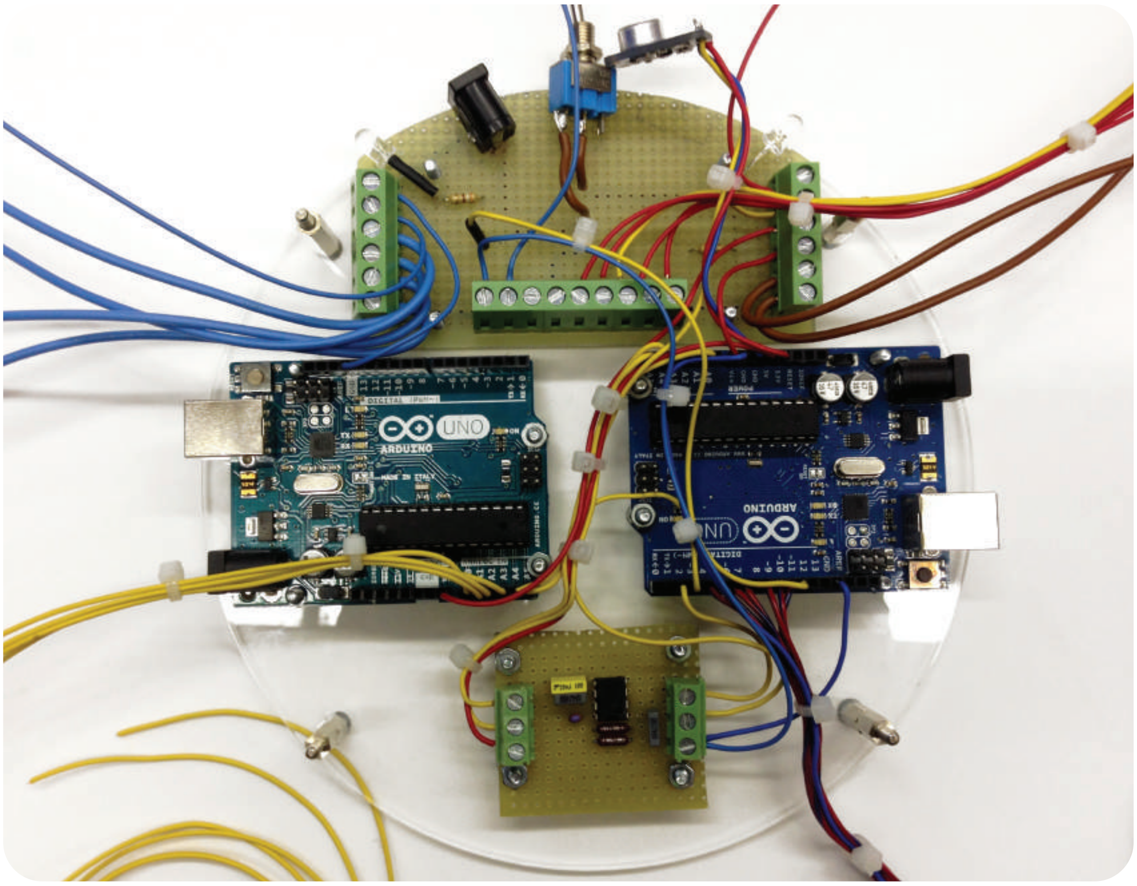
5. Place the robot about 30cm from the source of sound.

⚠ This distance can vary according to the volume of the music, we suggest to switch on the robot before the music starts and check the white LED to see if the robot hears the music.

