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Healthy Posture

Connected chair cushion

Internet of Things – Project Report

Digital Transformation & Cloud Services - Promotion 2021
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Back pain: the pain of the century. Common and widely spread, this pain can grow into a burden if neglected or treated carelessly. Healthy Posture aims to address this problem by operating at the source of the issue: our sitting posture.

As a major part of the population has felt this pain at least once in their lifetime, we have in front of us a blooming market. Indeed, whether it is manual or electrical, medical or not, there is a vast panel of choices for a wide range of prices. Despite these countless remedies and treatments to overcome the symptoms available on the market, the miraculous solution has not been created yet.

That is why we came up with the idea of a connected chair cushion, easy to use and to transport. Healthy Posture does not have the pretention of being the miraculous remedy, however as back pains keep troubling people, remaining a current concern, we take the opportunity to propose a solution that operates at the source of the issue, contrary to others. Therefore, with Healthy Chair you will learn to adopt a healthy sitting position.

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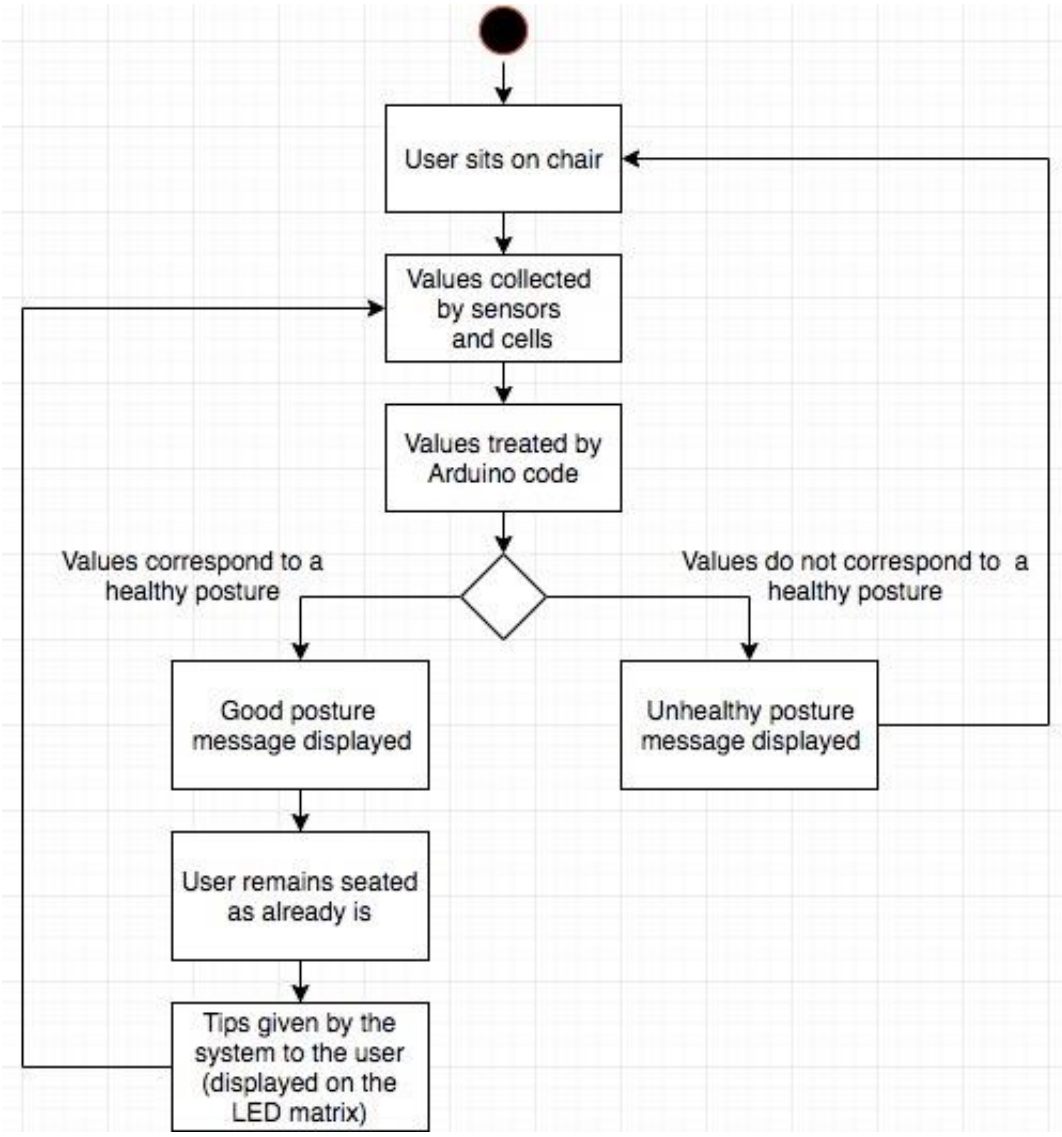
I. Functional presentation of Healthy Posture

