USING OF PROXIMITY SENSORS TO CONTROL BIOMIMETIC STRUCTURES

Ionescu Marian, Lecturer Ph.D.Eng.
Borcosi Ilie, Assoc. Prof. Ph.D. Eng.

"Constantin Brâncuși" University of Târgu Jiu, ROMANIA

ABSTRACT: *This paper presents a way to use an ultrasonic HC-SR04 proximity sensor and a TTP 223 touch sensor for controlling a biomimetic structure. The HC-SR04 ultrasonic proximity sensor leads to a head movement of the ELVIS ALIVE biomimetic structure, and the TTP 223 touch sensor leading to the closure and opening of the eyelid of the biomimetic structure. The sensors are connected to the Arduino development plate that controls the movements of the biomimetic structure.*

KEY WORDS: biomimetic structure, proximity sensors, arduino board, control structure

1. INTRODUCTION

Facial expressions implemented on robotic biomimetic structures are used in many fields such as education, robotics, entertainment, etc. and have the role of transmitting emotions. Researchers in the field of biomimetic robots considered the analysis and automatic recognition of facial expressions as very useful in various fields such as human-computer interaction, entertainment, pain detection, social robots, lie detection, etc. [1].

2. THE DESCRIPTION OF THE COMPONENT ELEMENTS OF BIOMIMETIC STRUCTURE

By commanding and controlling a biomimetic structure, different biomimetic expressive states can be achieved (for example: happiness, sadness, anger) and certain movements of the elements that make up this structure can be obtained. The sensors used in the biomimetic structure have the role of command and control for the actuating elements of the moving elements. Figure 1 shows the Elvis Alive biomimetic robotic structure [2].

Fig. 1 Elvis Alive biomimetic structure

2.1 The description of the Arduino Mega board 2560

The command and control structure uses an ARDUINO MEGA 2560 board. This is shown in Figure 2 and shows two basic elements: the ATmega 2560 microcontroller and the ATmega16u2 microcontroller for connectivity to the USB port. [3].

ARDUINO MEGA is an ideal development board for applications that need multiple communication pins, analogs and PWMs. It has the following features:
• 54 digital input / output pins, aut of which 14 can be PWM
• 16 analog input pins
• recommended input voltage 7-12V
• 5V supply voltage
• frequency 16MHz
Drivers of the L298N type are used to control the drive motors of the moving elements.

Fig. 2. The Arduino Mega 2560 board [3]

The control of these motors is made with PWM type modules for changing the motor speed, integrated in the ARDUINO electronic board.
To command this biomimetic structure, in order to obtain different emotional states, a command and control architecture is used as in figure 3.

Fig. 3. Command and control circuits of the biomimetic structure

Circuits are interconnected to the Arduino Mega motherboard and their control is done through the control program that can be charged via the USB serial interface of the motherboard. After loading the software, the biomimetic structure will work independently.
In order to achieve the expressive or biomimetic states, due to the fact that it falls into the category of slow processes, it is suitable to use a two-positional adjustment of the elements that achieve the expressive states (eyebrow, eyelid, mouth).
The expressive state of the Elvis Alive robot's face is mainly given by the actual position of the eyebrows (s), eyelids (p) and mouth (g).
From the analysis of the effective positions of the eyebrows (s), eyelids (p) and mouth (g), the biomimetic expressive states of the robotic structure can be obtained.
An important step in the application is related to determining the domains of variation for each potentiometer to which the elements eyebrow (s), eyelid (p) and mouth (g) are coupled because the references for these parameters s, p, g will have values that belong to these domains of variation.
Due to the fact that the measurement of the angular position is performed with a potentiometer, it will result in a useful measuring range between a minimum and a maximum value depending on the ordered element (eyebrow, eyelid, mouth).
For each of these three elements, will correspond numerical domains made with a 10-bit CAN, embedded in the Arduino Mega 2560 electronic board, domains within the range [0 ... 1024] CAN units.
The references for each parameter, in order to reach a certain emotional state, must not exceed the two minimum and maximum values, defined above. In this sense, a software limitation is made, in order not to force the motors with voltage.
The following table 1 presents the values quantified by the analog-to-digital converter associated with the biomimetic expressive state studied for the Elvis Alive animatronic structures.

