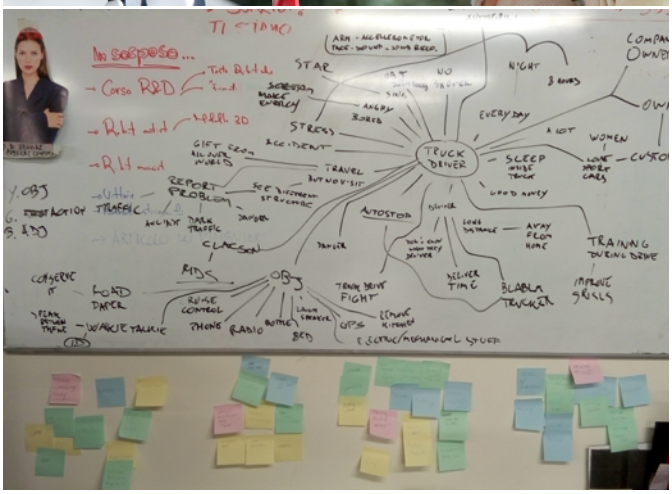
WILSON
THE ANGRY GORILLA

People stay alone in different situation and sometimes that could be sad and boring.
People are social and they suffer the loneliness.
Design of interaction beetwen people and technologies could be improve in order to help them in this situation.
The robot is a machine and our aim is to make it more similar to human/animal in order to interact with the users.



Truck drivers

Different types of people stay alone for long period, but for us the more intersting field is the worker drivers.Infact this type of worker always pass a lot of time alone, driving their means, without interaction, only with their radio and phones.Especially truck drivers pass whole days driving alone.
They uses different tricks to avoid the problem.
FIrstly they always use the walkie talkie to speak with the other truck drivers on the street, they have fun, sing and speak about everything.Secondly they use the phone to speak with family or friends.
Thirdly they give a ride to hitch-hicker to have a companion.

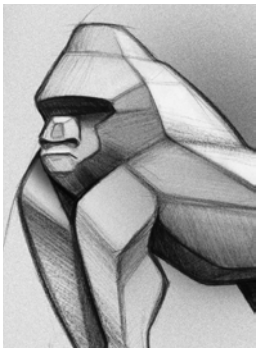
An important factor to create a living being machine is to work on facial expression and the interaction with external enviroments (as sound, light, smell, voice, etc..).

Design process

We used design tools to develop the idea :
the mindmaps and the six hat of thinking.
Thank to these methods we discover all the world of truck drivers, from different point of view.

Vision

Design tools made us focus on the walkie talkie.
Infact this object is always used by drivers to communicate with other people, aganist the lonliness.
Our vision was to improve and make more real the experience to talk with other drivers, in order to create a real community.
So we decide to match the corresponding with our robot, to make the driver directly interact with it.



Function

Wilson has several functionalities about interaction, comunication and perception.
It' s a funny interface to comunicate with the other truckdrivers through an integrated walkie-talkie.
It recognizes the driving style becoming angry if it perceives abrupt movements.
It also can execute some vocal commands like screaming to others overtoken drivers, or other
funny commands to interact with passengers.

Moreover when it's night it becomes luminous and interacts with the driver more frequently to keep him awake.

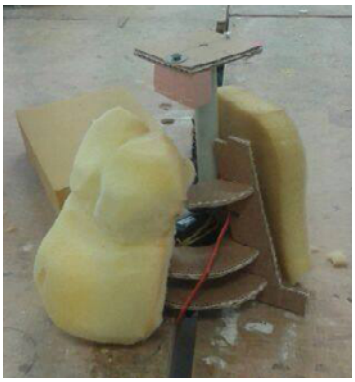
The robot on must be on the dashboard of the truck. in fact it is very large and full of space. the location is front and side than to the truck driver, in order not to distract him directly from the guide but can be watched easily. also the location close to the glass can be used to being looked at by other drivers, from the front or from the side during overtaking

Wilson

The choice of the character is closed to the coiche of the behaviour. We wanted to build an angry funny companion which could suit well to the classic stereotype of truck driver: a big and rough man.
So what's better than a gorilla?
However the name Wilson is a provocative reference to "Cast Away", one of the most famous movies about the loneliness.
In the movie the interaction with Wilson is the only way to escape from loneliness, in our
project, we want to offer a good companion to enjoy the driving and interact with the driver when he is alone.
Before the construction of the robot we defined in detail his behaviour.
He's a lazy, nervous gorilla who wants to sleep during the travel. So he becomes very angry if the driver brakes suddenly ore drive roughly.
But he can be very funny when he becomes excited for an overtaking and shout to other drivers.

