



Article Title: Development of Emotion Detector Using Biometric

Development of Emotion Detector Using Biometric

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ABSTRACT

Emotions play a vital role in people's everyday life. It is a mental state that does not arise through free will and is often accompanied by physiological changes. Therefore monitoring these changes is important as they are perceptions of emotional changes and can help in identifying matters of concern at an early stage before they become serious. Emotion recognition has become an important subject when it comes to human-machine interaction. Various methods have been used in the past to detect and evaluate human emotions. The most commonly used techniques include the use of textual information, facial expressions, speech, body gestures and physiological signals. In this project we have developed an emotion recognition system based on information provided by the physiological signals. These signals are obtained from a skin temperature sensor, a heart rate sensor, and a blood pressure sensor. The amplified and filtered signals from the sensors are input into the microcontroller where all the processing takes place. The microcontroller wirelessly transmits data to a computer where it is stored for data analyses and feature extraction for emotion recognition. The three basic emotions observed in this project are happy (excited), stressed and neutral (relaxed).

1 Introduction

Emotions play a vital role in people's everyday life. It is a mental state that does not arise through free will and is often accompanied by physiological changes. Therefore monitoring these changes is important as they are perceptions of emotional changes and can help in identifying matters of concern at an early stage before they become serious. Emotion recognition has become an important subject when it comes to human-machine interaction. Various methods have been used in the past to detect and evaluate human emotions. The most commonly used techniques include the use of textual information, facial expressions, speech, body gestures and physiological signals. In this project we intend to make an emotion recognition system based on information provided by the physiological signals. These signals are obtained from a skin temperature sensor, a heart rate sensor, and a skin conductance sensor. These signals are put into the microcontroller where all the processing takes place. These data can be used to alter the performance of a machine like a phone or a vehicle.



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Improving human health has been the subject of many research investigations. Recent research studies have been focused on improving the quality of human life in terms of health by designing and fabricating sensors which are either in direct contact with the human body or indirectly. These sensor based systems would have a positive impact on the annual medical cost and the health management system as it would allow for early detection of physiological and emotional changes. Emotions play critical role in rational and intelligent behavior. It is a mental state that does not arise through free will and is often accompanied by physiological changes. These changes need to be monitored as they contain information about different types of emotions which will assist in understanding behaviors. The main objectives of this project are to design a real time monitoring system, capable of evaluating four basic sad emotions and using low cost and non-invasive physiological sensors. The system should be capable of monitoring data in a comfortable and unobtrusive manner, with the ability of wireless communication.

2 Emotion Recognition Using Text

Emotion recognition using text has become popular these days, especially when it comes to human-machine interaction. Textual information is not only an important communication medium which exists in books, newspapers, websites, emails etc, but also a rich source of emotion. Different approaches have taken place in order to recognize and evaluate these emotions. The most common approach uses natural language processing techniques, which extract emotions and sentiments by analyzing the input text. Zhang, developed a semi-automatic acquisition technique to obtain emotion information using a sentence or text.

2.1 Emotion Recognition Using Facial Expressions

Facial emotion recognition plays a vital role when it comes to developing multi-cultural visual communication systems for emotion translation between cultures. As we know, computers and robots are being used widely for betterment of our daily life therefore it is important for computers and robots to have an artificial mind that would enable them to communicate with human beings using both logical and emotional information. Emotion recognition using computers can also be applied to psychological counselling and therapy which can help in the detection of criminal and antisocial motives. The basic idea of emotion recognition using facial expression is to segment facial images into various regions of interest. The common regions taken into account include movements of cheek, chin, wrinkles, eyes, eyebrows, and mouth. Different classification techniques are then applied to differentiate between different types of emotions.

2.2 Approach

The proposed system consists of three physiological sensors, signal conditioning circuitry, and a microcontroller. The three sensors used in this project are heart rate sensor, skin temperature sensor and blood pressure sensor. The physiological signals or bio signals from the body are



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collected by the sensors. These bio signals are then converted to electronic signals by the sensors. Now, these electronic signals are fed to the microcontroller. The microcontroller analyses these signals and compares them to a pre-fed threshold value, and assigns different emotions to these parameters.

