THE ANNALS OF "DUNĂREA DE JOS" UNIVERSITY OF GALATI
FASCICLE III, 2018, VOL. 41, NO.1, ISSN 2344-4738, ISSN-L 1221-454X
ELECTROTECHNICS, ELECTRONICS, AUTOMATIC CONTROL, INFORMATICS

SURVEY REGARDING THE COMMUNICATION BETWEEN A HUMAN AND A HUMANOID ROBOT

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Abstract: This paper presents the research on communication between a human and a humanoid robot. The humanoid robot is a robot that acts like a human. The first function of a humanoid robot is to fuse multi sensor data through an interface.The interface provides the environment where the data from the sensors is processed and transmitted to an avatar. The avatar uses the facial expression to expresss the emotion of a human and is sensible to human brain waves. The other robots uses both avatar and interface and can be remotely controlled by a human with no contact.

Keywords: humanoid robot, multi sensor data fusion, avatar, interface.

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1 .INTRODUCTION

The new challenge in the research about the communication between a human and a humanoid robot is based on human brain waves.

In our century human brain waves are used in several applications (Kumar, 2017):

- to move a hand of a robot located in a remote place;
- to filter the phone the incoming calls by monitoring the human brain;
- to create a 3D object with a printer;
- to avoid the obstacles with a smart car;

In our paper we present some modalities of communication between a humanoid robot and a human to understand the importance of human brain waves as an alternative in communication.

2. MODALITIES OF COMMUNICATION BETWEEN A HUMAN AND A HUMANOID ROBOT

When it communicates with a human, a humanoid robot chooses the most effective modality to communicate, it does not consider the data as large blocks of information and it acts like a human.

2.1. *Detection, observation and recognition of a human behavior*

When a humanoid robot communicates with a human, one is "talking", active behavior and the other is "listening", passive behavior, through the ultrasonic distance sensors (Kurosu,2016).The sensors detect the approach and the departure of a human. When the human is approaching, the humanoid robot performs the active behavior, greetings under basic settings (Fig.1). It modifies its state until it detects the contact with the human, When the human is leaving, the humanoid robot returns to initial state with no contact with the human. The human detecting distance is established by human. The sensors don't detect the tactile contact with the human.

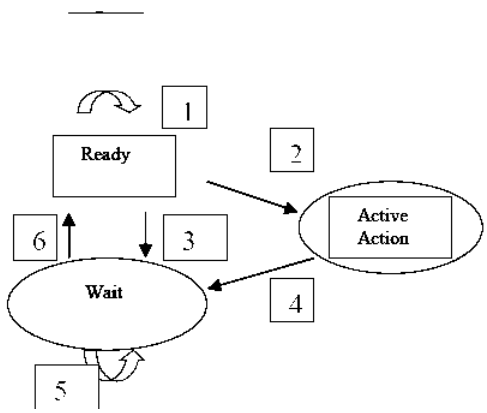

Fig.1.The active behavior of the humanoid robot

1. The detection of the human behavior with no human contact;
2. The detection of the action, then the activation of a command for the active behavior;
3. The detection of the action, without the activation of the active behavior;
4. The change of the basic settings and the waiting of the human behavior;
5. The detection of human contact and the humanoid robot answer;
6. The end of the human contact and the action of the retreat (Kurosu, 2016);

A humanoid robot that recognizes human behavior is called the recognizable humanoid robot and it is used to detect the delinquents from the urban and the rural life and to track down those which copy at the exams.

2.2. *Avatars*

Avatars are virtual agents through which the humanoid robot communicates with a human. They are based on brain signals and combine two higher level emotions as empathy and anger as sequences of signals. The empathy and anger are created by the increasing and the decreasing of the concentration of oxygenated hemoglobin, which influence the activity of prefrontal cortex. The prefrontal cortex has an important role in regulating the emotions and the behavior of human. His activity is observed through Functional near Infrared Spectroscopy and transformed by the humanoid robot in outputs (Aranyi, 2016).

The avatars use action units and body animation parameters that provide low level control for humanoid robot animation. It uses 8 human facial expressions to create his own expressions when it communicates with human (Fig. 2).

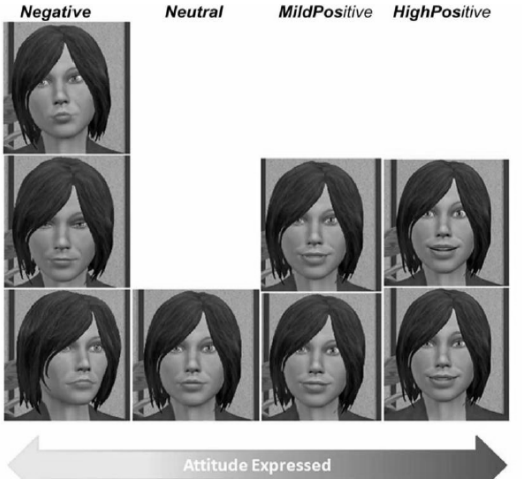

Fig.2.The human facial expressions used by the avatars in speech (Aranyi, 2016)

The avatars are used for storytelling and engagement in communication with the human. They don't use too much speech recognition, they react the same regardless of what the human communicates.