First Prototype

We started the work without specific skills
in robotics.
So we built the first prototype to test the dimension and the parts, to understand what we need and how much space inside.
We built it without specific technologies and we used what we had in laboratory.
This experiment make us understand to split the work in different parts.

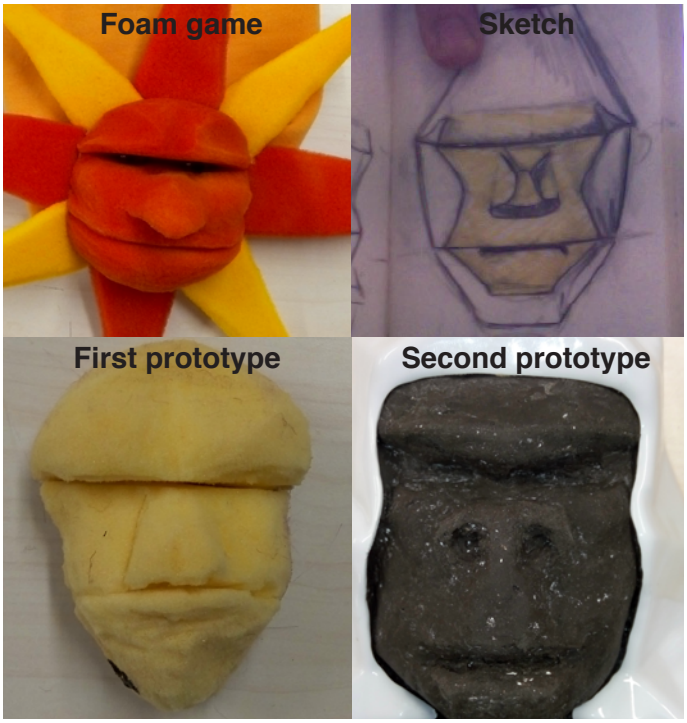


Final dimension

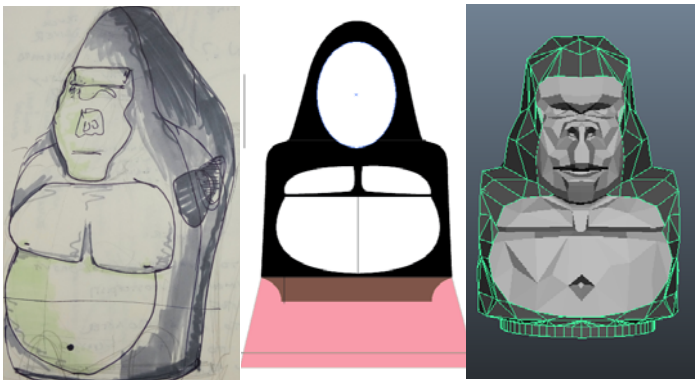
Starting from the first prototype, we used
the experience to design the second one.
The misure are 250mmx200mm.
We decided to make the robot in two different part:
A soft part for the face and an hard part for the body.
It is composed by the basis and the body part to allow the rotation.

The model was realized starting from a real gorilla's scan and we modify the mesh on Maya, arriving to the final model.

We split the robot in different groups of working to manage the different difficulties:
The face, the body, the basis, the arm,
the structure and electronics/codes.



When was ready the mold, we colored the lattex with different temperas (black, grey, brown) to have a "real gorilla color" .
So we casted the latex in the female mold and we twirled the mold in order to dry better the latex; the latex becomes solid in a few minutes in contact with the air and different layers of latex become a single piece.
During the casting step we dipped inside the mounth and eyebrows a dipstick plastic to reiforce the point of movement and eginee levers perpendicular to the latex so that are fixed to the movement point and they can be attached to the motor.
After two days the soft part was ready.



