DESIGN & ROBOTICS

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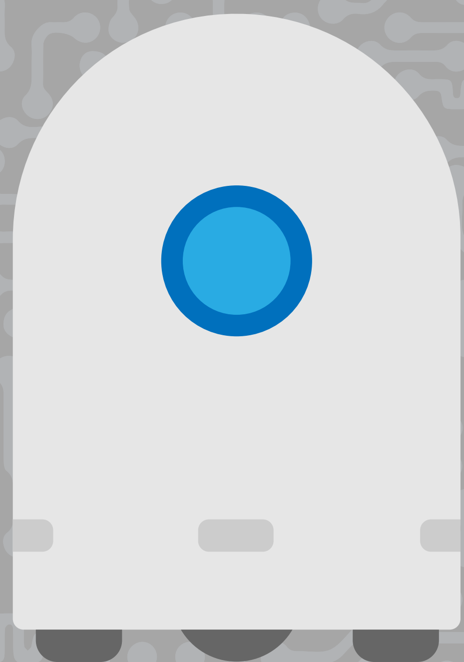


• ABSTRACT

The aim of our robotic toy, EEVA, is to interact with children both in an autonomous mode, with a funny and particular personality given by its peculiar sounds and multicolor lights, both in a controlled mode, using an iPhone/iPad as remote. Moreover the kid will be able to wake EEVA up and make it sleep by just knocking on its head and covering the top of its case, respectively. The kid could also build some paths of different difficulty and try to drive EEVA along them. More kids could challenge on the same path using their EEVA.

• LONG DESCRIPTION

TECHNICAL FEATURES

EEVA is a complex piece of technology that uses many sensors to achieve its functionalities. Here follows a list of all component and their purpose.
First of all we choose to use Arduino Mega 2560 instead of Arduino One because we need lots of output (for example EEVA has more than 20 LEDs) and at the same time a larger memory.
In order to give to EEVA a very fluid way of moving we bought four OmniWheels, a special type of wheels that allows to move in every directions. Every wheel is connected with a DC motors Micro Metal Gearmotor that combine a good power with very little dimensions. In order to handle four wheels in an easy way we use two motorshields that allow to control the four motors in both intensity and direction. The motorshields take the alimentation directly from the LiPo battery in order to provide the necessary current to the motors.
EEVA is equipped with four proximity sensors directed on the four main directions (North South East West). The North sensor, the one in the forward side is used to detect obstacles and to make EEVA avoid them. Moreover each sensor is connected to three red leds that are lighted up proportionally to the distance from the 'seen' obstacle. The central leds are just above the sensors, while the intermediate ones (NE,NW,SE. SW) are lighted up a little less than the central ones using diodes and higher resistors in order to give a fading effect. There are eight leds pointing at the eight main directions that are used for the robot breathe. They are lighted up as a sinusoid wave in order to simulate a sort of 'human' breath. Other eight white leds are positioned on the top of EEVA and they emit a flash of light when EEVA wakes up from sleeping. This behaviour is for showing the robot soul. There is one last led, a blue one: it is EEVA's eye and it points at the front direction, i.e. the direction towards the robot moves in the autonomous mode.
EEVA, as mentioned in the abstract, can be woken up and set asleep. In order to do that two different kind

of sensors are used. A microphone allows to recognise whether EEVA has been knocked twice on its 'head'. When a knock is detected the eye is lighted up, so that the user gets a visual feedback. Regarding the system for setting EEVA asleep, it consists of two photoresistors: the user put the robot in sleep mode just by covering the top of its case with an hand.
Another important feature of EEVA is its sound system. In particular there are two loudspeakers: one of them is used to make EEVA pronounce its name when it awakes (while it 'shows its soul' with the white leds). The other speaker, instead, is used to emit robotic-like sounds. These sounds are obtained by changing randomly the tone frequency in a range between 50 and 10000 Hz and the effect is very 'robotic'. The two speakers are separated because the playback of EEVA's name requires a higher amplification (it is in fact a reproduction of an 8kHz mp3 samples by PWM).
For the bluetooth connection EEVA is equipped with the BLE shield that allows the data transmission with the mobile phone used as remote. An EEVA application for iOS have been designed as part of the final product.
Last but not least a fan is used not to make the internal part of the robot heat too much. It is controlled by Arduino too and it is not active in the sleep mode.
All the electronic circuitry have been implemented on two custom PCBs.

I S S U E S

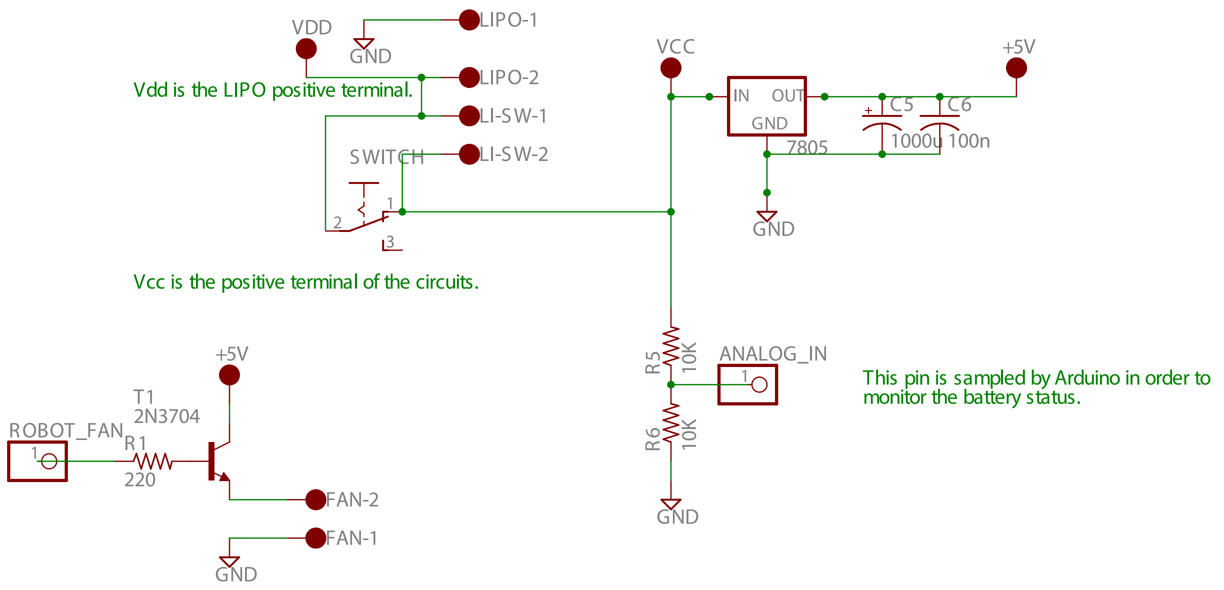
The main issues for EEVA are caused by the robot case. It is a single white thermoformed piece that covers the whole robot. Four 'windows' have been left transparent in order to make the proximity sensors work through it. Actually, in spite of this, the sensors don't work properly: first of all the have a higher basal value, and when the robot moves the vibrations produced make them 'see' an obstacle even when it is not present, because the windows are perfectly sized on the sensors' size. Another problem brought about by the case is about the photoresistors: when the light level is not high enough the photoresistors don't manage to get produce their signal and, thus , the robot can't be put in sleep mode. These issues could be solved using a case with a lighter layer of varnish.
The last problem came out only a few days ago: one of the 4 motors, in fact, stopped working properly and it rotates at a lower speed with respect to the others. The solution to this problem is buying a new motor.