a) Modelisation & explanation of its functioning

Healthy Posture is a chair cushion on which you sit on and informs you, thanks to its LCD screen, about your sitting position instantly. We chose the format of a cushion rather than a complete chair, so that the user is able to take it anywhere and use it wherever and whenever he or she needs it.

The following activity diagram sums up the functioning of our product.



Activity diagram – Healthy Posture functioning

Thus, all the user has to do is to sit on the cushion (fixed on a chair by the user) and focus on whatever work he or she has to do. The cushion takes care to analyze the posture of the user thanks to sensors (technical information will be further detailed in the second part) and informs the users through specific and precise messages displayed on the LCD screen, encouraging the user to correct her/his posture.

b) Public targeted

Throughout our years of formation, quantity of students spend time sat on a chair, studying, listening to the teacher. Number of jobs requires to be seated at a desk, working on a computer or on paper files for hours. At the end of the day, when our focus seems to slowly fade away and when tiredness gradually appears, we all tend to neglect or sitting posture. Indeed, 76% of office workers suffer from back pains, 71% of the youth complain about these similar health problems.

Therefore, the public that we first target is composed of students from high school to high studies, and office workers or any worker who spends the day sat on a chair. Of course, we also designed this connected chair cushion for anyone having back pains and who wants to correct their sitting posture, even during their leisure time like when watching a movie, eating at the table or simply while sitting and chatting.

c) *Norms and regulation*

The chair will be adapted to the length of utilization (good choice of material), ergonomic (adjustable seat) and comfortable, as the main purpose of our connected chair is to offer a pleasant seat and a healthy posture.
Like public office furniture, our connected chair will be under the following European standards:
- NF quality and security
- NF environment
- ISO 90013
- ISO 14 0004

II. Technical presentation of Healthy Posture

a) *Overview of the technical structure*

Healthy posture is a basic chair cushion in which there is an electrical assembly: load cells and force sensors connected to an Arduino card. The values collected by the cells and sensors and treated with an Arduino code, will determine if the user is sat correctly or not on the cushion therefore on the chair.

The following image indicates the location of the cells and sensors or the cushion. (image of the next page)