The face

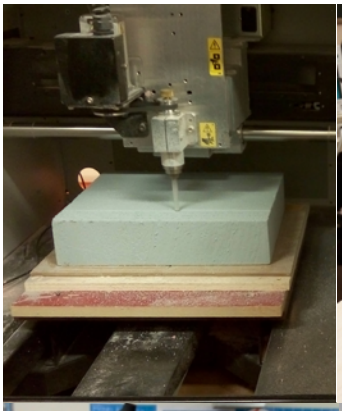
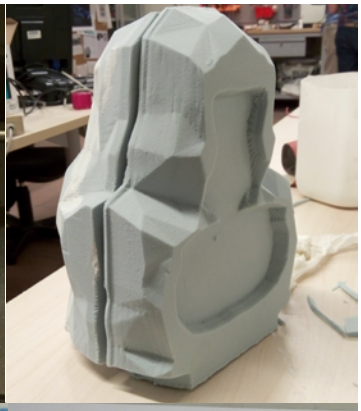
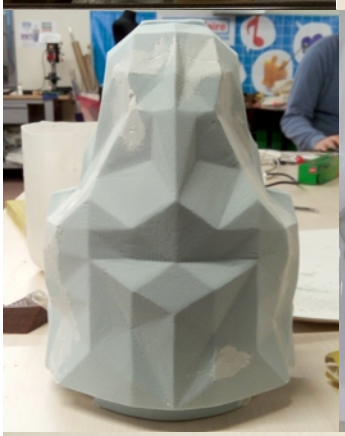
We started to study how realize the movement of the face, from a game made by foam.
We understand to divide the face in three area:
the central part still and part above and below able to move. thhat division allows as the best way
the movement.
The first protoype was made simulating the foam game, cutting a foam with the sewing scissor.
The final prototype is realized starting from a 3D model and it is explain in the soft make part.

Soft part

The center of the robot is made in latex to allow the movement of facial expression. We decided to create a single piece of stomach and face in order to make it more expressive: the movement of mouth and eyes make in motion the adjacent skin and these movements makes all the difference between a fake or more true motion.
We designed the 3D model and then we printed it to use it as a male mold. We cover the model with lattex as a release agent for making the final plaster female mold.After one day we deatched the 3d print from the mold using compressed air and the latex made it easy.

Hard part

We wanted to make it in hard plastic to contrast the soft part and to be the structural part.
We started from 3D model and we used the CNC to make the model in ciba.
We realized it in 4 layers and then we attached them with hot glue.
At last we used the thermoformature to realize the two covers.
Below there is a step which allows rotation and during thermoforming we left a recess for precise cutting of the central part.


Join hard and soft parts

After the work to realize the hard and soft part nobody of us care about how to join the two part.
Infact we thought to use a glue to make it. But the glue didn't work.
We tryed with several type :hot glue, vinavil, spray glue, super attack;, but in every case the latex peeled off from hard plastic.
So we decided to use a solvent able to melt the plastic.
We realized small pitted tabs of rigid plastic.
We put in position the latex and we stuck with the tabs, which have been fixed to the shell with the solvent.
Finally, we blocked all by pouring the latex on the latex and the tabs, so that the latex became a single piece anchored to the little holes of the tabs.

Fix the eyebrows

We make the upper part more stable introducing a structural part: we drowned in the latex a piece of harmonic steel stretched between the two sides of the body. So the forehead appears more stable over time to eye closure.

Base

It is realized form 1 male mold.
The upper edge has the function to put in safe the base, so that the top can not bend laterally.
Inside is present a laser cut support made by two layers and it is fixed inside Arduino, the shields and the central motor.

