Voice reactive biomimetic structure

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Abstract. The paper presents a Biomimetic Structures Reactive to Voice Commands (BSRVC). By sending voice commands the BSRVC will achieve the different emotional states. These states are controlled by a negative feedback control system with changed reference for each emotional state. Analyzing voice commands by comparing them with those stored in the phone database and sending the corresponding commands wireless to the biomimetic structure they determines the achievement these emotional states. Since contemporary information-retrieval systems rely heavily on the content of titles and abstracts to identify relevant articles in literature searches, great care should be taken in constructing both.

Keywords— reactive biomimetic structure, emotional states, control system, vocal command, PID control

1. Introduction

The biomimetics is an examination of nature, its models, systems, and elements that emulate or imitate (inspire) in order to solve human problems. It aims to achieve models, systems, imitating the inventions of life. It also investigates biological structures and processes, to use them as models in the development of artificial systems. Animal models are used as an inspiration for many different types of robots. One of this types of robots is the CHIMPANZEE ALIVE animatronic structure. Currently, the most interesting research in the field of robotics is represented by the creation of humanoid robots. The humanoid robots of the future are likely to have very large sensory capacities, more intelligence and judgment in decision-making and higher levels of manual dexterity and adequate mobility close to that of people. The most popular biomimetic robotic structures are: the twin android robot (created by Hiroshi Ishiguro engineer from Osaka University who can imitate seven different emotions); the android robot HPR-4C built to the average height and weight of Japanese women, specializing in the imitation of the moving of fashion models; the android robot Kansei that is scheduled to display 36 facial expressions; the android robot Saya created as a supervising teacher who can express six basic emotions; the Socibot Desktop robot (created by Engineertered Arts in the UK) that can mimic all emotional states using FACS facial coding; the structure animatronic ELVIS Robot that can play certain preset songs etc. Interaction of the robot with the environment, and especially the interaction between man and robot, is a field of research of great interest in modern robotics as it allows man to interact naturally with the robot. The easiest and most natural way to interact is by voice, allowing for a high level of expression of the requirements and an evolved bilateral mode of human-robot communication. Thus, the use of voice commands beside using fixed schedules can be "more
productive" and more attractive [1]. At present, many types of robots interact by voice. Thus, Alpha 1S, the first humanoid robot specially created for families, speaks, is an alarm clock function, sings and even tells stories to children, gesturing during the story [2]. The humanoid robot CruzR is basically the assistance of the future. It is our personal assistant, the one who helps us at the airport to find the embarkation gate, the one who can help us clean, the one who can embrace us when we are sad or dancing with us [3]. The humanoid robot Pepper is presented as "the first robot in the world who can read human emotions." The robot has been designed to be an "ideal" personal assistant, being endowed with capabilities and communication interface, including voice recognition, which allows him to interact with people [4].

2. Modified biomimetic structure Chimpanzee Alive

The Chimpanzee Alive biomimetic structure has been chosen because the chimpanzee has characteristics close to man and at the same time it can reproduce certain fascinating emotional / emotional states and behaviors close to man. This structure can be made to become interactive, able to realize the emotional / behavioral states required. The biomimetic structure CHIMPANZEE ALIVE has digital and analog sensors as well as 8 motors [5]. Figure 1 shows the sensors with which the biomimetic structure can interact with the environment. These sensors are: touch sensors (head, from the two ears, and chin), sound sensors and infrared sensors.

![Figure 1. The sensors of the biomimetic structure Chimpanzee Alive [5]](image)

Also, the structure also features 7 positional analog sensors (potentiometers) that are coupled to the motor shaft that acts on the following elements: up-down movement of the eyebrow, up-down movement of the eyelids, up-down movement of mouth as well as up- down and left-right movement of eyes and up- down and left-right movement of head. Another digital sensor shows when the top position of the nose is touched by proper motor movement.

In order to develop a reactive biomimetic experimental platform for authors modified the electronic and mechanical architecture CHIMPANZEE ALIVE. In Figure 2a) is presented modified biomimetic structure (chimpanzee ALIVE), and in Figure 2 b1)-b3) the mechanical structure of main emotion expressive states variable s (eyebrows), p (eyelid), g (mouths) are highlighted.
a) The Chimpanzee Alive modified structure  
b1) The eyebrow (s variable) action mechanism  

b2) The eyelid (p variable) action mechanism  
b3) The mouth (g variable) action mechanism  

**Figure 2.** The Chimpanzee Alive structure and its three mechanisms of action

Connecting multiple sensors to a microcontroller development board requires a large number of inputs, of which seven analog inputs for potentiometers. Therefore, it is used the ARDUINO MEGA board, which has the ATmega2560 microcontroller and the Atmega16u2 microcontroller for USB connectivity [6].