P O W E R   S U P P L Y

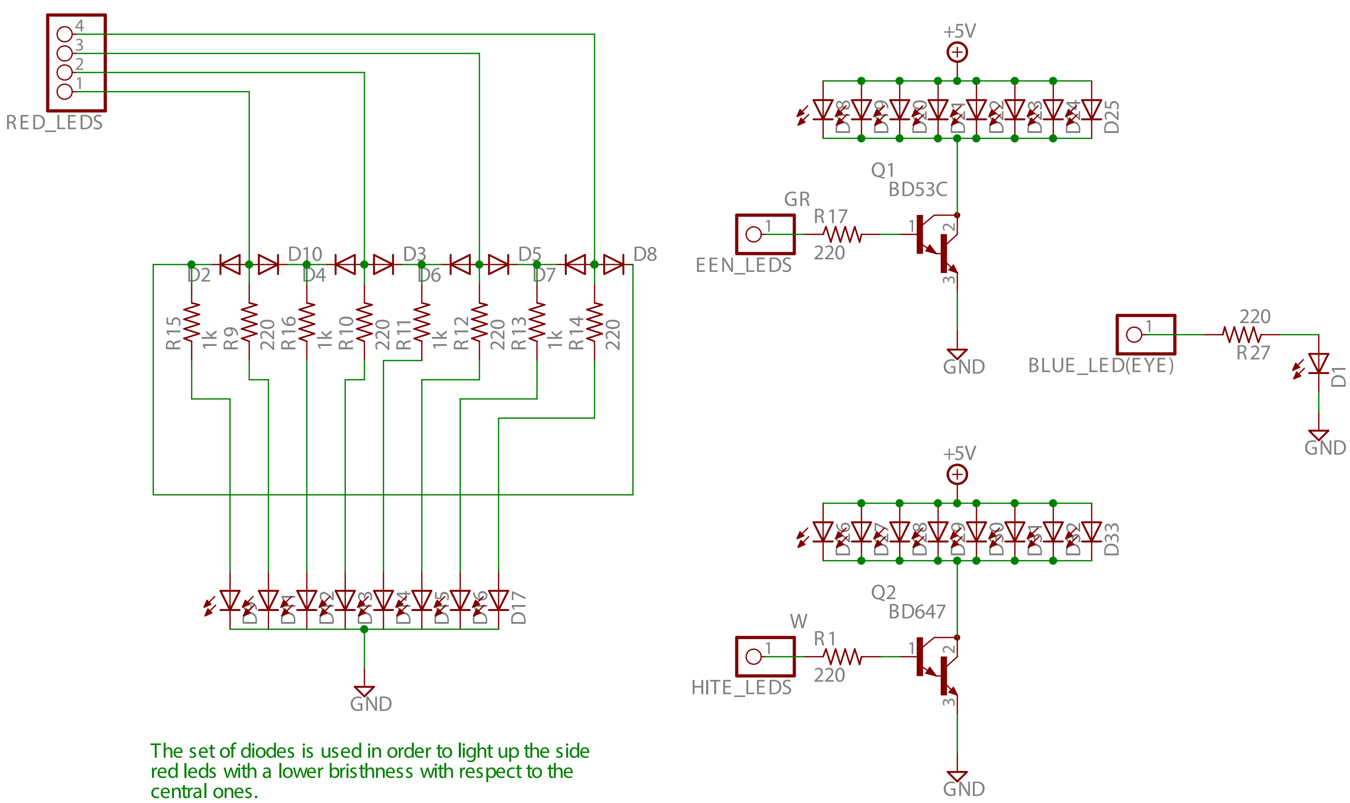
The alimentation has represented a big deal for our robot, because of the many components that requires much current. In the end we opted for a LiPo battery, 2200mAh, 7,4V,25C. This is a good solution for a prototype, but probably it's not the best option for a toy for kids. Under this point of view, maybe another and safer kind of battery could be preferable.