Image of the chair cushion with the location of the cells and sensors

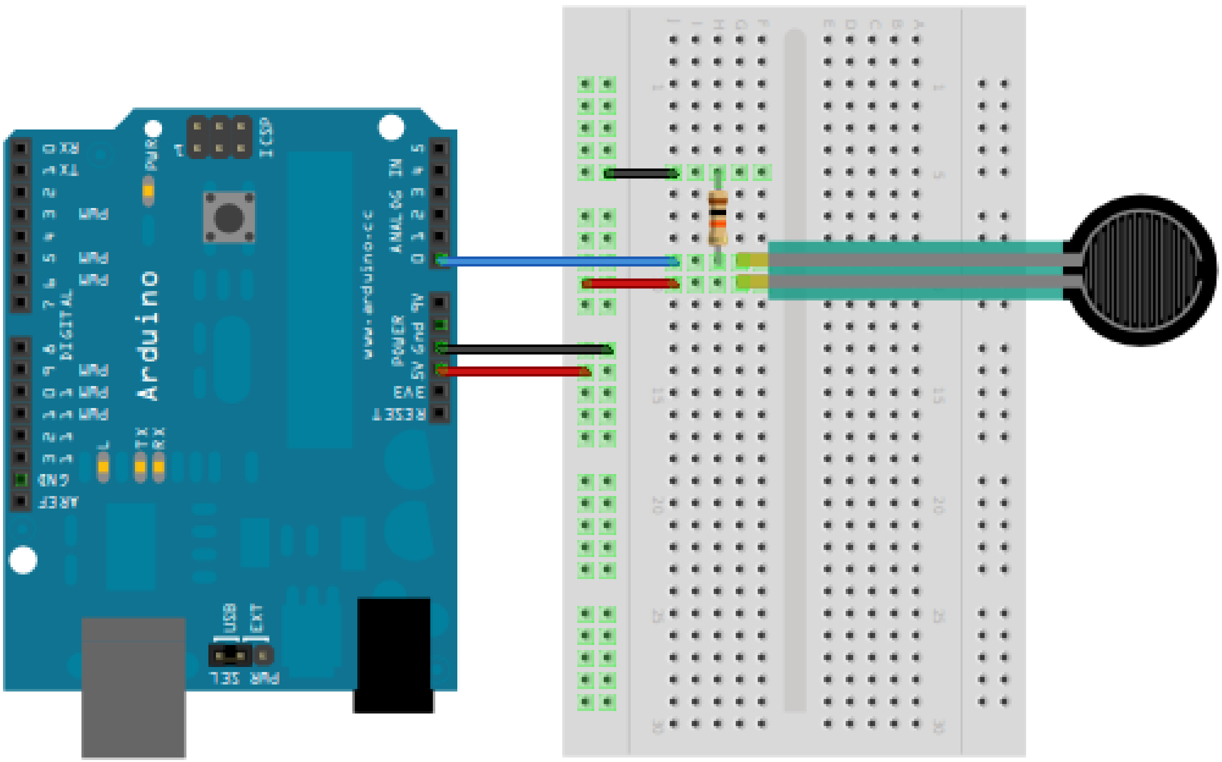
To determine if the user has a healthy sitting posture we intend to proceed as follows:

- The value collected by load cell 1 will be compared to the value collected by load cell 2. If this set of values matches (± 10%) then the user applies the same pressure on both sides while sitting
- This analyze is completed by the work of the force sensors. If each of the force sensors returns a non-zero value (ie detects a presence), only then a good posture message is displayed on the LCD screen of the cushion, informing the user about her/his healthy position.

These two conditions necessarily need to be fulfilled so as to confirm the user's good posture. If not, a warning message according to the position error will be displayed on the screen for the user to correct her/his position.

b) *Load cells, force sensors assembly & implementation*

Concerning the technical details of the force sensor assembly, here is the circuit we followed to connect the sensor and the Arduino Uno board together.