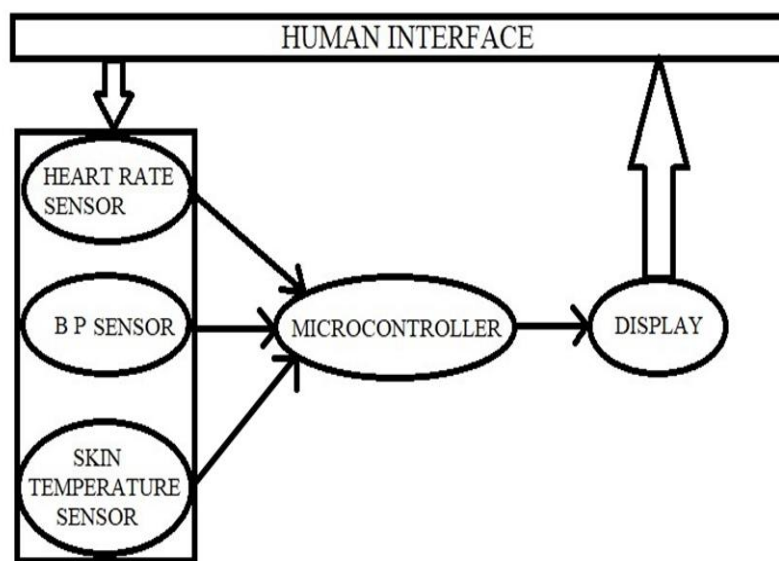


Figure 1: Block Diagram of Emotion Detector Using Biometric

2.3 Hardware-Software requirement

Required hardware used should be easy to maintain, implement and easily available. The required hardware is as follows;

- Heart Rate Sensor
- B P Sensor
- Skin Temperature Sensor
- Arduino Uno Microcontroller
- Display

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer



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with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

The human skin is an organ made up of a layer of tissues that protect underlying muscles and organs. As skin comes in direct contact with the surroundings, it plays a vital role in protecting the inner body from external threats. The skin is the largest organ of the human body as it covers the whole body and has the largest surface area. It weighs more than any single organ of the body. The skin has two major layers, the epidermis and the dermis. These layers are made of different types of tissues and have different functions.

The epidermis is the outermost layer and is responsible for keeping water in the body and keeping other harmful chemicals and pathogens out. The dermis lies below the epidermis and contains a number of structures that are responsible for lubrication, water-proofing, softening and anti-bactericidal actions. The other main function of the skin is to regulate body heat by controlling evaporation and excretion. Skin temperature is an effective indicator when it comes to evaluating human sensations. Investigation of the relationship between stressful tasks and the skin temperature shows that skin temperature falls when stress, tension or other sensations occur, because blood flow decreases due to factors like blood vessel constriction.

sphygmomanometer, also known as a blood pressure meter, blood pressure monitor, or blood pressure gauge, is a device used to measure blood pressure, composed of an inflatable cuff to collapse and then release the artery under the cuff in a controlled manner, and a mercury or mechanical manometer to measure the pressure. It is always used in conjunction with a means to determine at what pressure blood flow is just starting, and at what pressure it is unimpeded. Manual sphygmomanometers are used in conjunction with a stethoscope.

A sphygmomanometer consists of an inflatable cuff, a measuring unit (the mercury manometer, or aneroid gauge), and a mechanism for inflation which may be a manually operated bulb and valve or a pump operated electrically. Digital meters employ oscillometer measurements and electronic calculations rather than auscultation. They may use manual or automatic inflation, but both types are electronic, easy to operate without training, and can be used in noisy environments. They measure systolic and diastolic pressures by oscillometer detection, employing either deformable membranes that are measured using differential capacitance, or differential piezo resistance, and they include a microprocessor. They accurately measure mean blood pressure and pulse rate, while systolic and diastolic pressures are obtained less accurately than with manual meters, and calibration is also a concern.