• ELECTRIC SCHEMATA

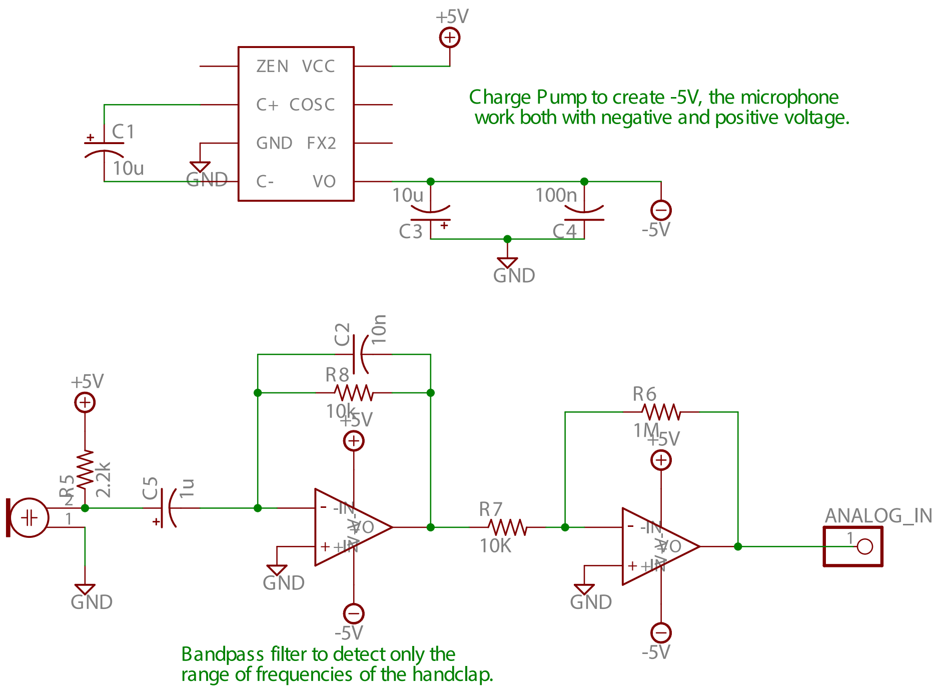
ALIMENTATION



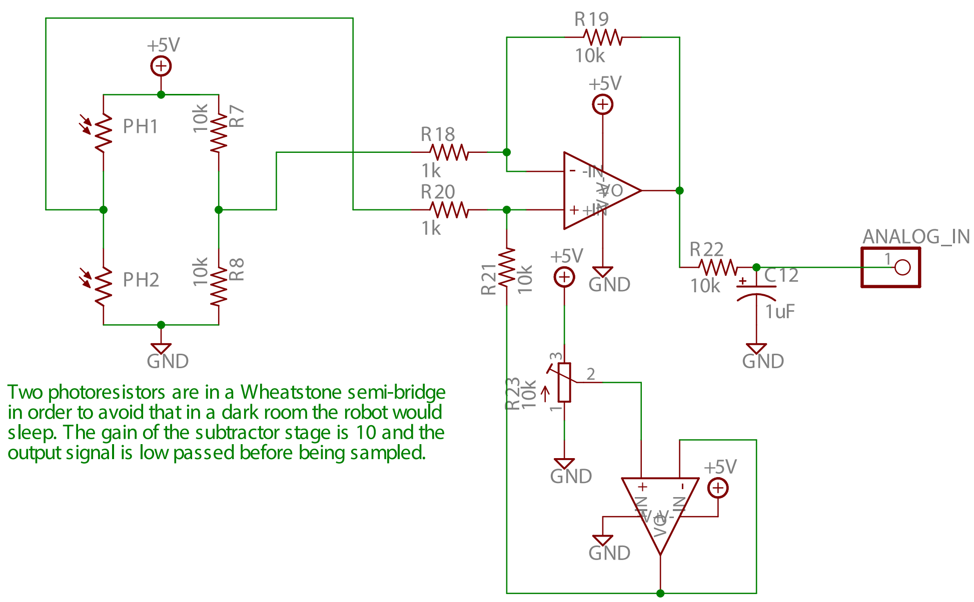
LIGHTS



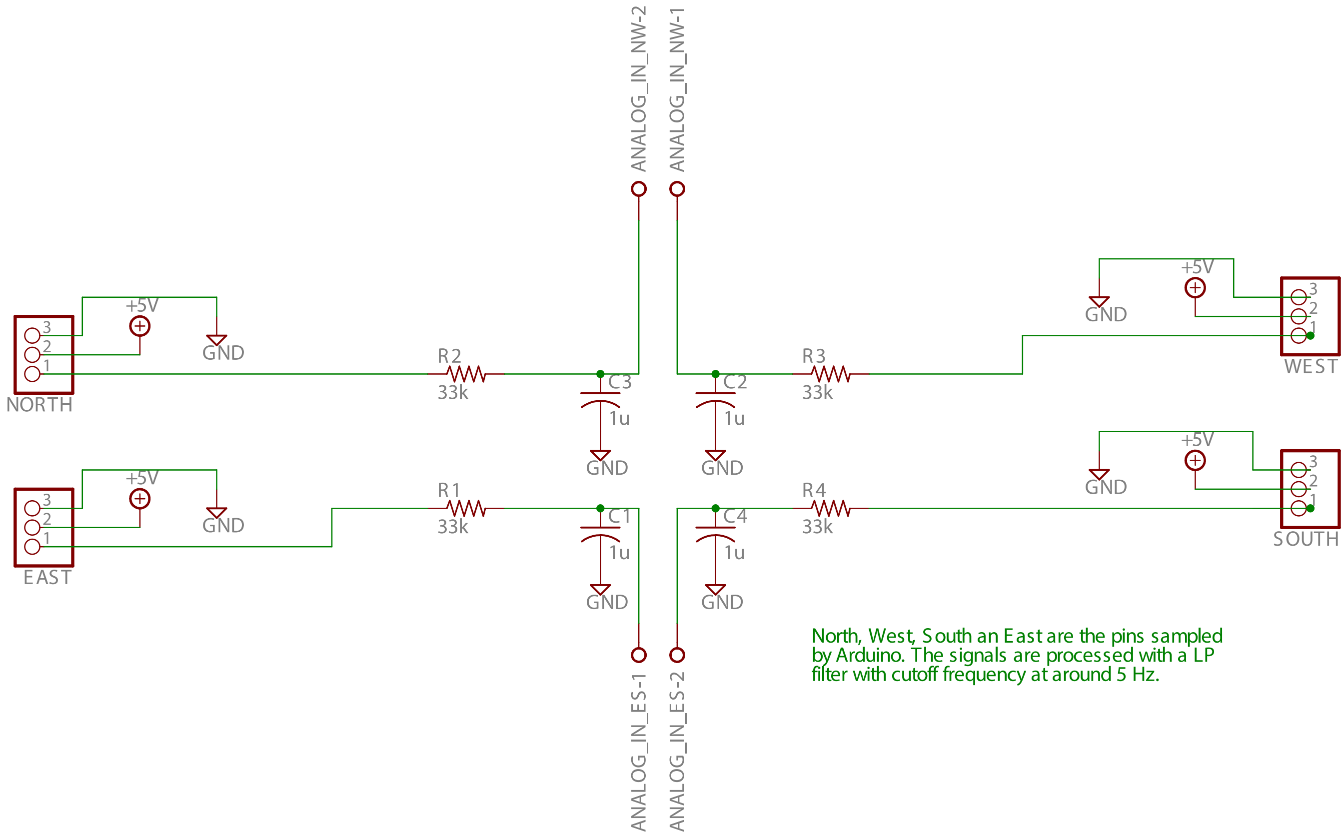
MICROPHONE



PHOTORESISTORS

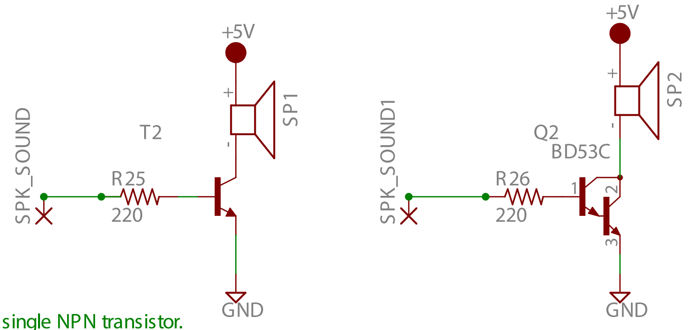


PROXIMITY SENSORS



North, West, South an East are the pins sampled by Arduino. The signals are processed with a LP filter with cutoff frequency at around 5 Hz.

SOUNDS



The first speaker uses a single NPN transistor. The second speaker uses a Darlington configu-ration because it is used to playback an mp3, and it has a lower intensi y.

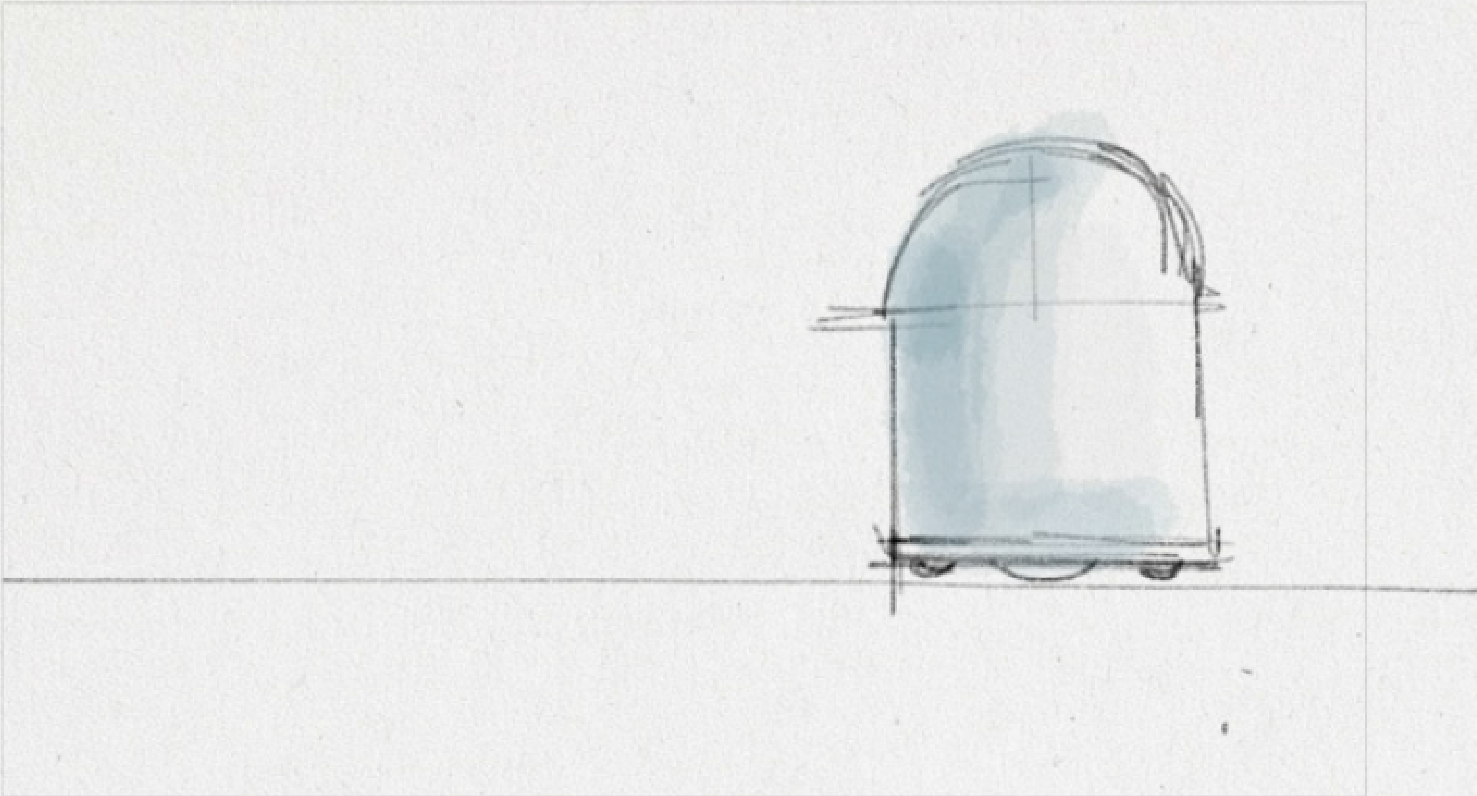
• BILL OF MATERIALS

ELECTRONICS

- 4 x Micro Metal Gearmotor 50:1
- 4 x 40mm Omniwheel
- 2 x 2A Motor Shield For Arduino
- 4 x Infrared Distance Sensor
- 1 x Bluetooth BLE Shield V2.0
- 2 x Mini Photocell
- 1 x Arduino Mega 2560
- 8 x Red HL LEDs
- 8 x Green HL LEDs
- 8 x White HL LEDs
- 1 x Blue HL LEDs
- 1 x LiPo Batterie 7,4 V 2200 mAh 25C
- 1 x Condenser electred microphone
- 2 x Miniature speaker
- 1 x Fan 5V
- 1 x 7805
- 3 x BD53C
- 2 x 2N3704
- 4 x OPA244
- 1 x TC7660
- 1 x Trimmer 10k
- 9 x R 10K
- 4 x R 33K
- 1 x R 2,2K
- 1 x R 1M
- 4 x R 1K
- 10 x R 220
- 1 x C 1000u
- 8 x C 1u
- 2 x C 100n
- 1 x C 10n