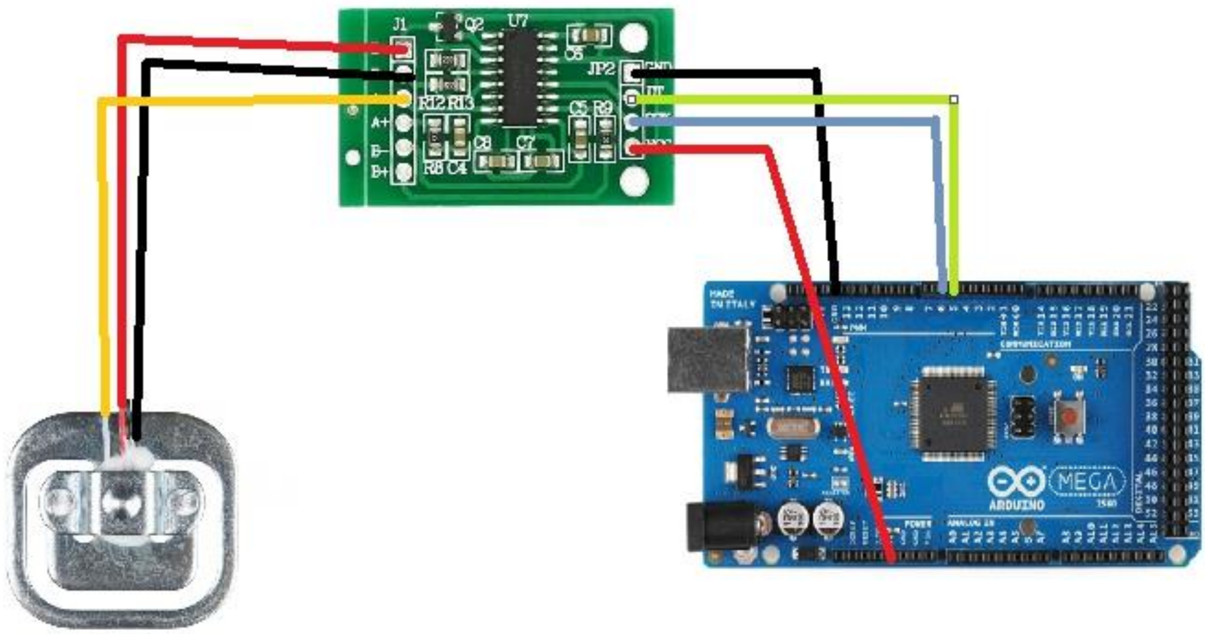
Force sensor assembly

Equipment needed:

- Force sensor
- 220 ohm resistor
- Jumper wires
- Arduino Uno board
- Breadboard

However since we moved to an ESP32 module for the display of messages, the force sensors will then be connected to this module instead of the Arduino Uno board; resistor is still used.

For the load cells, the following image indicates the connection details between the cell and the Arduino board.



Load cell assembly

Equipment needed:

- Load cell (50kg capacity)
- HX711 Module
- Arduino Uno board
- Jumper wires
- Breadboard

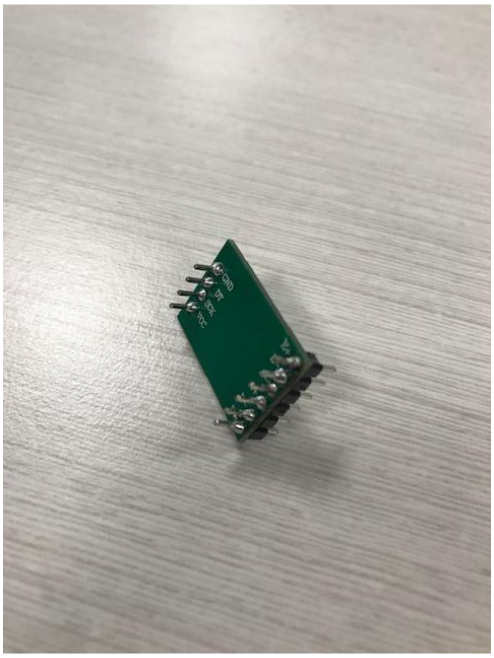
The HX711 module uses 24 high-precision analog / digital converter. This component designed for high-precision electronic scale, has two analog input channels, programmable gain of 128 integrated amplifier.

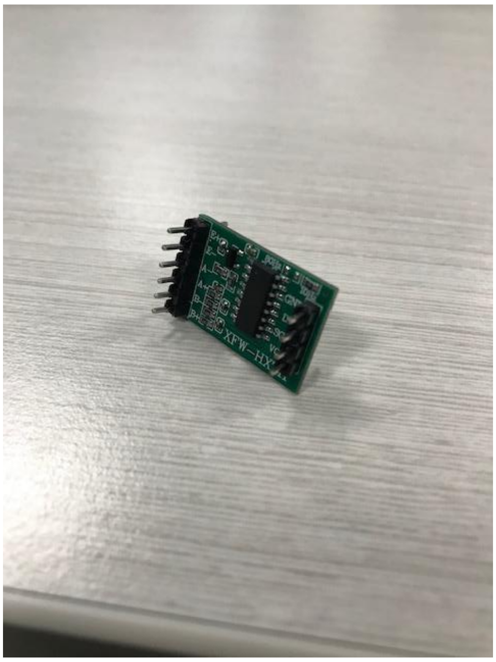
Difficulties :

Contrary to the force sensors, a calibration phase is necessary for the load cells as well as the hx711 module. For that purpose, we used an example code from the Arduino Library.

