RESEARCH ON THE DEVELOPMENT OF A HUMANOID ROBOT HEAD

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ABSTRACT: The purpose of this research is to develop a humanoid robot head. For this, several concepts were made, regarding the components, their location and the design of the product. In order to obtain the model, an analysis of competition and one of concepts was performed, being chosen the optimal concept for the realization of the product. Finally, the 3D components were modeled and printed and the mechatronic system was made, and then tested. Based on the information obtained, a prototype of the product was developed and some conclusions regarding it and future research directions.

Key words: humanoid, head, prototype

1. Introduction

Humanoid robots have made significant technological and artificial intelligence advancements in recent years. People's desire or need for common and recognizable characteristics in their surroundings served as the catalyst for this humanization transition.

As a result, engineers and programmers are continually attempting to create robots that are as human-like as possible by giving them human abilities, such as the capacity to move, move their arms, and engage when sensors detect another human. These characteristics enable users to start conversations and interactions with robots [2].

The goal of this research is to create a humanoid robot head that mimics human gestures and can communicate with humans.

2. Current state

To create a specific product, it is necessary to understand the demands of the intended audience and the conceptual approaches that will best address those needs. It is also necessary to analyze the market that will be introduced.

The life and advancement of man and society are impossible without meeting certain prerequisites known as needs [3].

This humanoid robot head will enable remote communication with a variety of people by mimicking some facial expressions during a conversation.

3. Conceptual model

An overview of future trends in robotics is provided in reports based on the quick development of technology and new robot models, which offer a diversity of information and viewpoints. They can offer predictions about where technology is headed and what effects it might have on the economy, employment and interpersonal relationships.

The needs of humans, including the integration of robots in various processes and the facilitation of interaction with humans through them, are reflected by the construction of such a humanoid robot head. These demands were determined utilizing a Google Forms questionnaire with clear, short questions that might give us useful information.

Following a market analysis of the intended market for the product, which included the identification of rival products and their features as well as the determination of product functions, numerous concepts were developed based on the questionnaire. An ideal notion for the actualization of the robot head was selected after a more thorough investigation of them, as it can be seen in Figure 1.

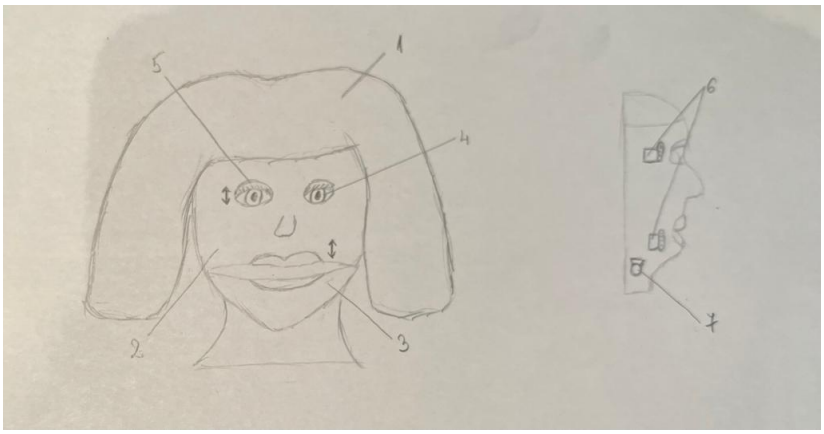

Fig. 1. The concept chosen for the realization of the robot head

A plastic face structure (2) is present on the robot head. Attach the maxillary (3) to it, fix the eyes (4), and arrange the eyelids (5). The actuator (6) conducts a top-down action. They move vertically thanks to two actuators (6), which are used to move them. For recording and issuing words, a voice module (7) is incorporated. The wig (1) is also affixed to give it a human appearance.

4. 3D modeling and printing of components

A thorough examination of the face's features is necessary to create a humanoid robot head, as is the creation of places for the integration of various operating circuits. Additionally, anthropometric measurements are taken to give the product a realistic appearance.

The robot head's 3D model was created with the help of the SolidWorks program. The product's constituent parts have been modeled within it. These are depicted in figures 2 - 6.

Fig. 2. 3D Eye Model

Fig. 3. 3D Eyelid Model

After the component 3D models were created, they were saved in STL format so that they could be used to create printing-related codes. These codes, which determined the parameters of the printing

regime for each component, were produced using Z-Suite software. They were then employed as Z-HIPS printing materials and printed on Zortrax M300 Plus printers.