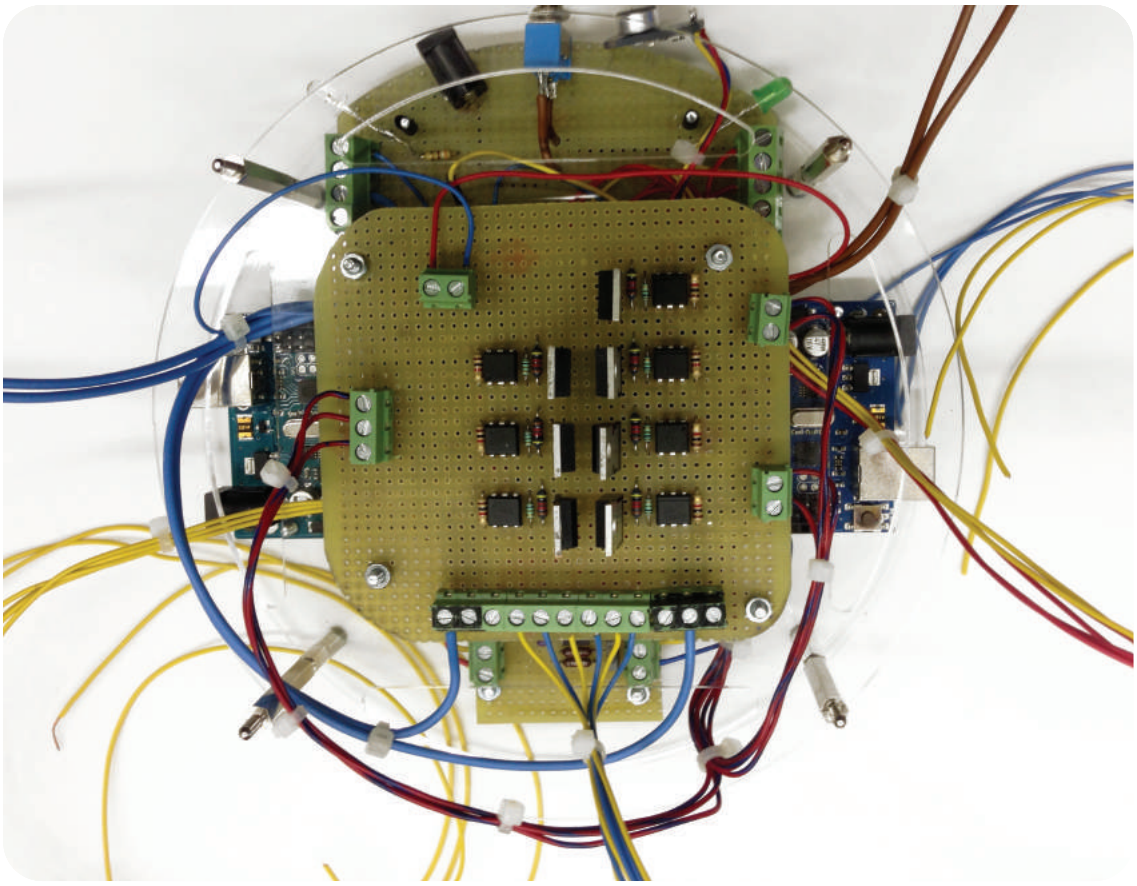
STRUCTURE



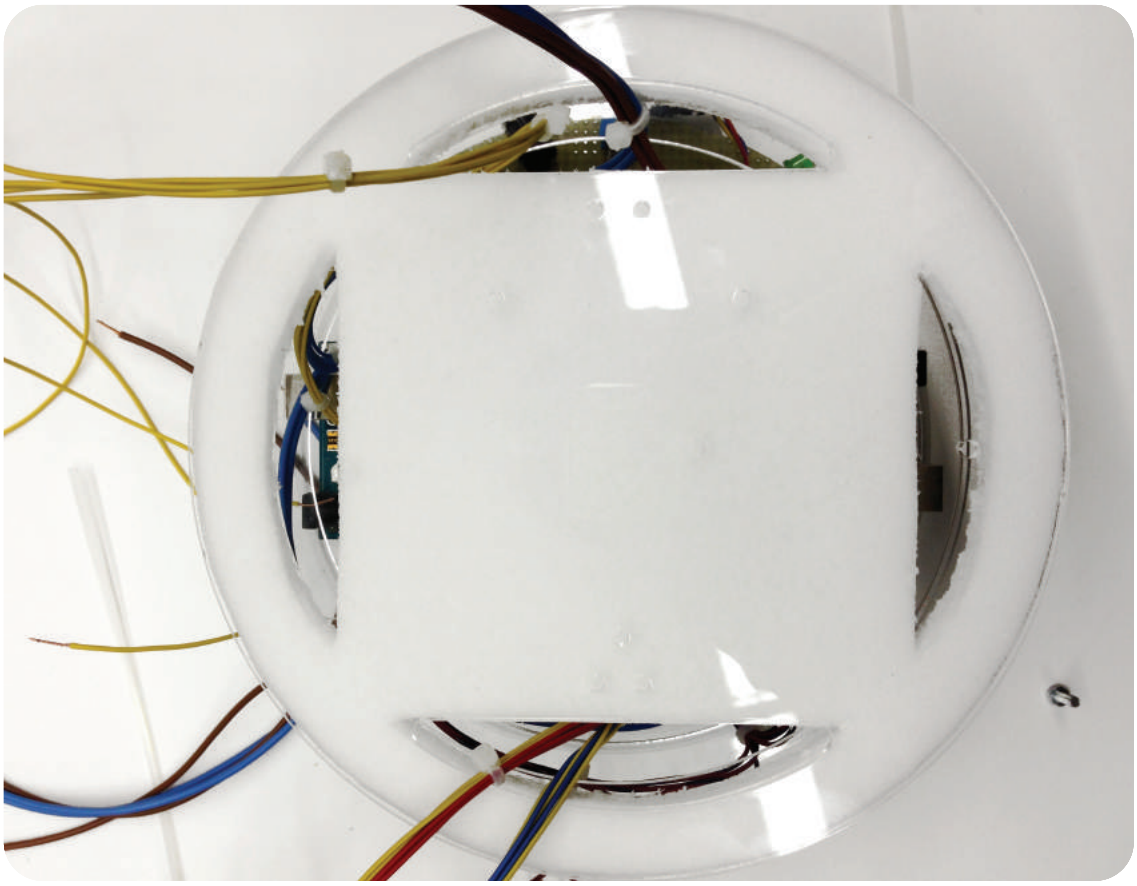
BASE
FIRST FLOOR



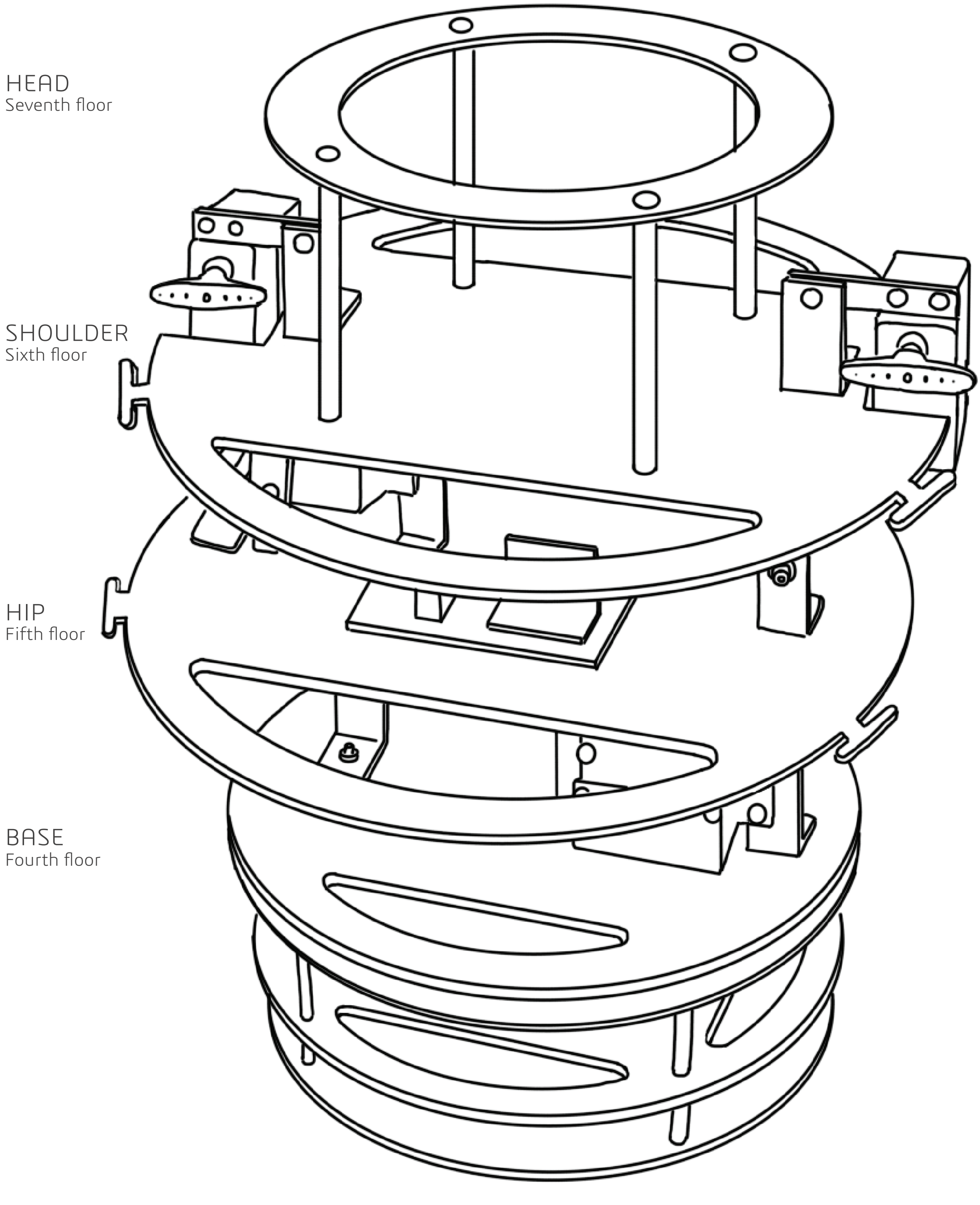
SECOND FLOOR



THIRD FLOOR



BODY

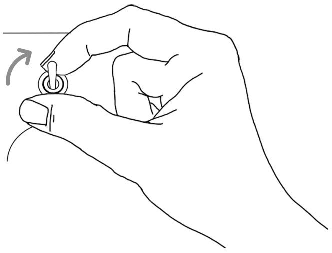