Once the assembly is done and the code executed, some results were displayed on the Arduino console, but false results. Indeed, the results lacked of accuracy, for instance when no weight was on the load cell, the output displayed should be 0 or a value very close to 0, but the result was in fact close to 40kg.

We then thought, that there could be wiring and connections problems, thus we welded the connection pins to the hx711 for a better connection in our assembly (photos following).





However, after welding the parts and connecting the assembly once again, we expected to have more accurate results but instead we got an error message on the Arduino console: nan (not a number).

Concerning the implementation of these two types of components, we implemented the two conditions required to validate or not the user's sitting posture, discussed earlier in this report.

First we selected the input pins for each of the load cells and force sensors used. Then, we created a variable for each of these components to store the value collected by the cells and the sensors.

In the set up loop, we set a serial port for communication, through the command line `Serial.begin`

Finally, in the void loop, we detailed all the possible positions for our chair cushion to detect and all the possible messages to be displayed according to these different positions. In the following table, are listed the positions detected by the chair and the warning message corresponding :

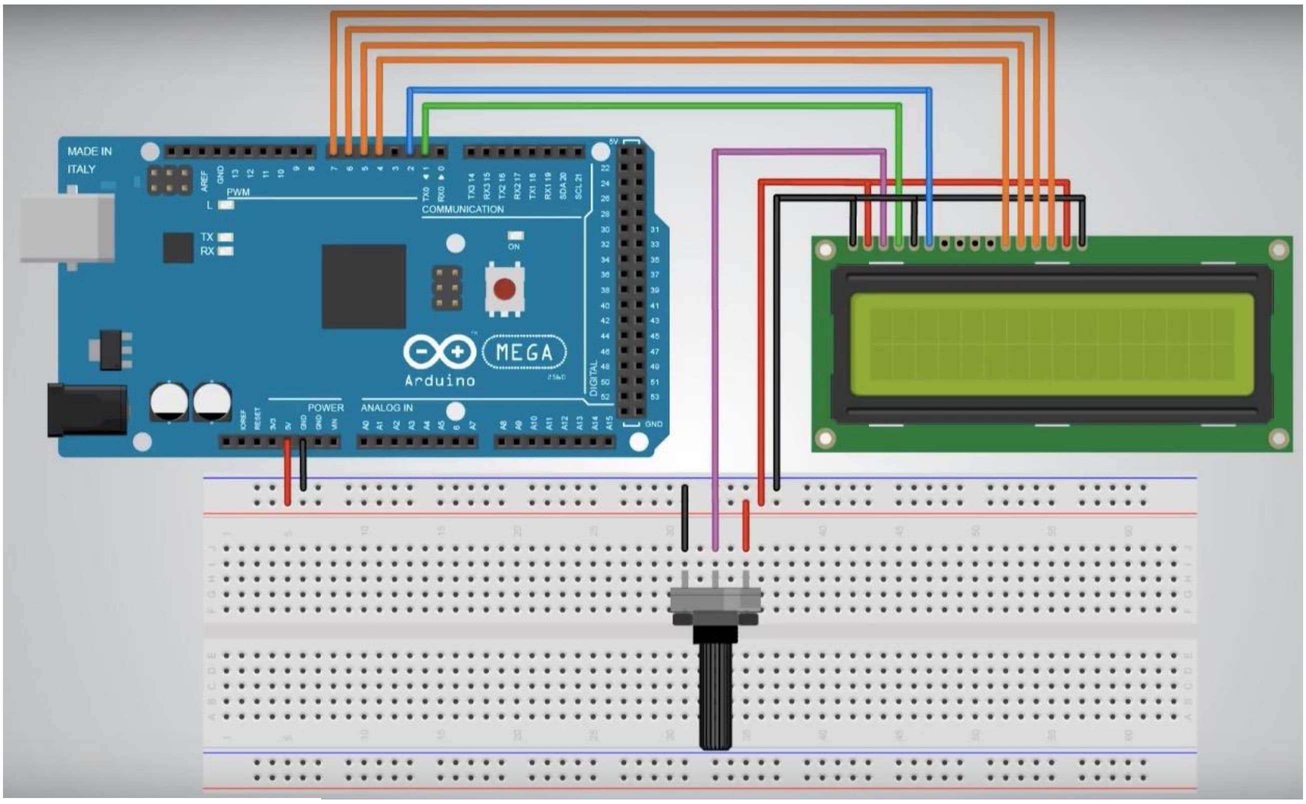
User's behavior on the chair	Chair's technical analysis	Message displayed on the LCD screen
Case 1: the user applies a homogenous pressure on the seat portion AND rest his/her back correctly on the back of the chair.	The load cells detect both the same range of values AND the force sensors both return a value	"Good healthy posture !"
Case 2: The user applies a homogenous pressure on the seat portion BUT does not correctly rest his/her back on the back of the chair	The load cells detect both the same range of values BUT only one or none of the force sensors return a value	"You'd have an even healthier position while resting your back on the chair"
Case 3: The user rests his/her back on the back of the chair BUT does not apply a homogenous pressure on the seat portion	The force sensors return both a value BUT the load cells do not detect the same range of values	"Wrong posture, try to sit correctly in the center of the seat"
Case 4: The user neither applies a homogenous pressure on the seat portion nor rest his/her back correctly on the back of the chair.	The load cells do not detect the same range of values AND the force sensors do not return a value	"Unhealthy posture! try to sit correctly in the center of the seat and rest your back on the chair"

