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Emotional Intelligence: Implementation in Humanoid and Semi-Humanoid Robots

Amit Pandia

Department of Computer Science, Jodhpur Institute of Engineering and Technology

Jodhpur, Rajasthan, India

Abstract- This paper suggests a method by which emotion intelligence can be implemented in humanoid and semi-humanoid robots. From a long time various people are trying to implement emotional intelligence in robots, this paper is an answer to their question "How to implement emotional Intelligence?" This paper suggests the approach required to implement emotional intelligence on humanoid robots. Since there are large varieties of humanoids present in today's scenario, therefore this paper gives a generalized approach that is suitable for humanoid robot of every type. The method discussed in this paper is very flexible. With a little modification it can be made to work with almost any humanoid. This research paper is based on a hypothetical humanoid robot having some sensors, some motors, some LEDs and at least one camera and a microphone. The paper also discusses the database design required to implement emotional intelligence. It suggest the names and characteristics of all the tables and columns required for mapping the emotional intelligence on robots. It also works with those robots which are not completely in human like shape such as robotic head. Sometimes there are robots that have only head and upper body, this composition is semi-humanoid composition. The method suggested in this paper suggests the algorithm that works on these kind of robots.

Keywords-Emotion, Humanoid, Semi-Humanoid.

I. Introduction

An emotion is a cause of feeling, rather, it can also be called as the starting point or the beginning of a feeling.

"What is feeling?" It is a specifiable sort of sensation, the sensation of one or more "visceral disturbances"- changes in the body due, for instance, to the stimulation of the autonomic nervous system. The great virtue of the Jamesian theory is that it ties down the nature of emotional "feelings" to quite particular and therefore verifiable bodily responses. For Example, when someone is emotionally attached to wellbeing of something in such a way that he can neither see it getting harmed nor lose it then it can be called as feeling of love. Still this example has a lot of unexplained perspectives to make it an ideal example for the feeling of love but it is sufficient to explain the beginning of feeling with an emotion.

Emotional intelligence for humanoids cannot be implemented in the way it is implemented in humans. In humans emotions and feelings are triggered by bio chemical means but it is practically impossible to make biochemically triggered emotional intelligence for humanoids. So to achieve the goal, we map the intelligence by means of speech and actions. Since, here the concern is about implementing emotional intelligence on humanoids so for every humanoid robot we have a generalized structure that is: a structure which looks like human body. This clearly indicates that whatever machine we are working on will definitely have a pair of arms, legs and eyes, a mouth, a neck, ears. Arms and legs are the mechanical parts designed to move in various directions and perform various tasks. The role of eyes is played by cameras that could capture pictures and videos. Mouth is actually a speaker that outputs analog audio signals. Ears can be either a single microphone for receiving analog audio input signal or it could be multiple microphones for receiving the same input but with more efficiency by using the techniques like active noise cancellation and multiple voice recognition.

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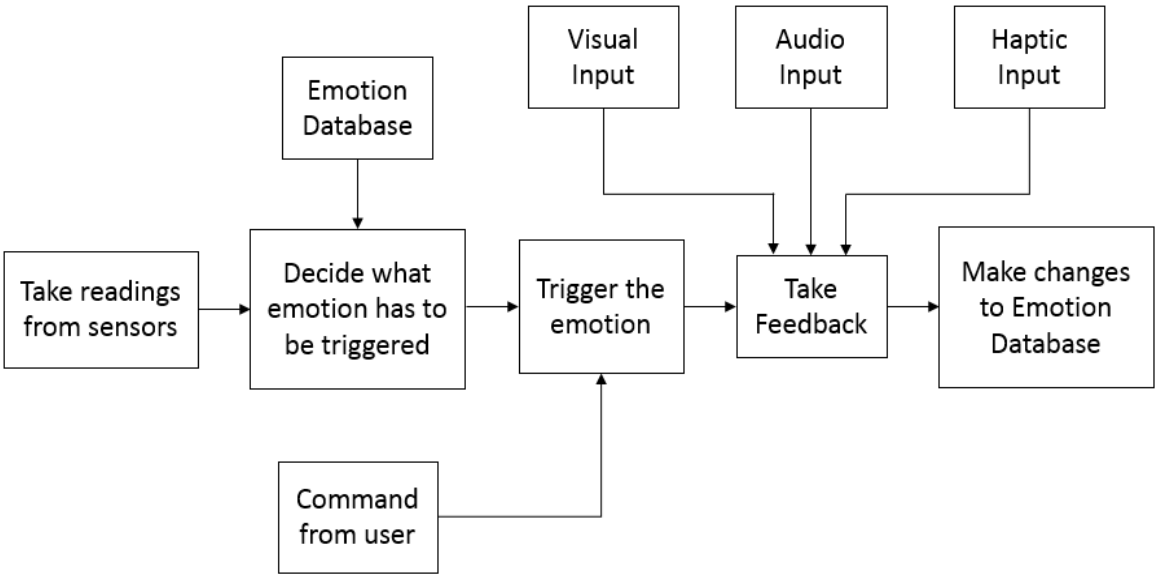
II. Block Diagram and its Explanation



(i) Taking readings from sensors- It involves collection of all the data form the surroundings i.e. reading data from cameras, microphones, gyro sensor, temperature and humidity sensor, distance sensor, proximity sensor, touch sensor, pressure sensor, light sensor, tactile sensor etc. and fetching information about the current body posture.