HEAD
Seventh floor
SHOULDER
Sixth floor
HIP
Fifth floor
BASE
Fourth floor

DISASSEMBLY INSTRUCTIONS

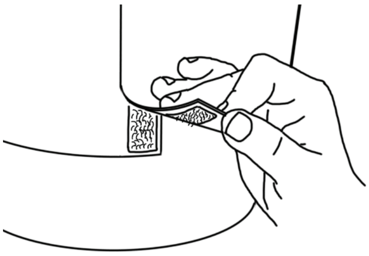
⚠ Warning!

Do not attempt to open the robot.
Not all components can be disassembled.
If you have questions or difficulties, contact our support team.
Please follow the instructions carefully.

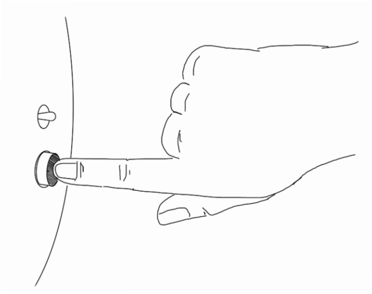
BASE



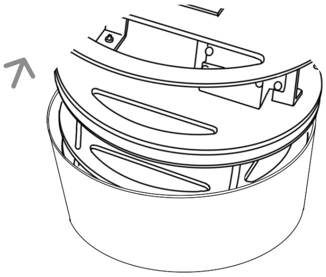
1. Release the lock switch.