Table 1

Expressive states / Biomimetic structure	The elements that influence achieving the expressive state	The range of variation associated with the element	The quantified values for achieving the expressive state
Happyness / Elvis Alive	Eyebrow	(min: 490, max:610)	590
	Eyelid	(min: 450, max:760)	710
	Mouth	(min: 340, max:490)	360

2.2 The description of the HC-SR04 ultrasonic proximity sensor

The ultrasonic proximity sensor HC-SR04, allows sufficiently accurate, non-contact measurement of distances from other objects in the environment. It can also be used to detect the presence of objects in the operating space (in the immediate vicinity) of a robot. It has the advantage that it is not influenced by electromagnetic interference (disturbances), it offers a high level of insulation and a wide frequency band [4].
Its principle of operation is based on changing the intensity of a light flux between a transmitter and a reflector (when an object is present) and applying the procedure of passing time (measuring the time since the emitter transmits the light beam, meets an object that reflects the beam and until when it returns to the receiver).
Figure 4 below shows the HC-SR04 ultrasonic proximity sensor.

Fig. 4 Ultrasonic proximity sensor HC-SR 04

2.3 The description of the TTP-223 touch sensor.

Touch sensors, in terms of the principle used, are of two types: capacitive and resistive. Capacitive technology consists in the appearance of a low current (electric charge) when the user touches the sensory support [5]. When the user touches the sensor with his finger, a small electrical disturbance occurs which is noticed by the sensor interface.
The interface has the role of filtering the parasitic signals and is adjusted for interaction only with a human body, so that accidental touches with other objects or possible occurrences of disturbances caused by impurities or liquids are eliminated.
Figure 5 shows the capacitive touch sensor TTP -223.

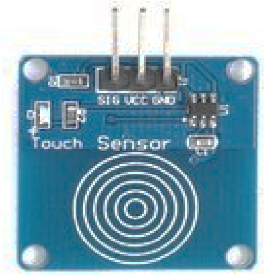

Fig. 5 Touch sensor TTP-223

3. BIOMIMETIC STRUCTURE CONTROL USING PROXIMITY SENSORS

By approaching the hand to the ultrasonic proximity sensor, the biomimetic structure is controlled, which will ultimately lead to obtaining the expressive state "happiness" of the Elvis Alive biomimetic robotic structure.
Figure 6 shows the block diagram of the experiment performed with the ultrasonic

proximity sensor HC-SR04, which achieves the expressive state "happiness".

