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Human Emotion Recognition using Bio Signals

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ABSTRACT

Emotion is any strong feeling which is caused by experiencing love, hate, fear, etc., and followed by certain physiological changes, such as increase in heartbeat, respiration, temperature, skin conductance and muscular tension in the body. Emotions can be recognized using facial expressions, speech, body gesture and physiological signals. In this, we considered the heartbeat and body temperature of a person which are obtained from the pulse rate sensor and DS18B20 body temperature sensor and a database is made based on the classification of the temperature and pulse values for a particular emotion. KNN machine learning algorithm is executed on the dataset which focuses on K nearest neighbors to determine the class to which an input belongs to. By applying Machine Learning we can accurately predict the emotion of the individual. So, this paper helps to detect emotion of a person and display the emotion of the person, if the person remains in a particular emotion for a longer period of time.

Key words: Emotions, Emotion Recognition, Physiological Signals, KNN Algorithm.

1. INTRODUCTION

Emotions play a vital role in human life. It affects both the psychological and physiological state of a person. Emotions are classified into positive and negative emotions. Positive emotions are happiness, excitement, love, etc.., which helps in the improvement of human health. Negative emotions are sadness, depression, etc.., which causes health problems. Physiological signals are obtained by the body when the physiological systems are under function. These signals hold information which are used to find out the state of functioning of the physiological systems. The extracting information from these signals is very simple. Emotion recognition is a process of identifying human emotions. This can be made using physical signals such as facial expressions, speech, gesture, posture etc. and physiological signals like the body temperature, respiration, galvanic skin response, electrocardiogram, electromyogram, electroencephalogram, etc. which are obtained from the body.

This paper mainly proposes the human emotion recognition system, in which if the person is under a particular emotion for a longer time, then the emotion is displayed. Here we have considered four types of emotions: happy, sad, fear and normal state, based on the Pulse Rate and the Body Temperature of a person. From the pulse and body temperature taken from the person we determine the emotion using the KNN classifier algorithm. This system can mainly be useful in monitoring the elderly person or patient as providing physical assistance for 24/7 is a bit difficult. With the help of this system, one can easily know if the person is in the same state then it is displayed and necessary action is taken. Emotion can be recognised using facial expressions, speech and text. The main drawback of those are one can hide their real emotions and fake their emotions. So, Emotion recognition with the help of bio signals is more accurate as one can fake their emotion but not their pulse and body temperature. Thus, this system is more efficient comparatively.

2. LITERATURE SURVEY

In order to develop the proposed system, a literature review was made to study the various techniques and methods that are used for human emotion recognition: Wearable Systems for Service based on Physiological Signals- Here the system obtains the data from physiological signals, predicts the emotional status and takes necessary action.[1]. Bio-Signal based Emotion Detection Device-Priyank Rathod, Department of Computer Engineering- In this experiment six emotions were detected with the help of audio visual shown to the person, their physiological signals (heart rate, skin

conductance) and facial expressions are taken in parallel. Where the emotion predicted from the facial expressions are matched with bio signals.[2]. Physiological Signals and Recognition of Negative Emotions- A research by Byoung-Jun Park - In this paper he considered negative emotions: sadness and disgust are recognized using six machine learning algorithms. The results shown here are highest training performance and testing among the algorithms. KNN is used only for testing.[3].

Physiological Signals Based Human Emotion Recognition: A Review- A research by Jerritta S from School of Mechatronic Engineering- In this paper they reviewed and presented different kinds of human emotions and its recognition using physiological signals.[4]. Emotion Recognition Based on Physiological Changes in Music Listening- research by Jonghwa Kim, Member of IEEE, - In this system the user's emotions are recorded before and after the audio visual is shown and then the emotion is classified.[5]. Using Physiological Signals for Emotion Recognition research by Szwoch Wioleta Gdansk University of Technology- Here they considered different physiological signals such as temperature, skin conductance, heart rate, blood volume pulse, respiration, and muscle electrical activity. This system is complex as they considered many physiological signals.[6].Analysis physiological signals for emotion recognition research by Khadidja GOUIZI - here emotion recognition varies according to selection of physiological signals related with emotions, selection of parameters extracted from those signals.[7].