2. Separate the surfaces of velcro that holds the flexible cover.
   There are located along the sides.

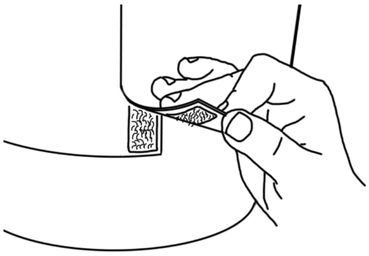


3. Gently press the microphone and switch.



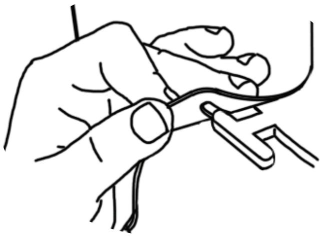
4. Extract the structure, lifting it.

BODY



1. Separate the surfaces of velcro that holds the flexible cover.
   There are located along the sides.

   ⚠ The cover can not be opened fully. The hair is permanently fixed to the cover.



2. Disengage the cover embedded on the disks. There are 6 cover supports, 4 at the sides near the arms and 2 in the back.

   ⚠ It is recommended not disassemble arms.

REPORT

CHOICES AND MOTIVATIONS

Motors:

The robot is realized by using 4 servo motors: 2 for the arms, 1 for the lower part and the last for the medium part; this configuration let us to give the robot a movement similar to a 70s dance song choreography. All the motors are directly attached to the part they move while the support bars have ball bearings in order to reduce frictions and mechanical issues due to the passive movements; we haven't found any kind of problem concerning the weight of the robot and the motor placed in the base was able to move all the structure.

Arduino:

To achieve a good computational power and allow the robot to perform the correct movements we've used a "Master-Slave" architecture with 2 Arduino "uno": this allow us to compute more accurately the rhythm of the song and select the movement independently from what the robot is doing solving the problem of synchronization.

We realize this architecture thanks to the Wire.h library.

To allow the motors to perform a smooth movement, the "Slave" Arduino imports the VarSpeedServo.h library.

Structure and material:

The cover of the robot is made by a flexible material (EVA), in this way we allow the robot to perform the desired movements while the arms are more rigid.

For the internal structure we've used rigid materials as plexiglass disks (3mm of thickness and cut with laser technique for higher accuracy) and plates in aluminium to avoid mechanical problems and maintain a lightweight of the entire robot.

The strucutre is divided in:

1. Base
2. Hip
3. Shoulder

On the shoulder part we've mounted the servo motors that pilots the arms, these last ones have an aluminium bar inside while outside is polyethylene and plaster in order to have rigid structure.

To join together the 3 substructures, we've used some metal plates fixed with screws on the disk and the motors of the internal part are linked to the disks through bars: to allow that rotation of this bars became a translational movement, on each disk we've mounted (aligned with motors) some support bars made of the same material of disks.

The electronic part of the robot is situated on the lowest part of the robot, we needed to make some holes on disks in order to allow cables to reach the top of the robot to light the LED placed in the "head" of it. We put some details (Polypropylene and Eva) into the Robot to show better the design concept.

Electronics:

As supply we've used a 12V 4A power supply in order to give current to the 4 servo motors, the two Arduino microcontrollers and all the LED that lights the head of the robot: actually the single led displayed in the circuit is a vector of 3 LEDs.

To reduce as much as possible the space occupied by the electronic components, we've used veroboards.

To further reduce the computation of the Arduino (avoiding synchronization problems) we've installed the "MSGEQ7" integrated circuit that given the signal in input provided by the "MAX4466" microphone (supplied with 3,3V) and gives as output 7 values corresponding to 7 preset frequencies, this allows us to receive more information from the audio signal and choose the the movement to perform according to the frequencies.

We've chosen that microphone because was small and amplified so less weight of the robot.