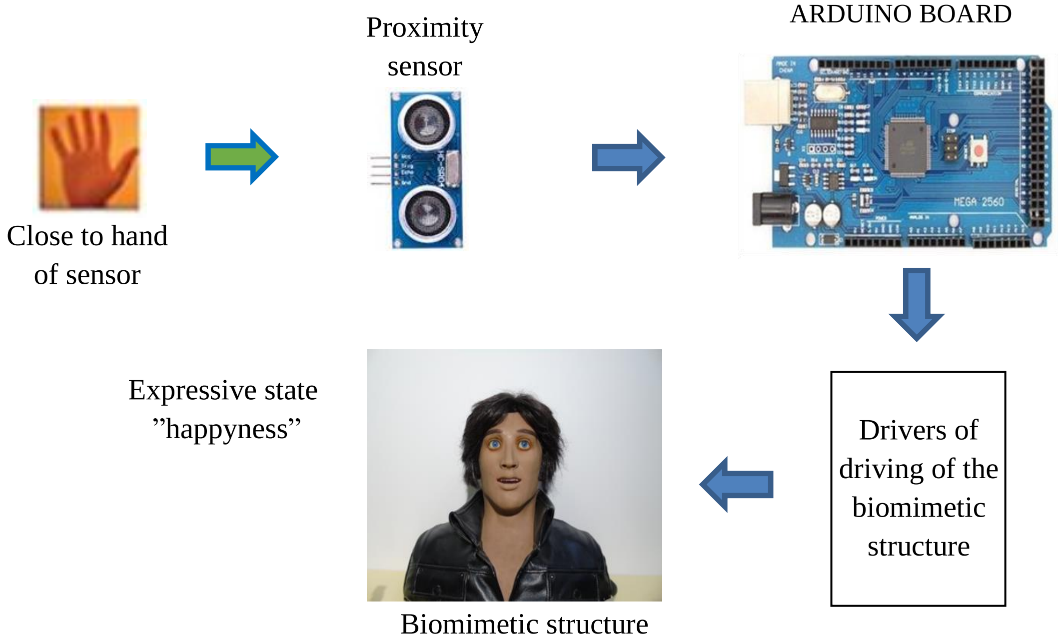

Fig. 6 Transmitting information from the ultrasonic sensor HC-SR04 to a biomimetic structure

Also, when the touch sensor is activated as a result of touching it, it will lead to a right-left head movement of the Elvis Alive animatronic structure.

Other expressive states can be implemented through the software implemented in the microcontroller of the Arduino motherboard as well as other movements of the animatronic structure.

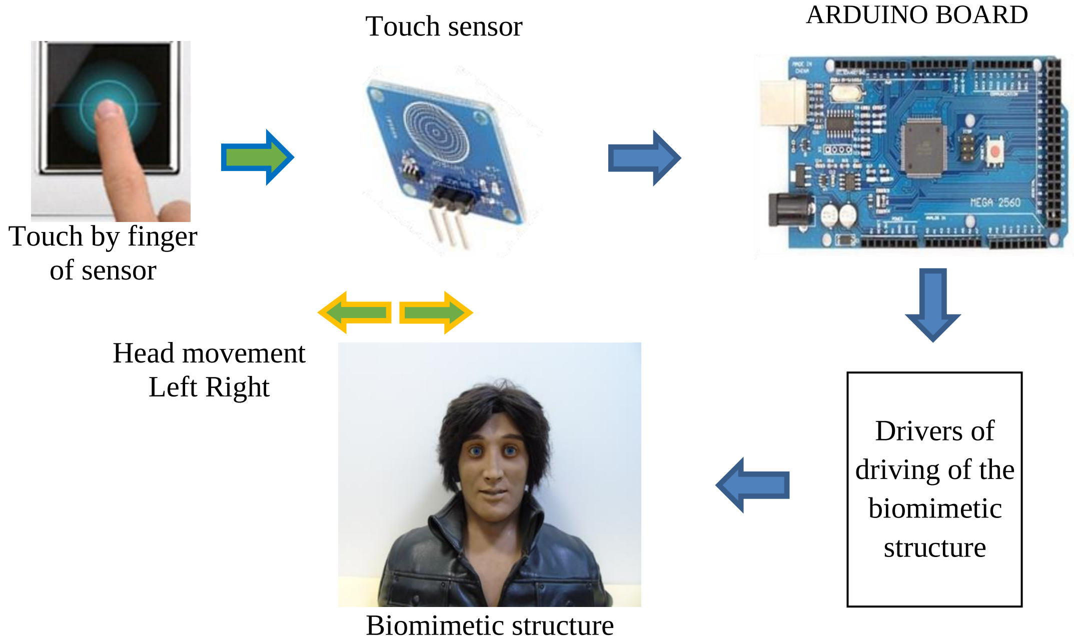

Fig. **7** Transmitting information from the touch sensor TTP-223 to a biomimetic structure

4. CONCLUSIONS

This paper aimed to create a control architecture that highlights the functionality of proximity sensors attached to a biomimetic structure to obtain an emotional state and movements of the moving elements of the robotic structure.
Through the experimental platform, any basic expressive state for the analyzed robotic structure can be obtained. Other types of sensors can also be attached to obtain controlled movements of the robotic structure. The final goal of the experiment was to explore how to integrate the developed humanoid platform, proximity sensors and touch sensors, in order to implement a reactive-affective system.

5. REFERENCES

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