2.3. *Hyper instruments*

Hyper instruments are modified musical instruments which interpret the human actions. In this case the humanoid robot communicates with the human through tactile contact and human brain waves. The direct sensors of the hyper instruments transform the human gestures into electrical signals which are used in the communication with the human. The indirect sensors of the hyper instruments transform the human brain waves into the necessary inputs to determine the human desired gestures when he plays at the instruments (Politis, et al., 2016).

The hyper instruments are used to explore the human digital sensing capabilities and to avoid sound errors which appear because of the acoustic noises and the interferences.

2.4. *Human - Humanoid robot interfaces*

Human - Humanoid Robot Interfaces are digital interfaces which allow verbal and non - verbal communication between a human and a humanoid robot. These interfaces transmit the information about the sound characteristics as: notation, pitch, velocity used in speech, the information about the control signals for the parameters as volume, vibrato, audio, panning, cues and clock signals that set and synchronize tempo between the words used in speech and about the type of the human brain waves. The data of HHRI is recorded by the hardware or software device, where it is analyzed and transformed in answers.

Mimicry is very important to create human - humanoid robot interfaces. The facial expression is

the same with what it is expressed in words and it is created by the electrical current passing through the hardware device.

The best example of the human-humanoid interface is the assisted communication tutoring through the music. This combines the video, the "piano roll" graphical displays, the 2-D fingerboard animations and even the 3-D avatar animations. It gives the feedbacks in the human absence.

The human- humanoid robot interfaces use the Electro - Encephalography (EEG) to measure the human brain signals and to transform them into words after the noise filtering, the clustering, classification with Bayesian network classifier and pair-wise classifier. The spectral power of human brain signals is set in six standard frequency bands, according to the different types of neural activity, after the Fourier Transform. The interfaces basic tasks are the emotion recognition and the polarity detection that are expressed in words (Radeva and Radev, 2016; Cambria, 2016).

The most successful humanoid robot - human interfaces are based on the convert attention decoding through the pupil metrics and use the pupil dimension as the signal of the control. The pupil transcendence from dark to light and from light to dark in the communication between a human and a humanoid robot is influenced by the affective state and the specific state anxiety and it depends on the anxiety levels increasing and the anxiety levels decreasing in the human brain (Riva, et al. , 2016).

2.5. *Robotic dance*

In the communication between a human and a humanoid robot, the robotic dance implies a close sensor, the multi contact and the non-contact sensors and the multi sensor data fusion. The four main contact sensors are on the waist, on the left hand, on the right shoulder and on the right hand of the robot, "closed position" (Fig.3).

Fig.3.Waltz dance and the closed position (Peng, et al., 2015)

During the robotic dance, the humanoid robot communicates with a human through body motions (contact forces) rather than through verbal commands. The most efficient software device in robotic dance is Control Architecture based on Step Transition, CAST (Fig.4).

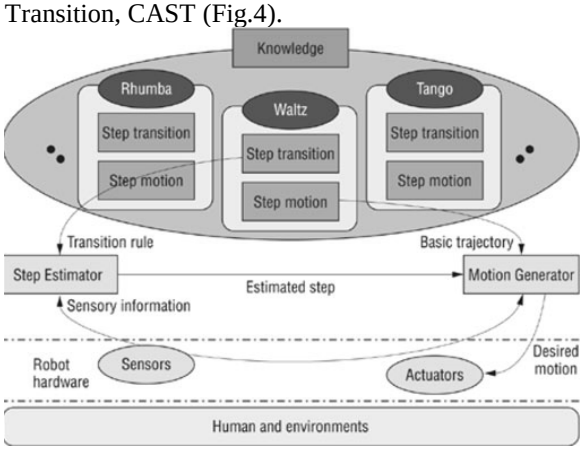

Fig.4. CAST (Peng, et al., 2015)

Random generation is the simplest method to create the robotic dance and it is based on the database of the primitive motions, each as the state of the Markov chain. The fitness function directs the evolution of motions and allows the next motion to be determined by the previous motion and each state of emotion (Fig.5).