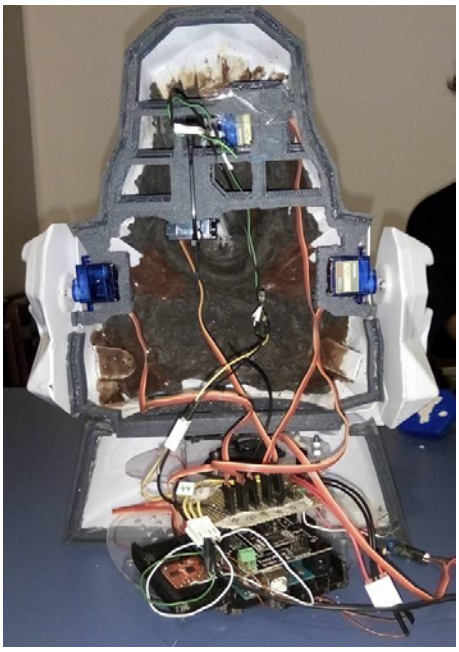
The arms

In order to make the arm movement swift and light the best material to use was plastic. So following the same geometric form the models were made in Rhino and then 3D printed for rapid prototyping and several mock-ups were made to get the perfect size and angle.

Initially the plan was to use these printed arms as the final ones for the robot. Unfortunately and obviously there was this drastic difference in the plastic f
inishing of body and that of the arms.

So we had this innovative idea of using 3D prints for thermoforming and we started with our experiment. To our surprise our experiment was a success and we were able to thermoform those printed arms.

Finally the robot body and arms looked as one and were working perfectly fine.



The Structure

Inside the robot there a lot of stuff to fixed and put in the right position to allow the work.
First of all we have 5 motors, 2 sensors, arduino and shields, wire, the speaker, microphone, leds and walkie talkie.
The more difficult part was the postion of motor for mouth and eyebrows. Infact they need a precise postion to make the motion of the skin as the best way.
The first test was with a modular structure made with layers in plastic fixed with screws and prancksters. But at last we didn't know how to fixed the motor on the structure and it was not stable.

Eletronics

We use Arduino microprocessor in order to implement our functionality.
Voice commands are detected thanks to a dedicate shield: easy VR shield that included microphone and output for spakers.
This shield communicate with Arduino with SerialPin 12 -13.
It processed alone the signal in order to recognize worlds and Arduino decide if it would have to play some sounds saved in it.

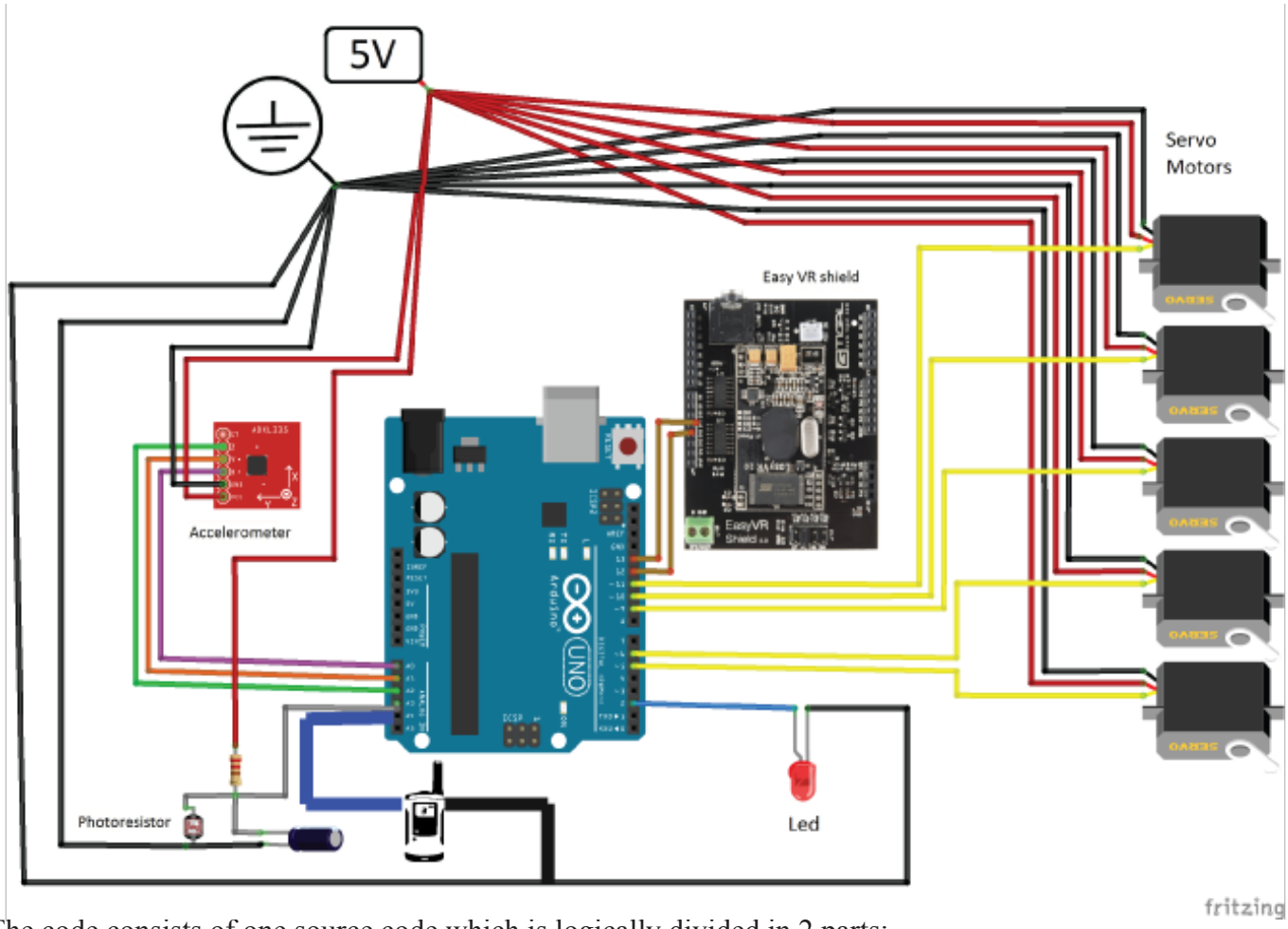
Five servo motors are used in order to permit movements, big one for the neck, 2 for the shoulder and 2 for expression of the face (month and eyes).