Inner Emotion Recognition using Multi Bio-Signals- A research by Jinho Shin has proposed about inner emotion recognition method using multi bio-signal. He has taken five emotions that are classified using SVM algorithm. The different signals are compared with one another to recognize the emotion and the final accuracy is displayed.[8]. Classification of emotion based on Bio-Signals -Another research by Eun-Hye Jang from Biohealth IT Convergence Technology Research that from multi-channel bio-signals, emotions are classified using machine learning algorithms. He measured physiological responses which derived from emotions such as joy, surprise, fear, anger, sadness, and boredom for bio-signal acquisition.[9].

3. PROPOSED SYSTEM

This system determines the human emotions and displays the emotion which the person is in. The proposed system contains the Arduino Uno board, which is used to read the body temperature and heartbeat from sensors connected to the board. KNN (K nearest neighbors) Machine learning algorithm is used to train the various classes of emotions. Also, to test and classify the input data. We are primarily concerned with four different emotions here i.e. happy, fear, sad and normal.

3.1 Architecture

The design is as follows (figure 1): The body temperature sensor and pulse rate sensor are used to obtain the body temperature and heartbeat of a person respectively. To obtain the data from the sensors, they are connected to the Arduino Uno board. We already train a data set based upon the pulse and temperature values i.e. we assign a particular emotion for a particular pulse and temperature range.

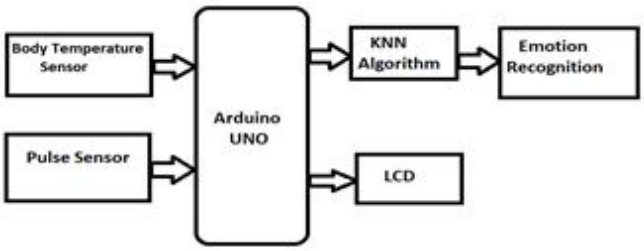


Figure 1: Architecture of the proposed system

Using KNN classifier we classify the obtained input (pulse and temperature) under which category it falls. This classifier algorithm is written in the MATLAB software. With the help of the KNN algorithm we can easily find under which emotion the person is going through.

3.2 Algorithm

Here, we have used K-nearest neighbor machine learning algorithm to determine the human emotion based on some parameters. Based on the emotion conditions, the values are generated by the individual from the sensors and a training dataset was prepared. To predict which class the input belongs to, the KNN algorithm is applied on the dataset which focuses on K nearest neighbors. To choose the best value for "K" is: Set the K values as K = N^ (1/2), where "N" is the no. of training samples in data.

KNN Algorithm:

- Load the training data and initialize the value of "K".
- To get predicted class, iterate the following steps from 1 to N:
    1. Calculate the distance between the input data and each row of trained data. Here we use the Euclidean distance. In 2-D the Euclidean distance formula between P=(x,y) and Q=(a,b) is:

$$d = \sqrt{(x-a)^2 + (y-b)^2}$$

    2. Arrange the calculated distance values in ascending order.
    3. From the sorted array get the top k rows.
    4. Return the most frequent class of those rows which is now the predicted class.

4. RESULTS AND ANALYSIS

The hardware components used in this setup are:

1)Pulse Rate Sensor: The Pulse Rate Sensor (figure 2) gives digital output of heartbeat. For every heartbeat the led in the

sensor flashes. To calculate bpm rate the obtained digital output is connected directly to Arduino.