The word plethysmograph has been derived from two Greek words - 'plethysmos', meaning increase; and 'graph', meaning write. It is an instrument mainly used to determine and register the variations in blood volume or blood flow in the body which occur with every beat of the heart. Plethysmography is the volumetric measurement of an organ, resulting from fluctuations in the amount of blood or air it contains. The change in blood volume is synchronous to the



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heart beat, so it can be used to detect heart rate. Photo plethysmography is just a means of Plethysmography that uses optical techniques. There are two basic types of Photoplethysmography: transmittance and reflectance.

Reflectance Photoplethysmography has been used in this project. In reflectance Photoplethysmography, a light source and a light detector are placed on the same side of a body part - for example, underneath the fingertip. The light source generally used is an infrared light emitting diode, and the detector generally used is a phototransistor.

When the fingertip is illuminated by the source, three things will happen depending on the volume of blood in the fingertip: certain amount of the light will be absorbed, certain amount of the light will be transmitted, and certain amount of light will be reflected. The intensity of the reflected light, PPG signal, varies with the volume of blood in the fingertip, which in turn varies in accordance with heart beat. Specifically, lower intensity of reflected light indicates higher volume of blood and vice versa.

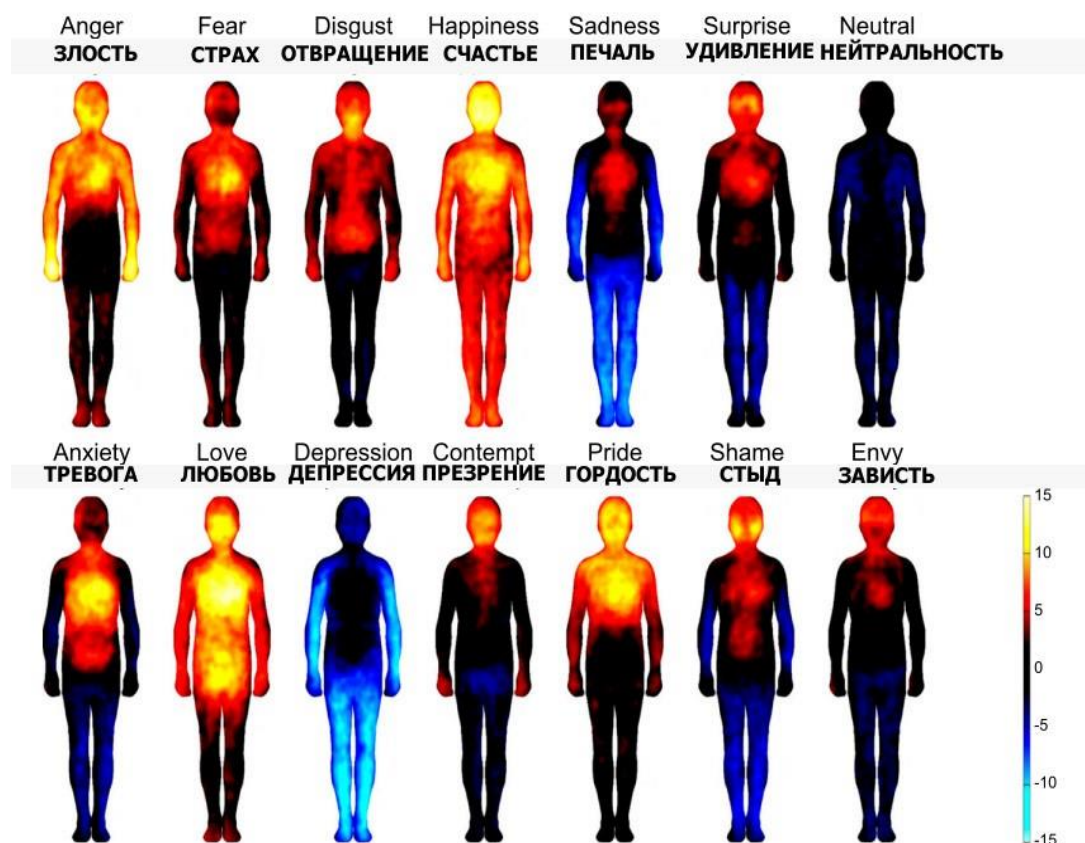


Figure 2: Skin temperature variations for different emotions

The above research provides sufficient evidence to prove that the nervous system and skin temperature are related. Due to this reason we chose skin temperature signal as one of our input



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signal for emotion evaluation in this project.

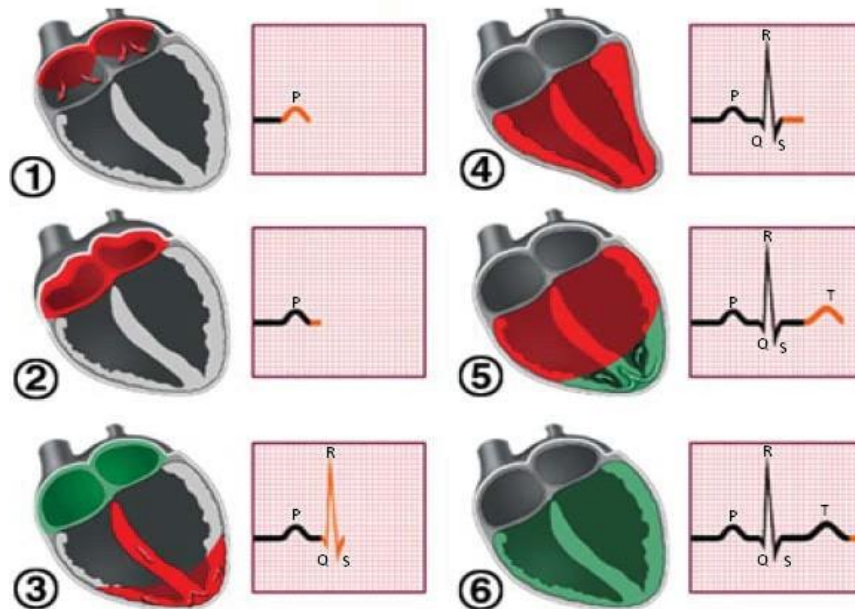


Figure 3: Heartbeat signals produced by the heart