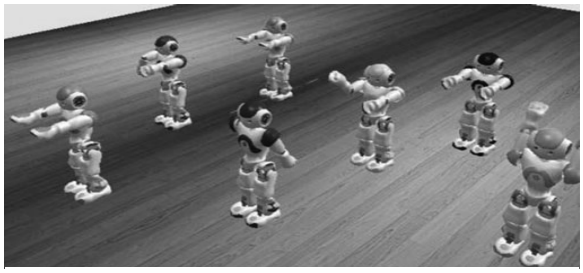

Fig.5.Robotic dance using Fitness Function (Peng, et al., 2015)

The multi sensor data fusion as the human brain achieves the information from the different sensors and fuses together. The humanoid robot takes the advantages of it and it communicates with a human (Fig.6).

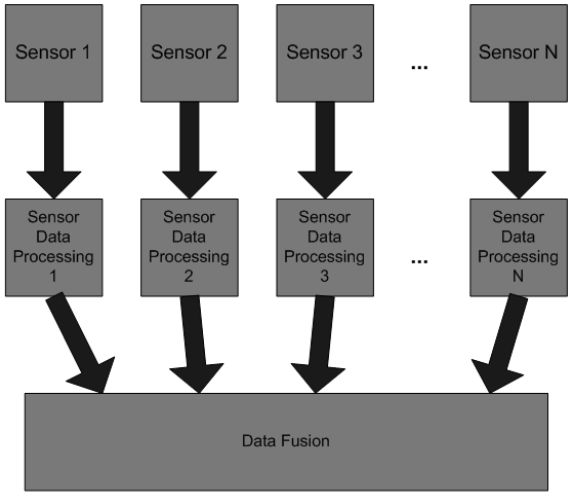

Fig.6.The multi sensor data fusion of a humanoid robot (htpp://www.nutaq.com)

The sensors depend on the humanoid robot operating system. The data processing sensors transform the information from a sensor without using the information of the other sensor.

The data fusion takes the inputs from the data processing sensors and it creates a robotic dance.

The emotions in the robotic dance are observed through multi modal multi temporal information fusion of individual classifiers outputs, using HMM-based on Adaptive Boosting classification algorithms. The fusion at the semantic level provides a better performance to the multimodal emotion analysis. So the emotions are analyzed by information extraction from the multi sensors such as video sensors for facial expressions, audio sensors for speech, inertial sensors for motions and multi sensors for human brain waves.

In the robotic dance a humanoid robot amplifies the knowledge and the human expertise and it is used to develop the human cognitive memory and to detect the human temperaments.

2.6. *Smart phone*

The smart phone is a multi functional multimedia mobile phone, connected to a GSM or UMTS and it is used by the human to communicate remotely with a humanoid robot via Bluetooth or Wireless(Dahir, et al., 2016).

Its command is transmitted by the Arduino Controller and the human – humanoid robot interface (seen in the Fig.7)

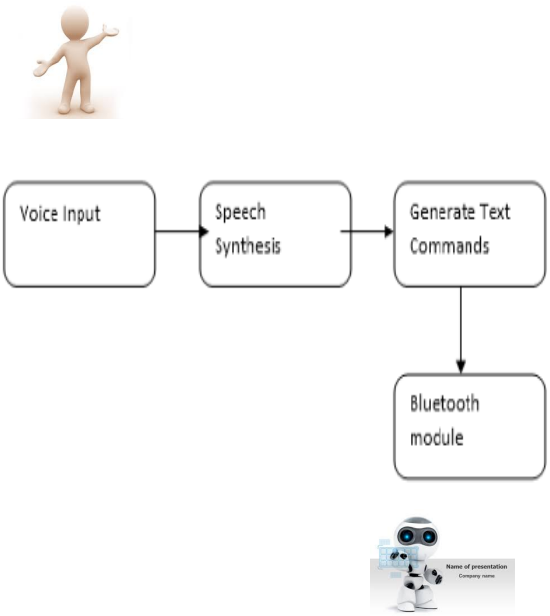

Fig.7. The block diagram of the software used in the remotely communication between the humanoid robot and the human (Dahir, et al., 2016)

The smart phone informs the humans about the appropriate earthquakes more quickly than other software devices, about the brightness setting of a day, of a star, of a planet or other galaxies or it is used to do astronomical and mathematical calculations.

2.7. *Other robots*

NAO robot

NAO robot with the multi contact sensors and an emotional intelligence is used in the communication between the human and the other humanoid robots. The purpose of the robot is to create verbal communication that allows to receive the human voice and to respond naturally to it. It uploads the speech request and the answer request.

The speech recognition is implemented by the Google Speech Recognition with statistical modeling and n gram modeling to reduce the errors in speech processing.. The received information is extracted with the Fast Fourier Transform Algorithm(Antona and Stephanidis, 2016; Syarif and Prihatmanto, 2016).

Lumen social robot

Social Robot Lumen (seen in Fig. 8) has 7 basic modules: server, audio, visual, motion, IA, database, social media (Syarif and Prihatmanto, 2016).