We also use two sensors accelerometer to recognize abrupt curve or unusual movement of the truck and a light sensor to detect darkness or daylight.

Three low current consumption led is directly connected to pin 2 of Arduino.
In order to implement the Walkie-talkie functionality we take the signal from the speaker of Walkie-talkie and it is processed by Arduino plug in an analogic input.

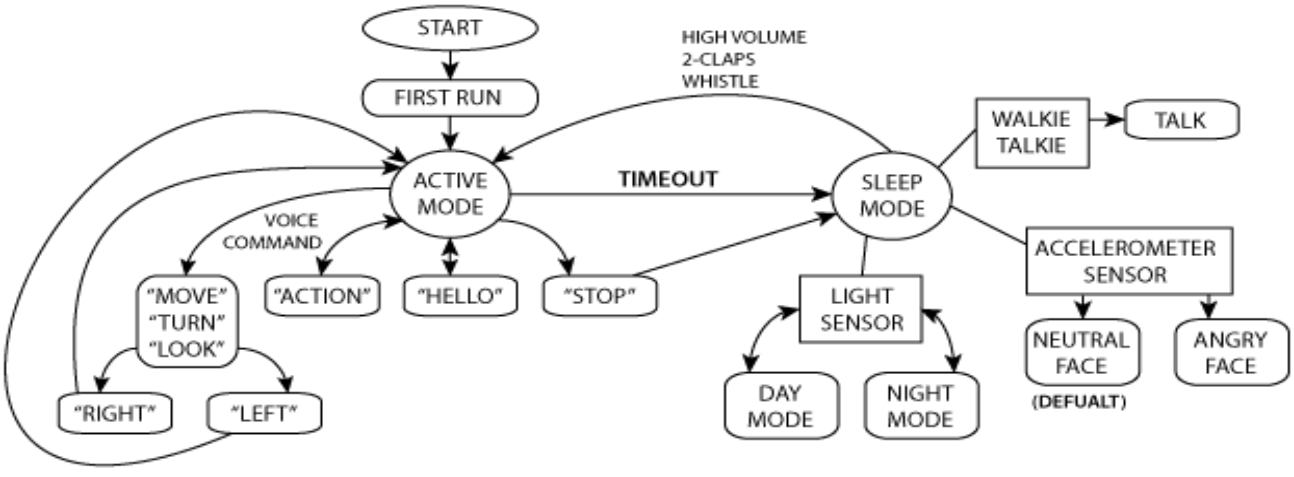
So we use very well the potentiality of Arduino connecting analogic sensors, using serial communication and controlling motors with pwm digital output.
We have to solve two problems:
power consumption especially of the servo motor and sensors and the managing of the many connection we have to plug in Arduino.