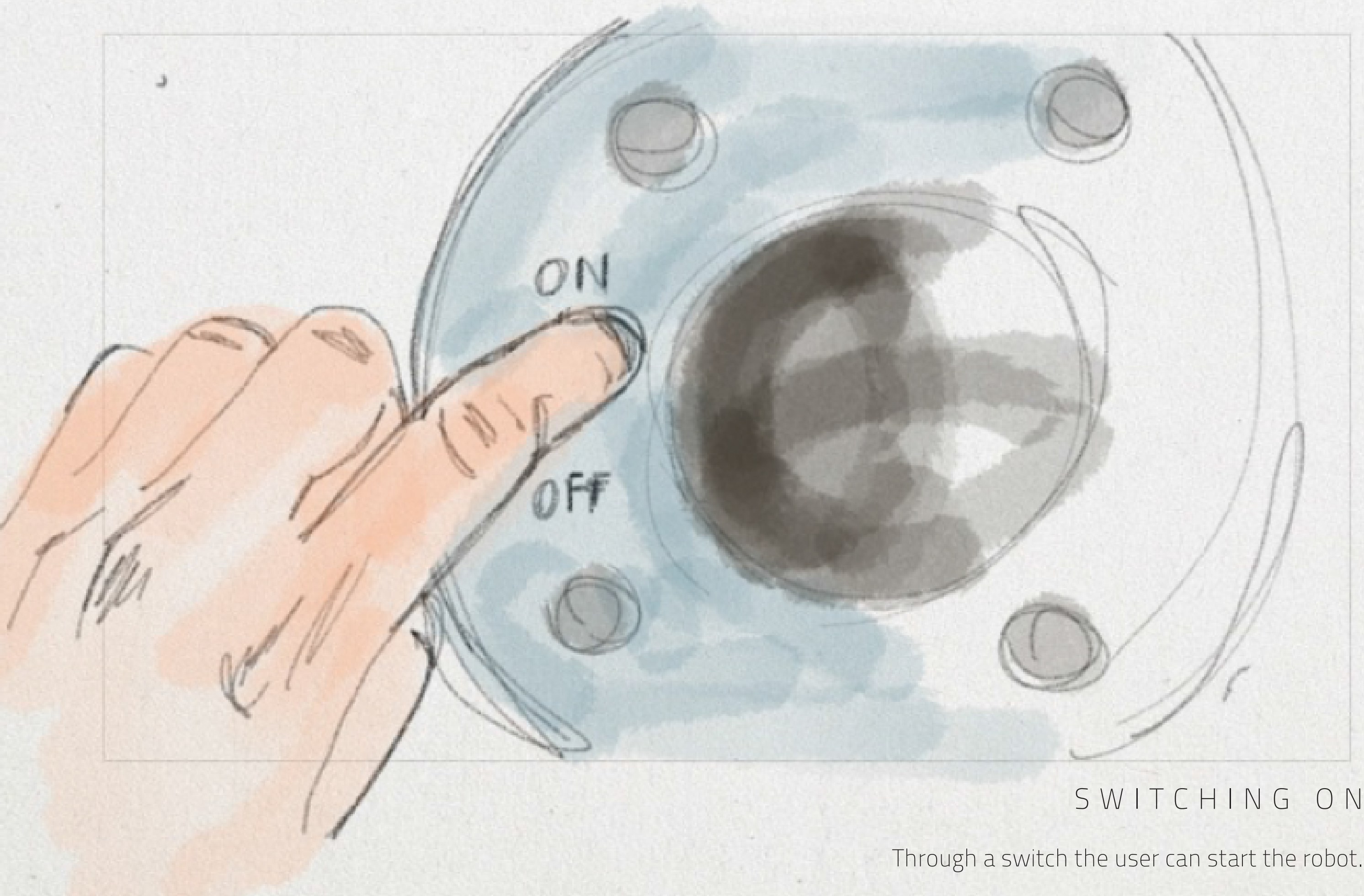
MECHANICAL

- 8 x M4 Bolt 50 mm
- 4 x M4 Threaded bar 100 mm
- 56 x M4 Nut
- 18 x M3 Bolt 10 mm
- 4 x M3 Bolt 15 mm
- 4 x M3 Bolt 30 mm
- 36 x M3 Nut
- 1 x Custom laser cut plexiglass plane 8 mm
- 1 x Custom laser cut plexiglass plane 3 mm
- 7 x Custom laser cut plexiglass plane 2 mm
- 1 x Reflective metal shet
- 1 x PS Case



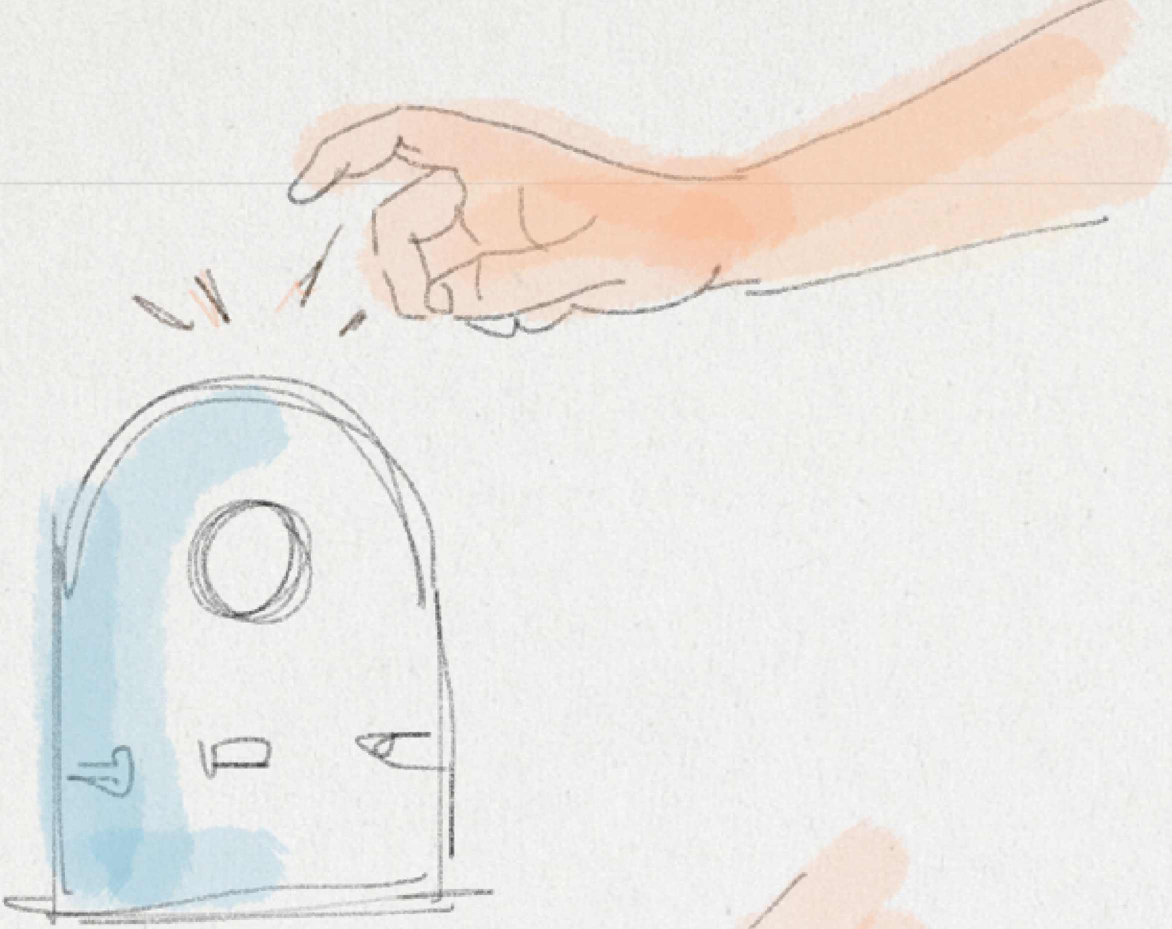
OFF MODE

The robot is still, it has no interaction.



SWITCHING ON

Through a switch the user can start the robot.

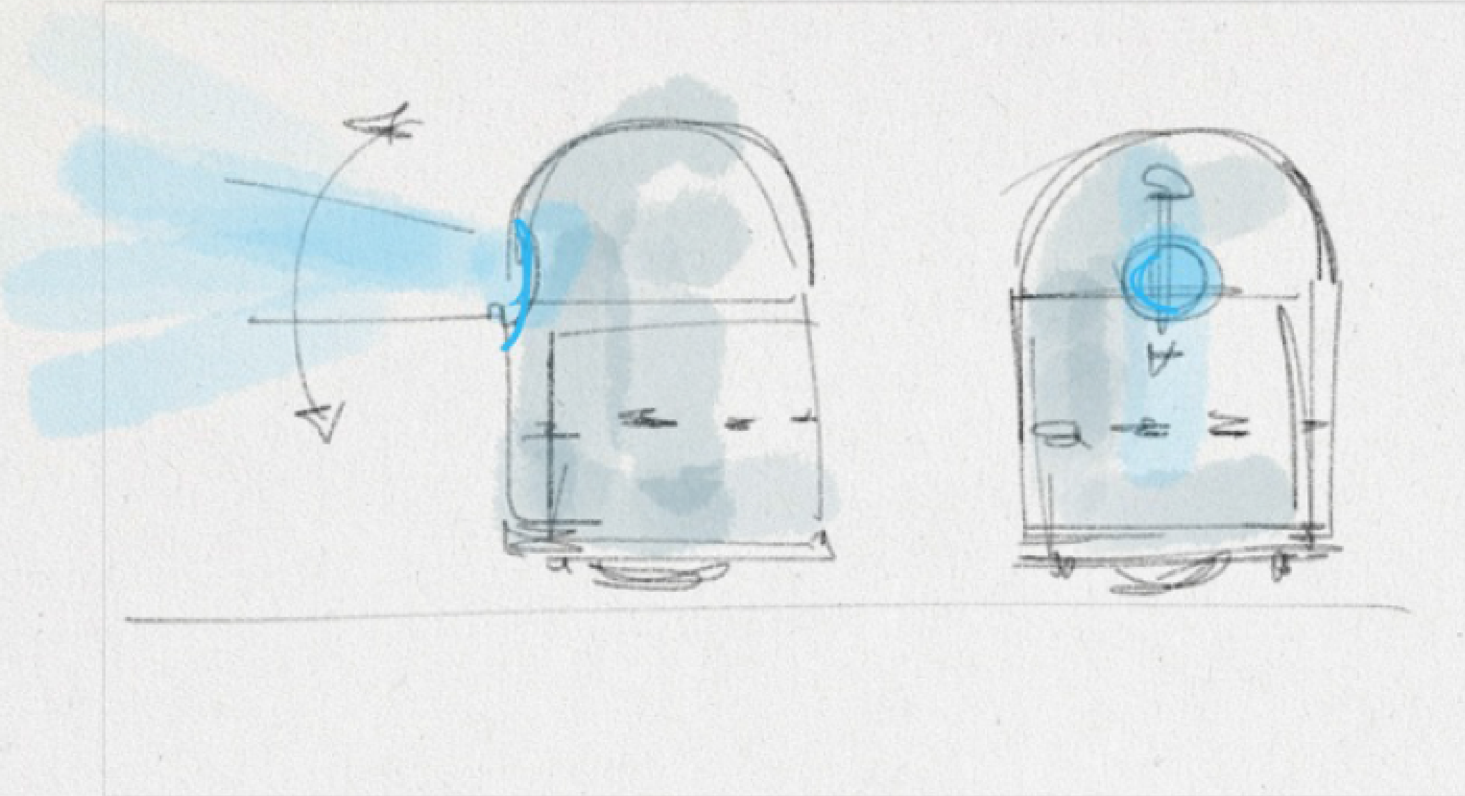


WAKE UP

Wake up Eeva by Knocking twice on its.