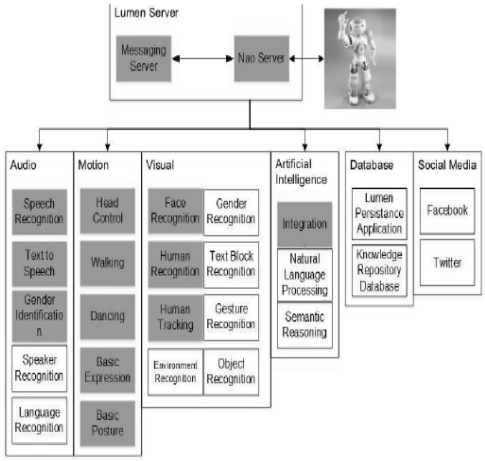

Fig.8.The software of Lumen Social Robot

The Lumen sever connects all the modules, takes the information from the sensors and controls the NAO engine.

The Visual module helps the robot to identify the humans and the objects.

AI module has 3 main modules and a module called Integration, which it reacts when it is searched a module. Motion module has 5 actions: head control, walking, dancing, basic expression and basic posture and uses Fuzzy Logic Control (MANZANI show). The Social Media and the Database help the robot to post on Twitter or FACEBOOK video or photos, to create an encyclopedia or to communicate online. Each module has a routing key which refers to a series of manipulated parameters by NAO robot. To connect a new module the routing key begins with "avatar" for the modules that communicate with other humanoid robots, with NAO robot or other virtual platforms and with "lumen" for Lumen social robot's AI module.

CARL robot

CARL robot allows remote access to the state-of-the-art robots via Cloud and via Web browser. Its behavior is guided by the human brain large-scale simulations. An interface with the human allows it to communicate with the other robot to make an action autonomously (Fig.9).

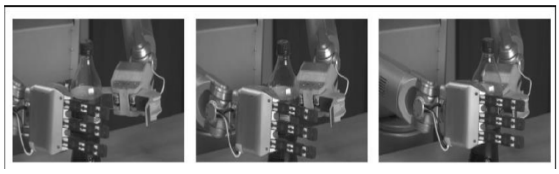

Fig.10. CARL robot used by the human to communicate with the Dreamer robot (Syarif and Prihatmanto, 2016)

This interface is equipped with multi sensors and it contains a data viewer which shows the information about the current state of the humanoid robot, stored in Cloud. An advanced human brain waves analysis gleans the useful information to speech.

ROBOVIE robot

ROBOVIE Robot is an interactive robot that uses the facial expressions in its body language and recognizes the human using 4 basic speech modules. The software (seen in Fig.11) shows that the information are not processed perfectly, but the humanoid robot reaction is correct.

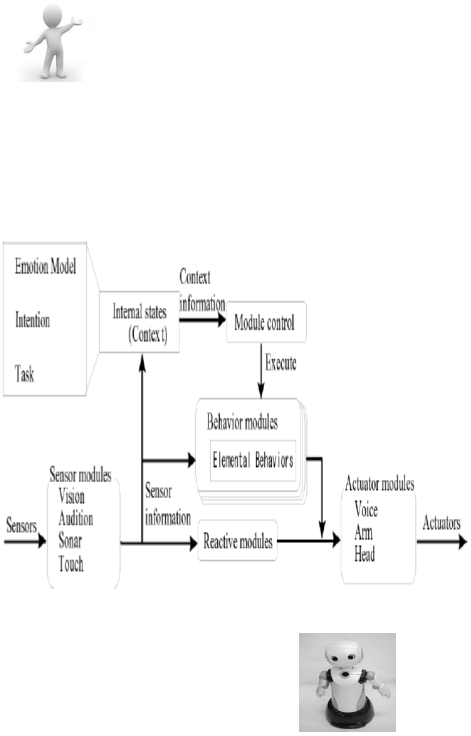

Fig.11.The software of ROBOVIE robot used in communication between the human and the humanoid robot (Ishiguro, 2016)

3. CONCLUSIONS

The modalities of the communication between the humanoid robot and the human described in this paper may provide a compromise between the real world and the virtual world.

The humanoid robot that works in the virtual world will be informed, will eliminate the faults and will bring the benefits and the actions quickly.

So the human brain waves control the humanoid robot and the human controls the human brain waves.

The research in this area is important because we need to communicate with a humanoid robot to make our life easier. The humanoid robot has application in the healthcare, in the psychological therapy, in the education, in the customer services, in the password security, in the everyday activities.

In the future there are some points which should be considered in the communication between the human and the humanoid robot:

- -the creation of better human brain sensors;
- -the creation of the improved multi sensor data fusion algorithms;
- -the creation of the improved facial emotion algorithms;
- -the creation of the improved neural fuzzy algorithms;

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