We made a dedicated Shield that allow us to have all the connection with the motor and sensors with an external alimentation that is supply thanks to a transformator connected to 12V socket of the car, so we don't need batteries.



The code consists of one source code which is logically divided in 2 parts:
Active mode
Sleep mode

The use case of the robot is shown in the picture below:



Wilson, after is powered-on starts with the first run routine where sound and movement of the motors is used through a code which is frequently used as beginning of every state/voice command. The code:

```
if(!firstRun)
      {
        easyvr.playSoundAsync(3, EasyVR::VOL_
DOUBLE);
                while(!(easyvr.hasFinished()) &&
(!firstRun))
    {
   presentTime=millis();
       if(durationMove==0)
              {
    durationMove=millis();
              }
//action with duration of   |--v--|
```

```
      if(((presentTime-durationMove)<=7000)
&& (presentTime-durationMove>0))
                              {        …….
```

The code used to move the motors(right and left arm) for specific duration (500ms) is:

```
if(((presentTime-timeArmR)>= 500) && (armRPo-
sition == ARMR_UP))
                                  {
                                  digi-
talWrite(pinLed, LOW);  // turn off LEDS
                                   timeArmR=pre-
sentTime;
                                   timeArmL=pre-
sentTime;
            armRPosition=changePosition(ARMR_
DOWN,armR);
                                  armLPosi-
tion=changePosition(ARML_DOWN,armL);
                                  Serial.printl-
n(firstRunCount++);
                                  }     …….
at the end of the first run routine, all the
parameters are reset
                              durationMove=0;
                              firstRun=true;
```

Then the robot works in the active mode where it loops by constantly checking the if clause on the beginning of the loop function. The presentTime variable is used throughout the whole code and it is the crucial reference time point. It value is updated with the millis() function. The code :

```
void loop()
{
if (!isSleeping)
  {
    presentTime=millis();
    if(activeTimeOut==0)
    {
      activeTimeOut=presentTime;
    }          ……
```

Wilson is waiting for a voice command. When it listens (for a duration of 5 seconds), recognizes the command or restarts the attempt to recognize using the code:

```
presentTime=millis();
    Serial.print("Say a word in Wordset ");
    Serial.println(set);
    Serial.println("Listening ");
    digitalWrite(pinLed, HIGH);
    easyvr.recognizeWord(set);
    while(!easyvr.hasFinished());
```

If it recognized a word, the idx variable will hold the index of the word from the used wordset. The code:

```
    idx = easyvr.getWord();
 if (set < 4 && idx>=0)
      {
        if(set==1){
        c1=(char*)ws[set][idx];
        Serial.println(ws[set][idx]);
          }
```

Then depending of the recognized word, Wilson makes a routine. The words used are: "HELLO", "ACTION", "MOVE","LOOK","TURN" & "STOP". After using "MOVE","LOOK" & "TURN", Wilson changes the wordset in to set=2 and recognizes the words from the second wordset, which are "RIGHT" & "LEFT".

```
if(set==1 && (c1=="MOVE" || c1=="TURN" ||
c1=="LOOK") )
      {    ……  set=2;     }
if(set==2 && (c1=="MOVE" || c1=="TURN" ||
c1=="LOOK"))
     {
       if(c2=="RIGHT")
         {   …… }  }
```

ds The "STOP" recognized word changes the mode of Wilson, from Active mode to Sleep mode. This is also done by the activeTimeOut variable. This variable switches to sleep after 20 seconds of false recognition or no recognition of a word for a given wordset. The code:

```
if(c1=="STOP" || presentTime-activeTime-
Out>=20000)
{    ……
mode = random(1,8);         // set the sleep-
mode randomly
isSleeping = easyvr.sleep(mode);    /// go to
sleep
while (!easyvr.hasFinished())
  {  presentTime=millis();   …..  SLEEP MODE ……
}
```

The sleep mode operates within the while (!easyvr.has-Finished()). The mode variable sets up in which way Wilson will be able to wake-up (to be put back in the active mode). There are 8 values, but 4 sound options (HIGH VOLUME sound, WHISTLE sound, 2-CLAPS sound & 3-CLAPS sound), the other values are for sensitivity. The waking up is always in random way. In the sleep mode, Wilson has activated all the sensors, but not the voice recognition. It constantly checks for the input values of the walkie-talkie, accelerometer and photosensor.