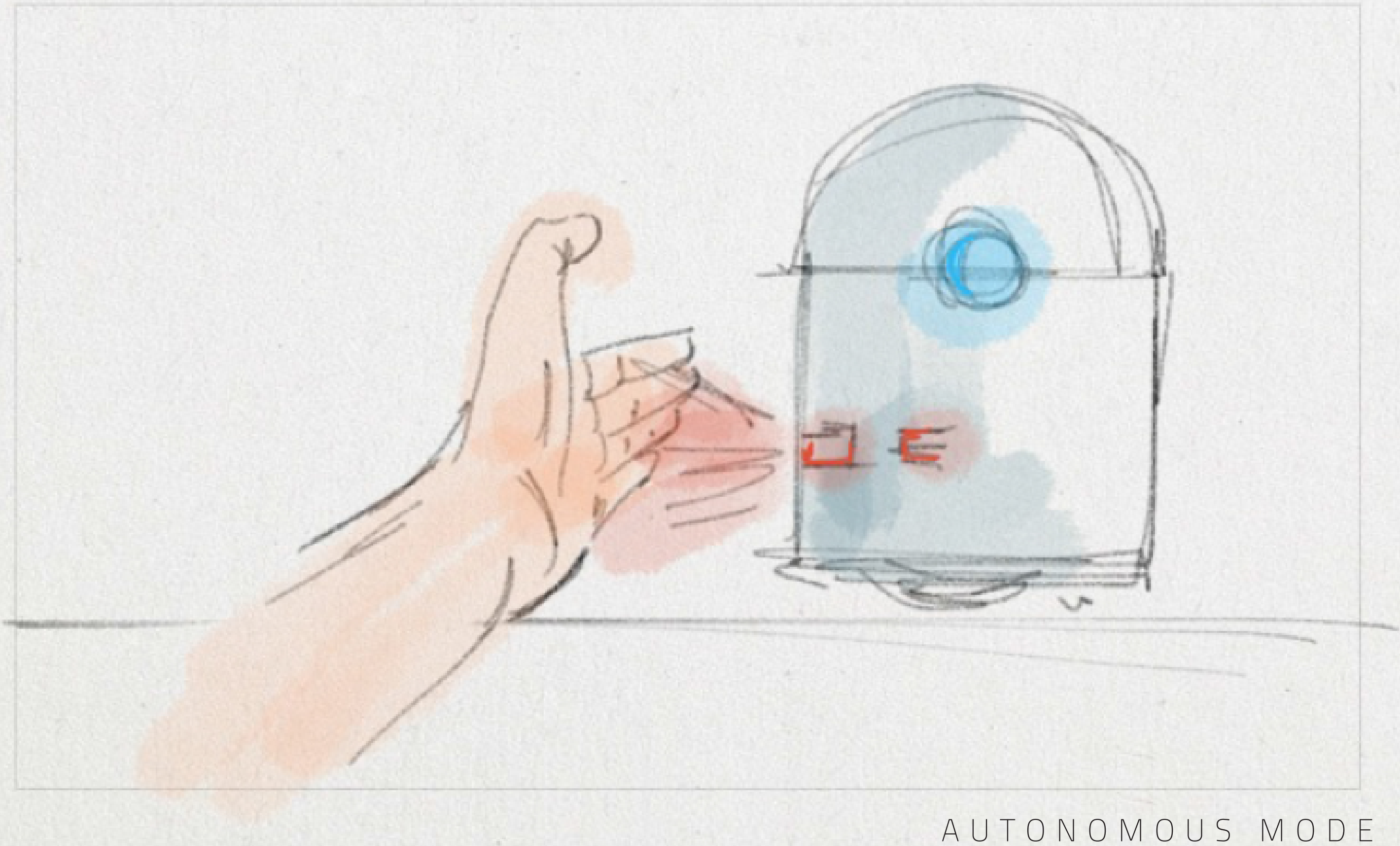
SLEEP

Cover Eeva's head whit you hand to make it sleep.



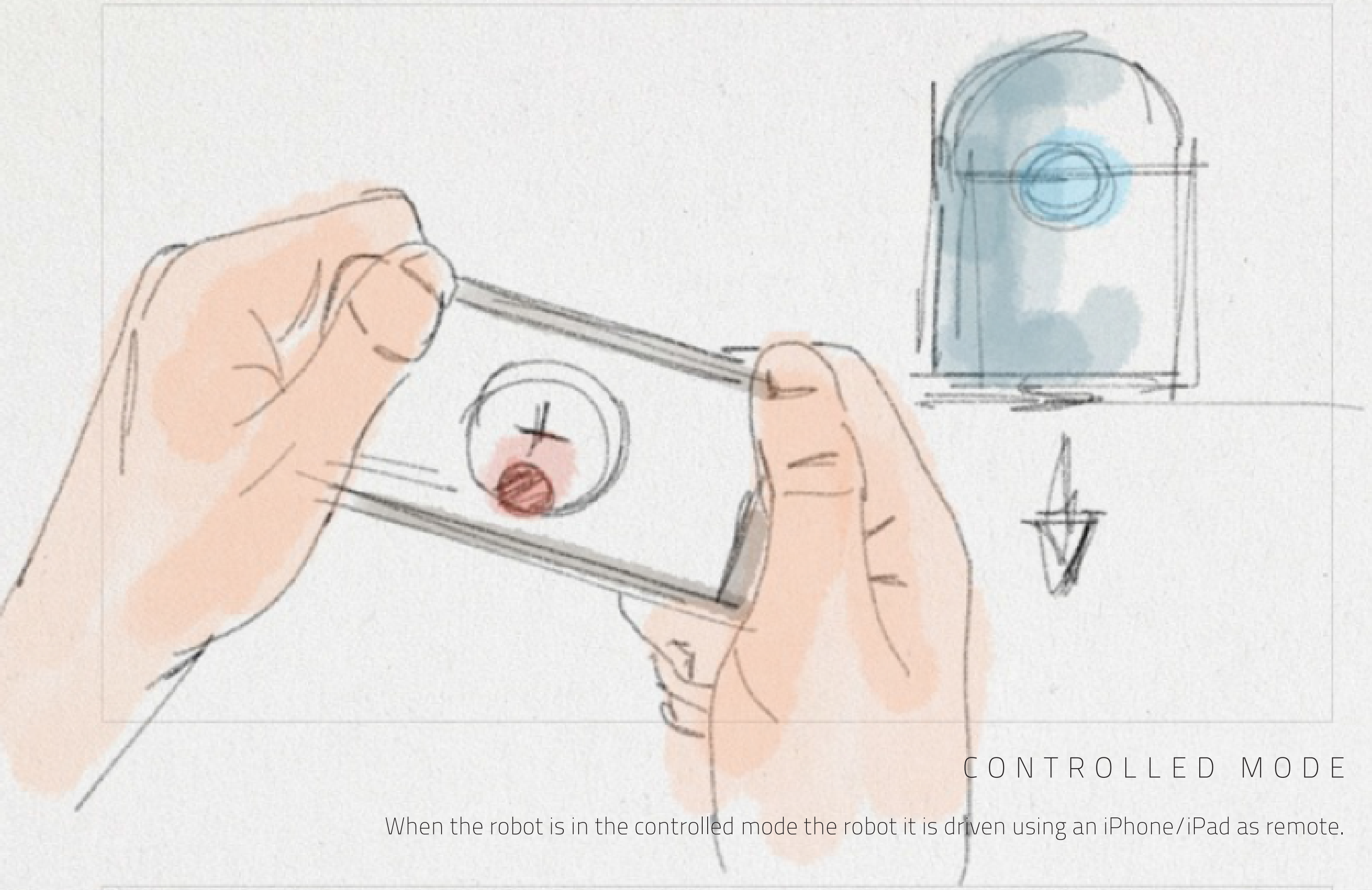
GREETINGS

After the robot awakes, it greets the kid by lighting effects.