Obviously we've used capacitors and resistances to allow everytihing working correctly and a stabilizer (not shown in the electronic diagram) to give 5V to the motors and a dissipator to avoid overheating; to switch on LEDs without problem we've applied optocouplers (see electric diagram).

At the end of this document you can see the entire electric schema.

Software:

As mentioned, we've implemented a "Master-Slave" architecture that work in this way:

The master get the signal from the integrated equalizer, stores the value of three frequencies in three different arrays and for each of them, the master compute the average among 15 samples and store it again in an array of 100 values: this last one is the array which allows us to choose the movement and switch on the LEDs.

After this, basing on the difference of the values we've computed in the past we decide which set of movement to perform and send this choice to the "Slave" by using the function Wire.write();.

The "Slave" in notified with the function Wire.onReceive(); and perform an action that is a particular movement: to avoid repetition of the movements we keep track about the previous performed movement and after a certain time (value stored in variable DELTA_TIME) the software select a different movement to perform.

We've used many functions to make the robot moves in order to give the software high modularity: in this way, any modification required was easier to apply.

PROBLEMS AND SOLUTIONS

- The used servo motors have enough torque to move all the structure: during the realization it happened that the movements were too wide and could bring damages to the structure. Consequently we have placed physic limit switch (simple metal bars) to stop earlier the movement.

- The material for the base was too light: to avoid overbalancing and falls of the robots we have added some heavy plaster to reach more stability by increasing the weight of the base

- To avoid the weight of the robot to crush the electronic components situated under the base, we've separated this last ones with some spongy material and different electronic part of the base are separated with some spacers in 2 levels.

- The robot was too reactive to the music because of high range of value: this implied a low variable selection of the movement to perform.

We tried to compute a sort of fuzzyfication in order to know the level of the various frequencies but we were loosing much information about the music so this idea was discarded.

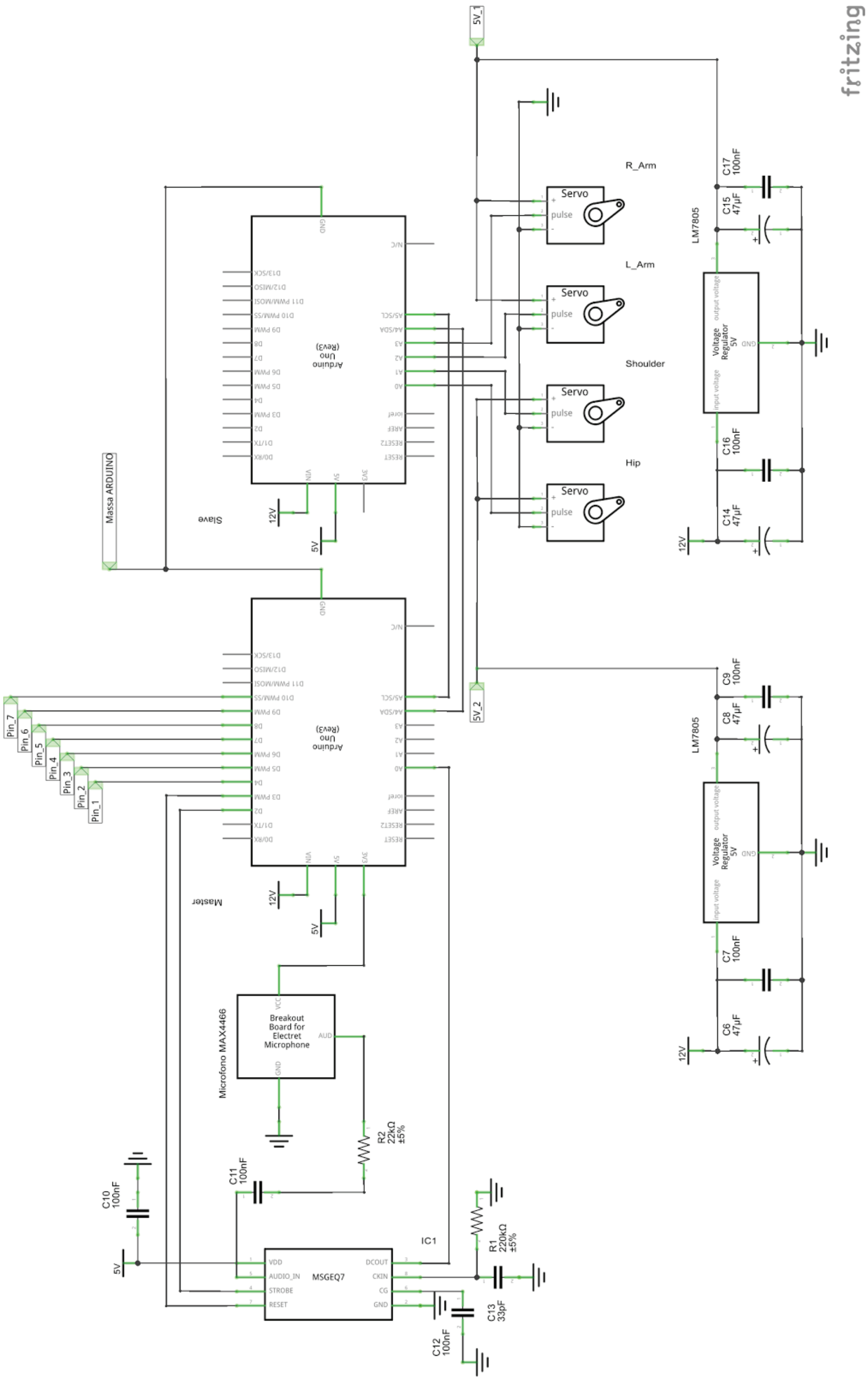
To solve this problem definitively we have decided to implement an algorithm that computes the moving average of the signals with a window of 100 value where each value is the average of 15 samples: during the performance, the "Master" compute the average of the values in the window that is continuously updated