To read the collected values from load cells and force sensors we used the command line `analogRead()`

c) User interface : displaying messages

LCD screen & assembly

To connect the LCD screen to the Arduino board we followed the connection indicated in the assembly schema below.



LCD screen assembly

Equipment needed;

- LCD screen 16x2
- Potentiometer
- Arduino Uno board
- Jumper wires
- Breadboard

For the implementation of the screen we used the Liquid Crystal library from Arduino.

To display a message on our LCD screen, here is the base code we used:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd (1, 2, 4, 5, 6, 7);

void setup() {

     lcd.begin(16, 2); // dimension de l'écran lcd utilisé

}

void loop() {

      lcd.print("Good ! Healthy posture !); // Affichage sur l'écran
LCD pour l'utilisateur

     delay(3000); // Temps d'affichage pour permettre à l'utilisateur
de lire le message sur l'écran

}
```

We then adapted this base code, to our needs, that is to say displaying either a good or warning message according to the user's current sitting position.

WiFi connection with ESP32

Another option for displaying messages to the user is using WiFi connection, thanks to the ESP32 module.

For this second option, all the components seen before (load cells and force sensors) are connected to this ESP32 module instead of the Arduino UNO card.

Once the assembly is done and the ESP32 is connected to a WiFi network, an IP address is indicated through the Arduino console. Then by simply, copy-pasting this address on a web browser (either on a smartphone or a computer connected to the same Wifi network), a web page will appear.

On this web page, a message according to the sitting posture of the user will be displayed (messages amongst the options presented in the "table of messages" above). This message will update automatically and constantly according to the user's behavior on the chair.

The design of the page is coded in HTML in the .ino file. Retrieving the data collected by the cells and the sensors is done thanks to HTTP protocol methods.

III. Conclusion

At the current time, our project is not at its final state, due to technical problems related to the load cells. However we succeeded in connecting the force sensors to the ESP32 module, collecting and retrieving data from these sensors as well as displaying messages on a mobile phone and computer screen via ESP32.