Fig. 4. 3D maxillary model

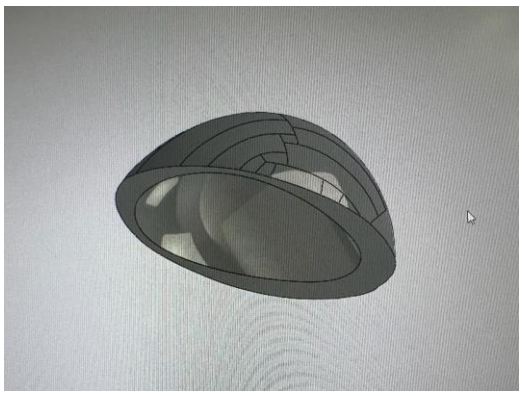

Fig. 5. 3D cap model

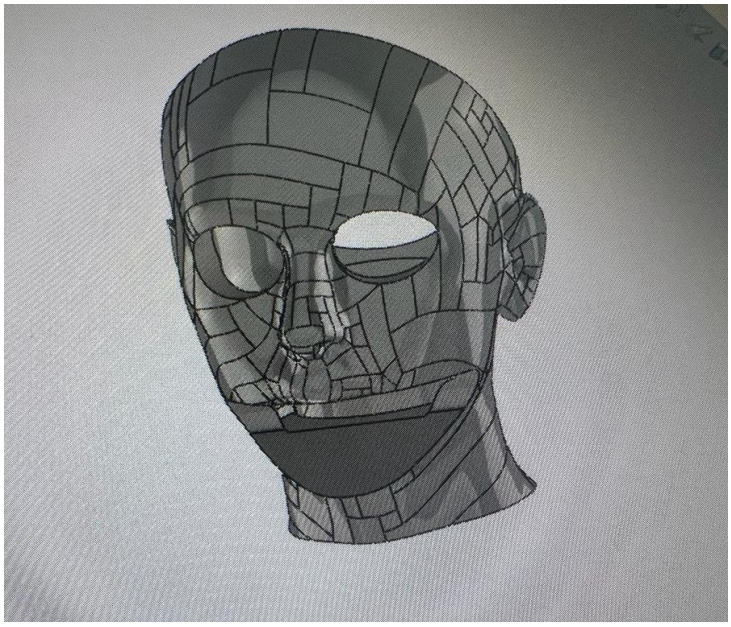

Fig. 6. 3D head model

A kind of styrene is high impact polystyrene (HIPS). In limonene, a solvent obtained from citrus trees, it dissolves. HIPS can dissolve in d-Limonene when used as a support material, erasing any traces left behind by removing the support and leaving the print intact. HIPS is a great option for pieces that need to be lighter because it is more dimensionally accurate and lighter than ABS. Since this filament is relatively new, using it is still in the testing phase [4].

Table 1 contains printing parameters for 3D models.

Table. 1. Printing parameters

Parameter	Value
Layered height	0,19 mm
Number of exterior walls	2
Filling pattern density	30%
Filling pattern	Line (patern 1)
Printing temperature	250° Celsius

Table. 1. Printing parameters (continuation)

Parameter	Value
Printing bed temperature	80° Celsius
Printing Speed	40 mm/s
Addition of support material	No Yes - support material density 15%
Adhesion to the printer bed	Raft

Figures 7 and 8 show the 3D-printed parts and their assembled counterparts.

Fig. 7. Printed cap

Fig. 8. Printed and assembled components

5. The mechatronic system

The robot head was designed as a mechatronic system in order to be interactive. The mechatronic system consists of actuators and modules that replicate user-transmitted language and human movements. Table 2 lists every element of the mechatronic system.

Table. 2. Mechatronic system components

Component name	Number of pieces
Arduino board	1
Breadboard	1
Actuator	3
Voice mode	1
Father-father wires	11
Mother-father wires	5

The Arduino Uno board was linked to the breadboard in order for the circuit to function, and then the other components were joined to it using the mother-father and father-father connections. When using

an actuator, the connection is made as follows: a father-father wire connects the red pin of the actuator to the line on the breadboard connected to the Arduino Uno board's 5V port, another father-father wire connects the white pin to the plate's digital pin, and a third wire connects the actuator's black pin to the line on the breadboard connected to the board's GND port.

In the case of voice mode, a father-father thread connects the red pin of the module and the line on the breadboard connected to the 5V port of the Arduino Uno board. A second thread connects the voice module's black pin and the line on the breadboard connected to the GND port. The remaining four pins are connected to the digital pin of the plate using father-father threads.

Making the necessary code using Arduino software is the final step in the operation of the mechatronic system. Declaring the variables and their types was followed by performing a code sequence for each servomotor and the speech module, which was then combined at the end to produce the whole code.

Component libraries are part of the source code. Then, a declaration of the components and pins to which they are attached follows. Figure 9 depicts a few of these.

```
#include <Servo.h>
Servo servomotorol;
Servo servomotoro2;
Servo servomotoro3;
int j;
int i;
#define REC 2
```

Fig. 9. Adding bookstrings, declaring variables and pins

The void setup section of the code contains a declaration of the variable types, and the void loop section contains the operating instructions for each component. Part of this code can be found in figure 10.

```
void loop() {
 for(j=10;j<=50; j+=10){
    servomotorol.write(j);
    delay(1000);

  for(k=10; k<=40; k+=30){
     servomotorg.write(k);
     delay(1000);
 }
```

Fig. 10. Sequence void loop

6. Functional prototype

They came back together to create the first prototype after finishing the realization and testing of the circuit and assembling the robot head. Figure 11 depicts it in visual form.

Fig. 11. Initial prototype

In order for the system to work, two actuators are used to move the eyelids, and a third actuator is used to move the jaw when the voice module makes sounds.

7. Conclusions

In conclusion, following the development of concepts, the choice of the optimal one, the design of components related to the concept, their printing and the realization of the mechatronic system, the first functional prototype of the product was obtained. Within it are features very close to human ones and gestures similar to a person's behavior.

In future research, it is intended to create another functional, improved prototype that reflects as much as possible the final product.

Thus, the humanoid robot head to be developed as a final product is intended to provide an image as close as possible to reality, can be used in various ways and facilitating fast distance communication.

8. Bibliography

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