In figure 3 a) there is presented the electronic control circuits and animatronic structure (chimpanzee ALIVE), and in figure 3 b) the elements attached to the variables s (variable is for eyebrow), p (variable is for eyelid), g (variable is for mouth), which perform the expressive states, are highlighted. Using these structure and an suitable control algorithm we can implement mimic expression.
In Figure 4 are presented three basic emotional states of a chimpanzee robot, namely: ecstasy, melancholy and furious. The references for the 3 states have the values showed in the figure.

Figure 4. The emotional states of a chimpanzee robot: ecstasy, melancholy and furious

3. The voice command of biomimetic structure analyzed
In order to implement a voice reactive biomimetic structure, expressive states has to be obtain when a voice commands are sent to structure, using the mobile phone. By using the dedicated Bluetooth software SPP Tools Pro (serial port protocol) download in the phone, it can communicate with the control architecture. Binary codes are sent using the phone corresponding for each the emotional state (these codes are initially declared / stored in the phone by the user using the application / software mentioned above). Sending these wireless codes to the biomimetic structure determines these emotional states. Receiving these codes is done achieved by means of a Bluetooth attached to the control structure. The voice reactive control has the following structure (according to figure 5):

• A Bluetooth Master Slave HC-05 module attached to the Arduino Mega development board. It is powered at a voltage of 3.3V and for the data transmission are used the communication pins Rx and Tx which are connected to the ARDUINO development board.
• An Android-based mobile phone with a Bluetooth terminal application that provides a serial communication between the mobile phone and the ARDUINO board. The Bluetooth terminal application is called Arduino BlueControl, which provides, in addition to the panel of type terminal, the ability to use voice commands that are processed with voice synthesis provided by Google. To achieve this, some text sequences (Figure 6a and 6b) must be stored in the
application, which will be compared to the voice command sequences given by the user with the voice interpreter offered by Google.

![Image](image1.png)

**Figure 5.** The connection by Bluetooth for the vocal command [7]

For example, in order to transmit a voice command to the "Chimpanzee", to achieve the state of ecstasy, in the location for voice command no.1 (figure 6 a) enroll to save the "Ecstasy" text sequence that will be compared with the voice sequence what is to be interpreted when pressing the application button to initiate the voice command. If the voice sequence sent by the user and recorded by the application coincides with the "Ecstasy" sequence (figure 6 b), a character will be sent to ARDUINO (for example, the "Ecstasy" will send the "E" character that was set in the development stage of ARDUINO' soft), which will then be interpreted by the developed software (figure 6 c).

![Image](image2.png)

**Figure 6.** The interpretation of voice commands by mobile phone for the command and control of Chimpanzee Alive robot

Other voice commands may be sent, for example, the "Melancholy" command (figure 7a) for the sad emotional state and the character "M" will be transmitted to ARDUINO (figure 7 b). Another Bluetooth terminal application is "SPP Tools Pro" which offers the user the possibility of bidirectional communication with the development board. The application allows the user to configure commands through a 4x3 button array. Each button can be configured to send different characters in different states of action: press, hold (if the button keeps pressed over a set application time) and release. For example, in order to command the monkey in the ecstasy state, press the button with the name assigned - "Ecstasy", and after pressing the Bluetooth will be sent to the Arduino development ard, the character - "E" (as shown in figure 8 ). Arduino board interprets the characters received through a conditional switch structure (as shown in figure 9), where the prescribed values for the s, p and g parameters are set for the emotional state ordered and what is to be achieved.
The interpretation of "Melancholy" voice command by mobile phone given to the Chimpanzee Alive robot.

The interpretation of the voice commands by mobile phone using „SPP Tools Pro” given to the Chimpanzee Alive robot.

The interpretation of the voice commands by the Arduino board given from mobile phone using „SPP Tools Pro”.
When accessing each case from the "switch" structure, which corresponds to an emotional state, in order to see that the state has been achieved, it is planned Arduino board to send through Bluetooth a message to the application on the phone mobile (for example, "I'm happy" - message associated with ecstasy state).

4. Conclusions
A voice reactive biomimetic structure offers an efficient artificial friend solution for older persons or persons with disabilities. In order to develop a commercial solution the control structure has to be simple but efficient. For the control and regulation of the BSRVC it is used a PID algorithm as well as bi-positional regulation techniques. The use of voice synthesis applications for making voice commands to different types of biomimetic structures allows user interaction.

The proposed experimental structure can be easily controlled and the expressive states are in accordance with reality. The disadvantages of the present proposal regards that the positioning variable s, p, are good when it is a slow process and when no quality indices are required for superior performance. For good performance can be used a proportional regulator but instability can occur.

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