(ii) Emotion Database- It contains all the information about all kinds of emotions. It also plays a crucial role for making the decision that which emotion has to be triggered. The design of database is such that its columns can be divided in three categories:

a. **Category 1 (Analysis category):** The columns belonging to this category contains sensor values that help to decide the current environmental conditions and posture of the humanoid.

b. **Category 2 (Action category):** The columns belonging to this category contains those values that decide the motion of each part of humanoid robot to represent a feeling or an emotion.

c. **Category 3 (General Information Category):** Columns belonging to this category contains general information about every emotion such as emotion ID, description, threshold values for sensors and threshold values for motion of various parts of the robot. These threshold values are different for every emotion.

(iii) Deciding what emotion has to be triggered- The decision of the emotion that has to be triggered is determined by comparing the values of readings from sensors with the preset values stored in the Category 1 columns of database. This comparison tells about current posture and current environment conditions of the humanoid. After getting the information about self-posture and environment the values read from sensors are matched with the values of columns of category 3 of database. This comparison determines what

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has happened in the environment and is the correct emotion to be triggered.

(iv) Triggering the emotion- Once the humanoid identifies which emotion has to be triggered then it's time to represent that emotion. This is done by moving the body parts according to values stored in category 2 of emotion database. Sometimes user might want the humanoid to represent some emotion (either for fun or for testing and calibration.) In this case, whatever the emotion is requested by the user the humanoid represents it according to the values of category 2 columns of emotion database for that particular emotion.

(v) Command from user- It is the request sent by user to humanoid to show an emotion.

(vi) Visual Input- The input received from camera (in form of picture).

(vii) Audio Input- It is the input received from microphone. If there are multiple microphones, then the final output depends on the processing algorithm used for the audio inputs.

(viii) Haptic Input- These are the inputs received from touch sensors, tactile sensors, gyro sensors and vibration sensors.

(ix) Taking Feedback- Feedback can be either in form of visual or audio or haptic input. Visual inputs detects the gestures on the basis of which emotion has to be triggered. Here feedback refers to the environmental activity that happens just after the presentation of emotion. Feedback helps the humanoid robot to improve the way it expresses an emotion. It also helps to predict the expressions of surrounding people once it learns all possible feedbacks. These feedbacks can sometimes be used as the input to trigger another emotion.

(x) Making changes to emotion database- On the basis of emotion presentation the developer may want to calibrate some of the values in emotion database. In such case the command given in feedback will be used to calibrate certain values in emotion database.

III. Database Design

- **Table 1**- It contains list of all emotions with their Id. (Table below is a sample for Table 1)

S.no	Emotion ID	Emotion Name
1	E1	Happy
2	E2	Sad
3	E3	Anger
4	E4	Fear
5	E5	Shy
6	E6	Pain

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- **Table 2 – It contains Category 1 columns**

Reading ID	Sensor 1 (Sensor Data)	Sensor 2 (Sensor Data)	Motor 1 (Current Position)	Motor 2 (Current Position)	Camera 1 (Image path)	Camera 2 (Image Path)	Mic 1 (Audio file path)	Mic 2 (Audio File path)
R1	-	-	-	-	-	-	-	-
R2	-	-	-	-	-	-	-	-

- **Table 3 – It contains Category 2 columns**

Emotion ID	LED 1 (Color code)	LED 2 (Color code)	Motor 1 (Position to represent selected emotion)	Motor 2 (Position to represent selected emotion)	Speaker (Audio file path)
E1	-	-	-	-	-
E2	-	-	-	-	-

- **Table 4 – It contains Category 3 columns**

Emotion ID	Sensor 1 (Threshold value)	Sensor 2 (Threshold value)	Motor 1 (Threshold value for position)	Motor 2 (Threshold value for position)	LED 1 (Default color code)	LED 2 (Default color code)
E1	-	-	-	-	-	-
E2	-	-	-	-	-	-

IV. Algorithm to detect and trigger emotion-

1. Read values of all the sensors and current position of all the motors and store all the values in table 1.
2. Take the photograph from cameras and audio input from microphones and store their file paths in table 1.
3. On the basis of above input, decide the expression to be triggered.
4. Compare all these values from values from threshold values stored in table 3.
5. On the basis of above comparison determine the current state, posture of the robot.
6. Move the parts of robot according to the values stored in table 2 (i.e. to on/off the motors, LEDs and play the audio files required to represent to that emotion).

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VI. About Author

Amit Pandia

(amit.pandia9@gmail.com)

Department of Computer Science (Batch 2013-17)

Jodhpur Institute of Engineering and Technology

Jodhpur, Rajasthan, India