The walkie-talkie upon receiving wireless signal from a different user, transforms the signal to a sound signal through the speaker of the walkie-talkie. The current (change of voltage) sent to the speaker in order to reproduce a sound, is captured by the Arduino as analog input. Depending on that input Wilson is moving the mouth and acts like it opens the mouth like the distant speaker/person. The code:

```
if(presentTime-walkieTime>200)
                          {
                            walkieTime=present-
Time;
```

```
                        //Serial.print-
ln("***** walkie-talkie breakpoint
**********");
                        walkieValue =
analogRead(walkiePin);
                        //Serial.printl-
n(walkieValue);
                        if(walkieValue>5)
                         {
                         Serial.println("-
SPEAKING!!!!!!!!");   ……..
```

The photoresistor checks for the intensity of light and decides if it is Day or Night. If it is day Wilson checks the light intensity on every 2 seconds. Once it gets dark, after 5 seconds switches to the Night mode. In the Night mode, the light intensity is checked more frequently and the LEDS are turned on. If a car or other vehicle has lighted on Wilson, it reacts to the light with a movement routine (arms up). If it exposed to constant lights, switches back to Day mode. Code:

```
if(!isDay)      //// NIGHT MODE
                {
                     if(presentTime-check-
Time>200)     /// During the night check on
200 milliseconds
                      {
                        checkTime=present-
Time;
                      //   Serial.print-
ln("***** NIGHT light sensor breakpoint
**********");
                        photoValue =
analogRead(photoPin);
                        Serial.println(pho-
toValue);
if(photoValue>750)
            {
               digitalWrite(pinLed, HIGH);
                           darkCount=0;
                           Serial.printl-
n("NIGHT DARK regular");
……
if(photoValue<740)
                         {
                           darkCount++;
                           digitalWrite(pin-
Led, LOW);
                           Serial.println("-
CAR in the Night");
…….
if(isDay) //// DAY MODE
              {         …….   }
```

Wilson checks for sudden movements (such as braking) or constant movements (bumpy road) using the accelerometer. Each 300 ms Arduino records the values of the accelartion of all three axes and put them in a matrix with all the values of the last 8 timesteps. Then calculating the deltas it can recognize a "brake" or a "bumpy road". If there are no such movements, Wilson is in NEUTRAL face position (set of fixed positions of the motors). If there is a sudden movement, Wilson reacts by turning into ANGRY face position/ expression. If there are constant movements (bumpy road), Wilson sets the NERVOUS face. When the braking or bumpy road ends, Wilson goes back to NEUTRAL face of the sleep mode. The code:

```
if(braking())  {
                           currentFace=ANGRY;
                           Serial.printl-
n("BREAKING");
                        }
                        if(crazyDrive())
                        {
currentFace=NERVOUS;
                           Serial.println("CRA-
ZY_DRIVE");
nervousCount=0;
                        }
                        else if(nervous-
Count>=10)
                        {
                           currentFace=NEUTRAL;
                        }
nervousCount++;                          }
```

To interrupt the sleep mode, the user needs to use the wake up sound (the 4 sound options).

Conlusion

Making a robot like Wilson is a continueous problem solving. Starting from the choice of the right material, the choice of a nice design, a coherent behaviour, the managing of the power consuption and the many connection,the handle of the simultaneus movement of all motors and the setting of the voice recognition and above all the integration of all the solutions.

The whole process of building Wilson was not always easy, but it was a lifetime experience for all of the members of the team.

Bill of Material

Arduino Uno
Easy VR shield
Accellerometor adlx335
Photoresistor
4 servo motors 9g
1 servo motor 6V, 43 g
Car Plug adapter 12-5 V, 2A output
Walkie Talkie
Wire
External AUX Speaker
Latex
PVC (thermoforming)
PLA (3D Printing)
Steel armonic
Plexiglass
Screws
Solvent