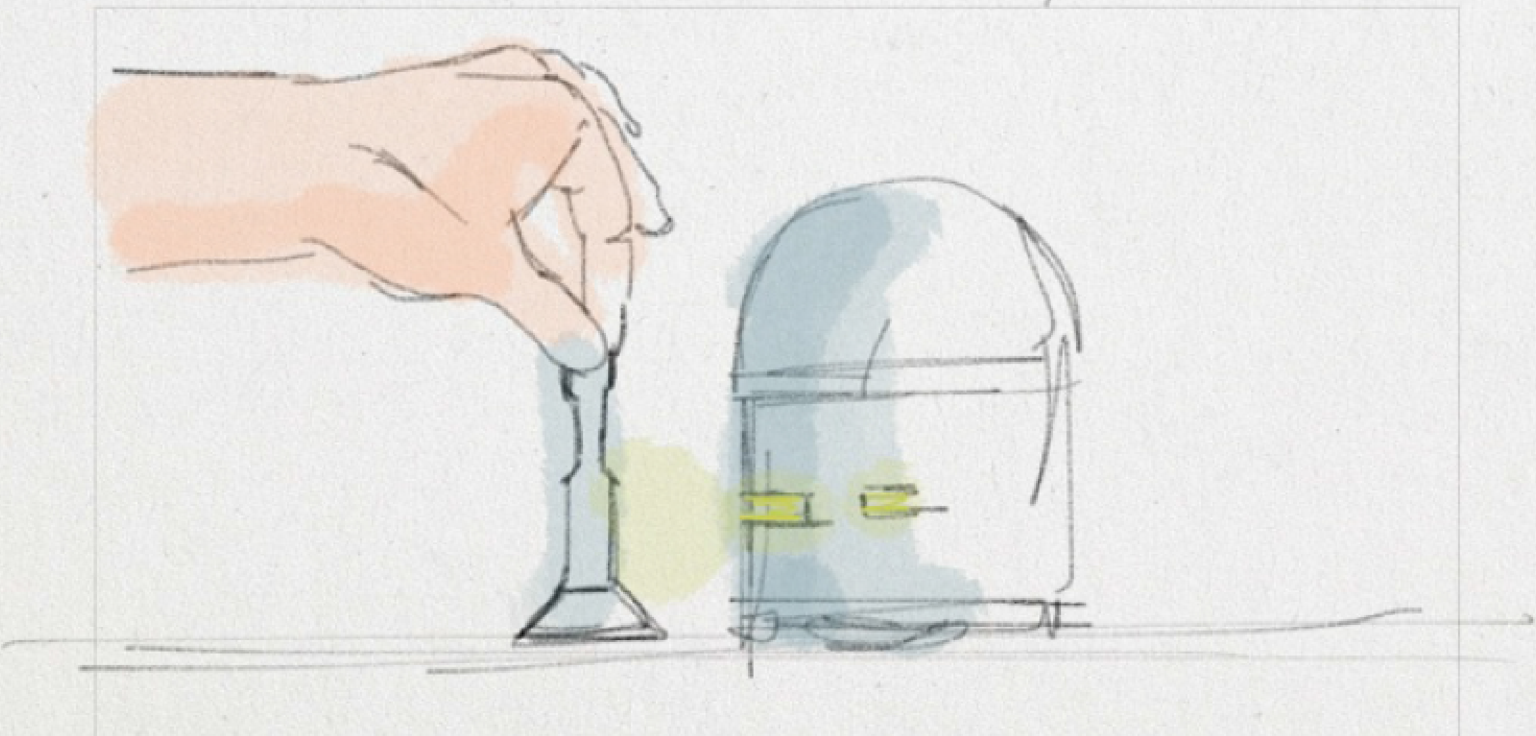
AUTONOMOUS MODE

The robot interacts with children in a funny and particular way, showing its personality with sounds and light effects.



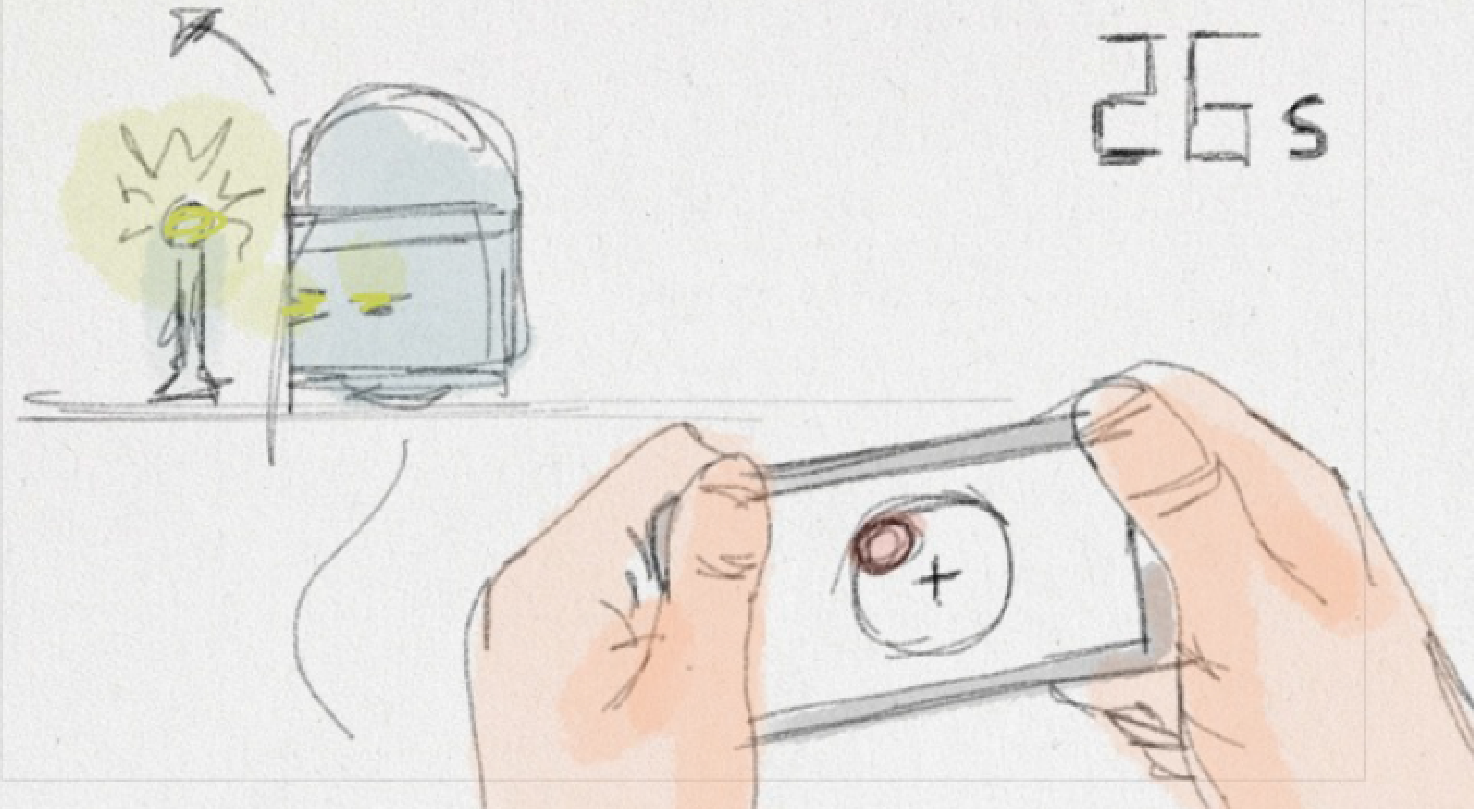
CONTROLLED MODE

When the robot is in the controlled mode the robot it is driven using an iPhone/iPad as remote.