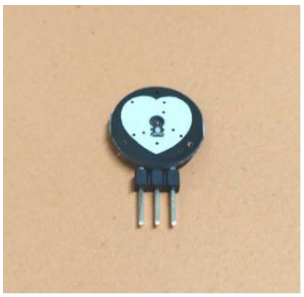


Figure 2: Pulse Rate Sensor

2) DS18B20 Temperature Sensor (figure 3): It is a digital temperature sensor which is used to indicate the body temperature in C and measures temperature from -55 C to +125 C

Figure 3: Body Temperature Sensor

3) Arduino Uno: Arduino (figure 4) is an open-source platform based on hardware and software.It is a microcontroller board based on 8-bit ATmega328P microcontroller. It can be programmed using C and C++ language and very easy to implement.

Figure 4: Arduino UNO Board

4) LCD 16 x 2: The term LCD (figure 5) stands for Liquid Crystal Display. It is an electronic display module preferred for multi-segment light-emitting diodes. The advantage of using this is simple, programmable, and inexpensive.

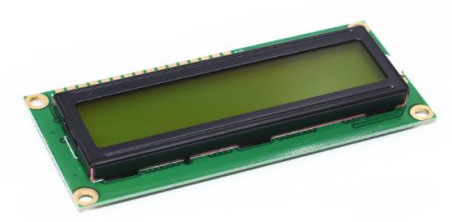


Figure 5: 16x2 LCD Display

5) MATLAB: MATLAB (Matrix Laboratory)is a high-performance programming language used for technical computing. It combines computation, visualization and programming in a user-friendly environment. It allows interfacing with programs written in other languages.

Dataset: This dataset contains different temperature and heartbeat values which are taken from the individuals of age group 20-21yrs. The values are assigned to a particular emotion class. The gender of the person doesn't affect the emotion. Body temperature is calculated in degree Celsius(□C) and heart rate in beats per minute (bpm). Below are the data entries shown in Table 1 which were used in the algorithm for training and testing.

Table 1: Data values for different emotions

S.no	Emotion	Pulse Rate(bpm)	Temperature(□C)
1	Normal	70 - 90	36.5 - 37.5
2	Happy	90 - 110	37.0 - 38.0
3	Anger	110 - 130	36.5 - 37.5
4	Fear	110 - 150	36.0 – 37.0

This system determines (figure 6) the emotion of a person, based on their pulse rate and body temperature.

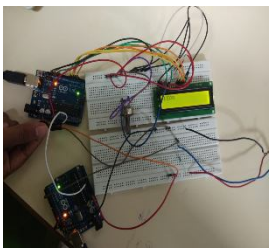
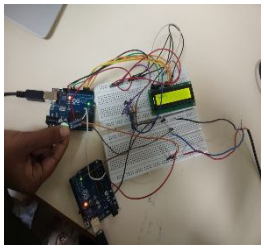
a)  b) 

Figure 6: Experimental Setup of the Proposed System with the output for (a) Fear and (b) Happy

We have allocated a particular emotion to a particular range of temperature and pulse. If a person's temperature lies in the range of 36.5 °C to 37 °C and the pulse lies in the range of 70 bpm to 90 bpm, then he is Normal. A person is said to be in a happy state, when the temperature lies within 37 °C to 38 °C and the pulse lies within 90 bpm to 110 bpm. If a person's temperature lies in the range of 36.5 °C to 37.5 °C and pulse lies in the range of 110 bpm to 130 bpm, then he is Anger state. A person is said to be in anger, if his temperature and pulse lies within the range 36 °C to 37°C and 130 to 150 bpm respectively.

5.CONCLUSION

We have developed a human emotion recognition system based on the physiological signals which are collected from sensors. We have considered only two physiological signals and we have classified the emotions into four types. Based on the input obtained, the emotion is predicted with the help of KNN classifier. This setup is useful for the health monitoring system and also for the investigation purpose where one can easily predict the victim's emotion. The future scope for this paper is extending the setup by sending an alert message using IoT. And also, by implementing a wearable device which can take the pulse and body temperature and directly depict the emotion of the person.

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