- We have encountered a problem with the library VarSpeedServo.h used to pilot the servo motors "MG995" that at a certain point they stop working: we've substitute them with other servo motor "E303"

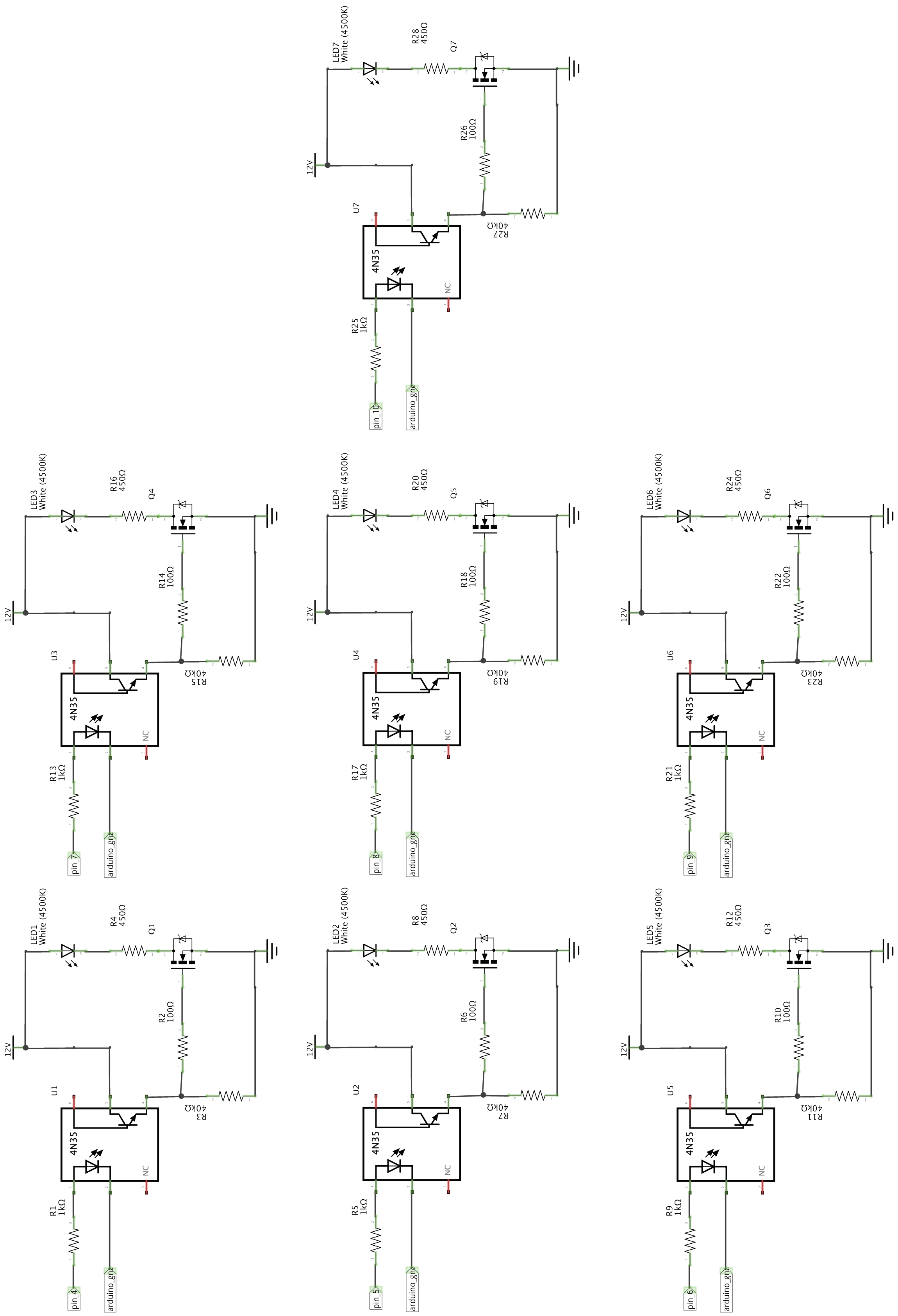
- The transparent plastic wasn't a proper material for holding the color, so we decide to use for the head the same material of the body but coloured: the thinness of the material allow us to don't loose the LED effect and the shape we gave to the head gives the idea of curly hair.

- At the beginning the head didn't have any kind of support but we encountered a problem to keep stable the part with hair: to overcome this problem we add a disk on top of the shoulder.

ELECTRONIC CIRCUIT DIAGRAM



ELECTRONIC CIRCUIT DIAGRAM
Led Board



fritzing

BILL OF MATERIAL

Final product

COMPONENT	QUANTITY	COST
Equalizer	1	€ 10,00
Servo motors	4	€ 40,00
Microphone	1	€ 22,00
Switch-mode buck regulator	1	€ 19,50
Vector LEDs	1	€ 17,00
Screws and bolts	—	€ 20,00
Ball bearings x4	4	€ 4,00
Cables	—	€ 8,00
Veroboards	—	€ 10,00
Capacitors and resistors	—	€ 15,00
Power Supply	1	€ 18,00
Plexiglass	1	€ 25,00
Laser Cut	1	€ 20,00
EVA	10	€ 20,00
Velcro	2 mts	€ 6,00
Spray Paint	1	€ 6,50
Wood Plastic (Ciba)	1	€ 38,00
Polystyrene	1	€ 10,00
Polypropylene	1	€ 10,00
Box	1	€ 2,00
Others	—	€ 20,00
		€ 341,00

Process (Prototypes and testing)

Servo Motors	4	€ 60,00
Equalizer	1	€ 9,00
LED stripes	1	€ 17,00
Power Supply	1	€ 20,00
Design Material 1st prototype	—	€ 95,00
Box	1	€ 2,00
Others	—	€ 35,00
		€ 238,00

CREATIVE
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