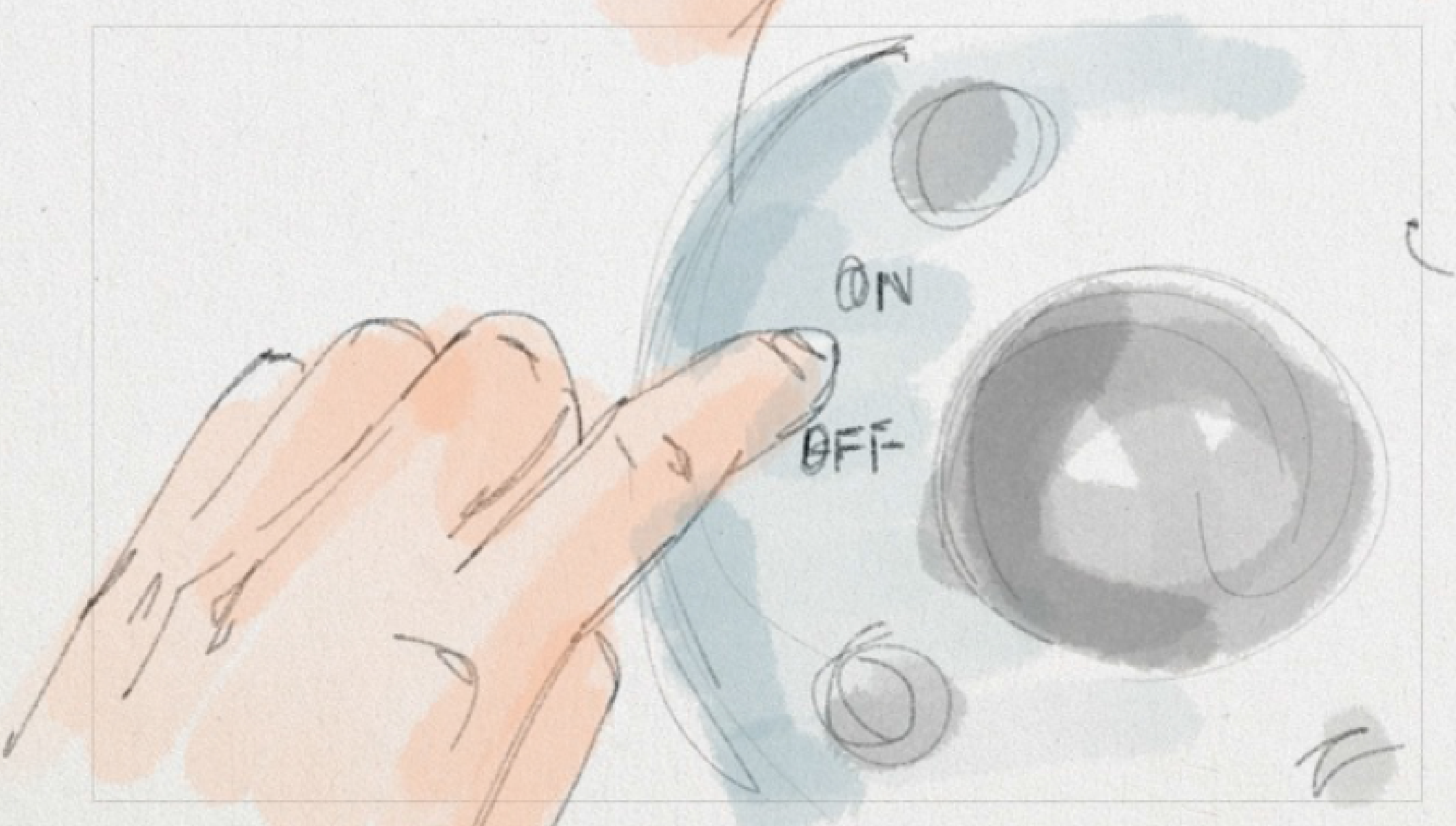
GAME MODE - BUILDING THE PATH

The robot tells the kid where to place the doors for the game, by reaching the door spot and lighting its side leds.



GAME MODE - PLAY LEVEL

The child drives the robot through the sequence of doors and the aim is to reach the end of the path.



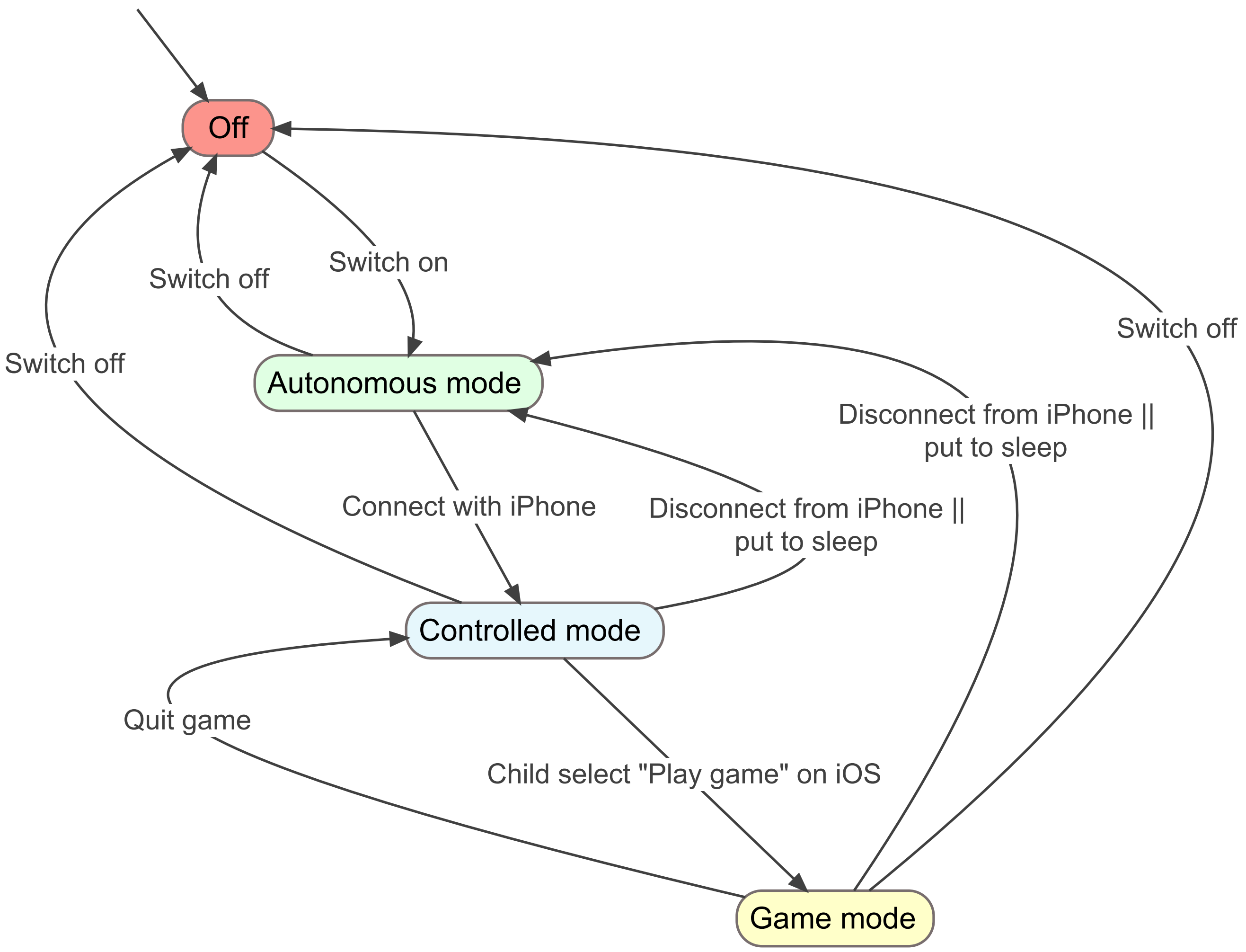
SWITCHING OFF

The robot is turned off by a switch.

• DIAGRAM OF CONTROL

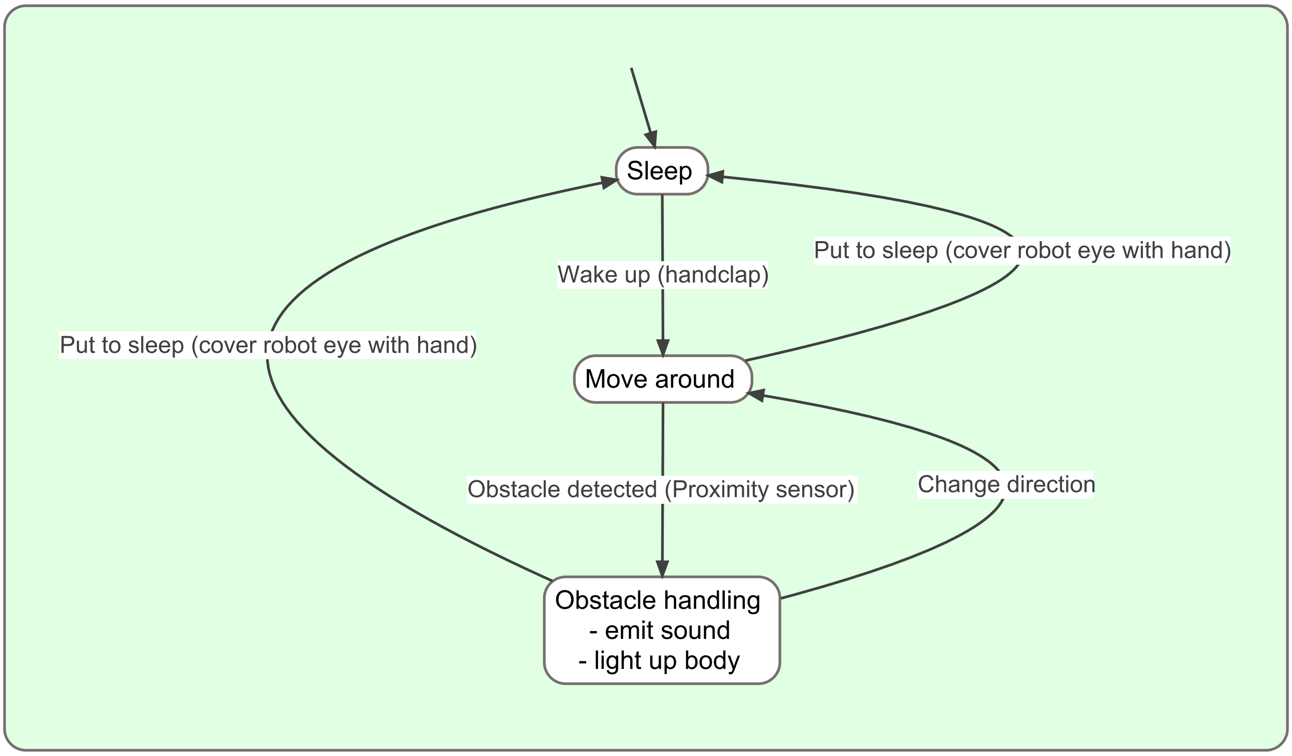
MACRO STATES

This state diagram represents the main macro-states for the robot toy system. Each macro-state is then refined with much more details in order to better understand how the system behaves.