There are a number of factors that cause irregularities in heart rate. The most common heart rate variability at rest can be due to serious heart problems, respiratory problems and emotional imbalance i.e., stress, panic attacks, anxiety and depression. In this project we are interested in finding relationship between heart rate and emotions.

The importance of heart rate variability has been well known for decades now. According to Saul the normal variability in heart rate is due to autonomic neural regulation of the heart and the circulatory system. The degree of heart rate variability provides important information about the functioning of the nervous system. Similarly, according to Amour, the heart has a network of several types of neurons, neurotransmitters, proteins and support cells that are similar to the ones found in the brain. For this reason, he called the heart as a 'little brain'. His research also revealed that the heart has its own intrinsic nervous system that operates and processes information independently of the brain or nervous system.

3 Conclusion

In this project we have developed a real time emotion recognition system, based on data provided by physiological sensors. The literature review enabled an appropriate method of selection for the sensors utilized in order to achieve emotion recognition. Physiological sensors were found to be the best approach to recognize emotional changes, as they provided information about changes that take place physiologically and are out of a person's control. Information and knowledge gained from other researches helped in providing information about the ranges of the physiological parameters and allowed in confirming results obtained



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from this study.

The emotions showed variation in data output. Along with emotion recognition and evaluation, the designed system is capable of recognizing physiological changes that arise because of various health conditions. This shows that the system has other advantages along with emotion recognition. The developed system has therefore achieved its objectives of attaining low cost, non-intrusive and low power physiological sensors capable of detecting four basic emotions in a comfortable manner.

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