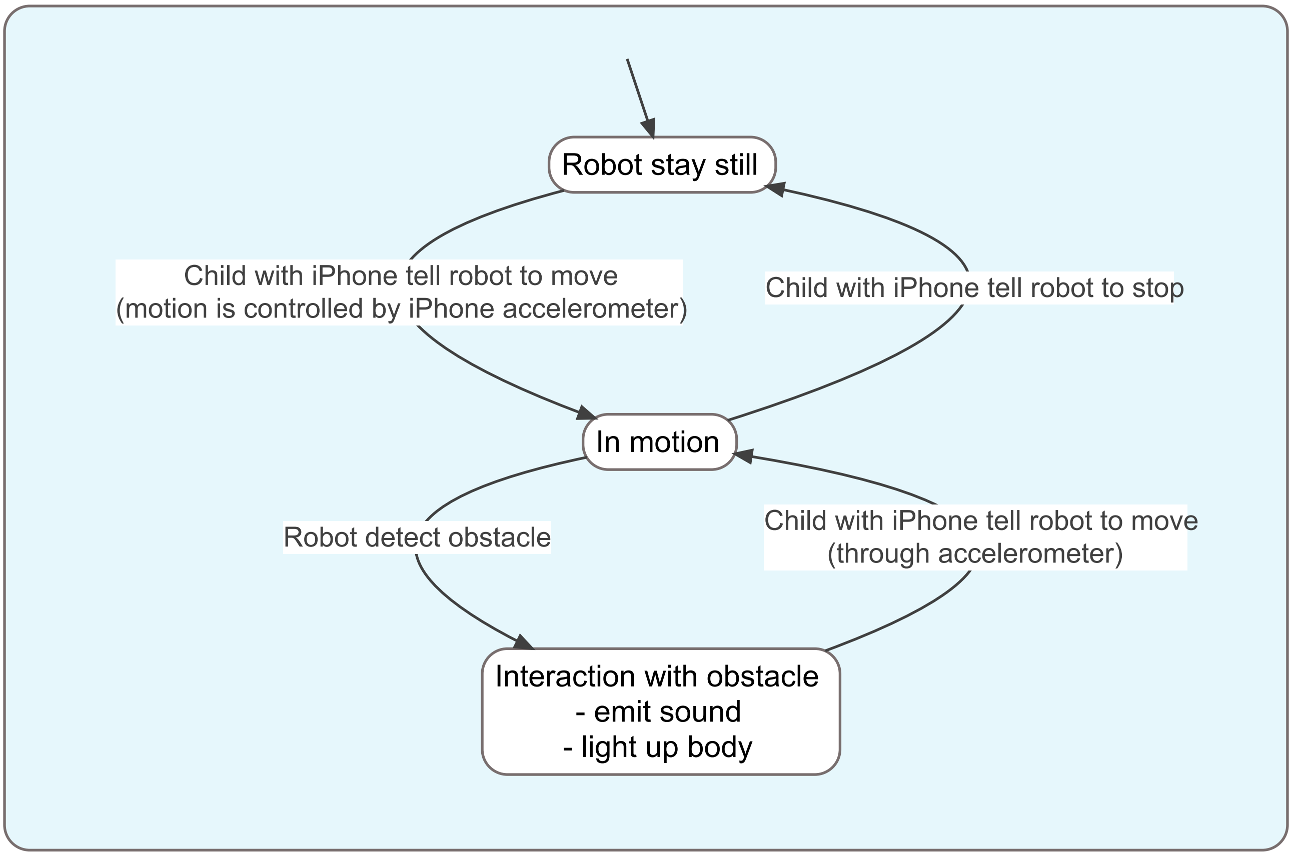
AUTONOMOUS MODE - (MACRO STATE)

This macro-state represent the behaviour of the robot toy system when the system is not connected to an iOS device. In this state the robot will show autonomous behaviour, exploring the world and showing its character.



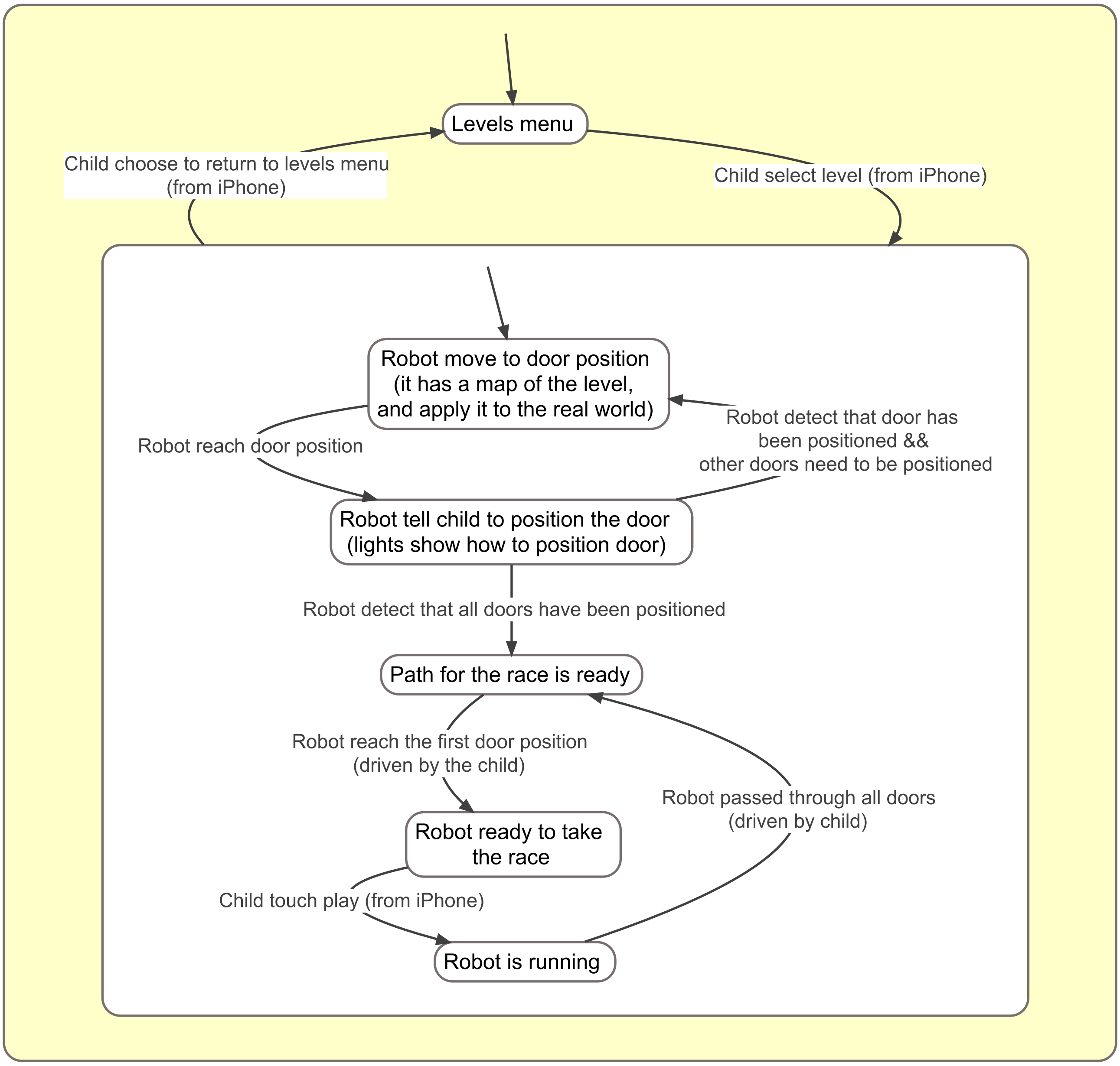
CONTROLLED MODE - (MACRO STATE)

This macro-state represents the behaviour of the robot toy system when it is controlled by the child through an iOS device. At this stage robot is not moving autonomously but still shows its personality, interacting with the world (emit sound and light up its body when detects obstable,...)



GAME MODE - (MACRO STATE)

This macro-state represents the gaming mode of the robot toy system. In this case, a virtual race is brought to reality combining robot, little doors through which the robot has to pass and the iOS platform that wil show mainly statistics of the races (the time to complete the race, ...)



- VIDEO

http://vimeo.com/94878339