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Facial Emotion Recognition using Stress Meter

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***Abstract*: As the population increases in the world, the ratio of health cares is rapidly decreasing. Therefore, there is an urgent need to create new technologies to monitor the physical and mental health of people during their daily life. In case of stress recognition using a biological signal and thermal image, a device acquiring the corresponding information is required and an algorithm that recognize behavior of the person from images acquired with a general camera. The deep neural network that receives facial landmarks as input to take advantage of the fact that eye, mouth, and head movements are different from normal situations when a person is stressed.**

***Keywords*: Stress recognition, Face image, Facial landmark, Deep Neural Network.**

1. Introduction

A facial expression is the visible manifestation of the affective state, cognitive activity, intention of a person and plays a communicative role in interpersonal relations. Generally, human beings can convey intentions and emotions through non-verbal ways such as facial expressions, gestures and involuntary language. On a day-to-day basis, humans commonly recognize emotions by characteristic features, displayed as a part of a facial expression. For instance, happiness is undeniably related to a smile or an upward movement of the corners of the lips. Similarly, other emotions are characterized by other deformations typical to a specific expression. Research into automatic recognition of facial expressions addresses the issues surrounding the representation and categorization of static or dynamic characteristics of those deformations of face pigmentation. The main purpose of this system is efficient interaction between human beings and machines using facial expressions, cognitive modeling, etc. And the system intensity varies from person to person and also varies along with age, gender, size, the shape of the face, and further even the expressions of the same person do not remain constant with time. If people are informed of their stress levels, they may become empowered to take some pre-emptive measures in order to minimize stress, so that stress balance is achieved before it results to serious health problems.

2. Block Diagram

The facial expression recognition system is trained using a supervised learning approach in which it takes images of different facial expressions. The system includes the training and testing phase followed by image acquisition, face detection, image preprocessing, feature extraction and classification. Face detection and feature extraction are carried out from face images and then classified into six classes belonging to six basic expressions. Arduino Uno is a microcontroller board. A liquid-crystal display (LCD) is a flat-panel display. The LM35 series are precision integrated-circuit temperature sensors. Pulse Sensor a well-designed plug-and-play heart-rate sensor for Arduino. A transformer is a device that transfers electrical energy from one circuit to a different through inductively coupled conductors without changing its frequency. Sweat sensors are often placed on the skin, that is, in close proximity to the sweat-generation site. In this proposed algorithm, face image and facial landmark detection are performed first for stress recognition. We use a deep learning algorithm for face detection that detects the position of the face more accurately through three networks in turn. To detect facial landmarks, we use a hand-craft algorithm that uses a cascade method of the features extracted by random-fem and the regression tree classifier.

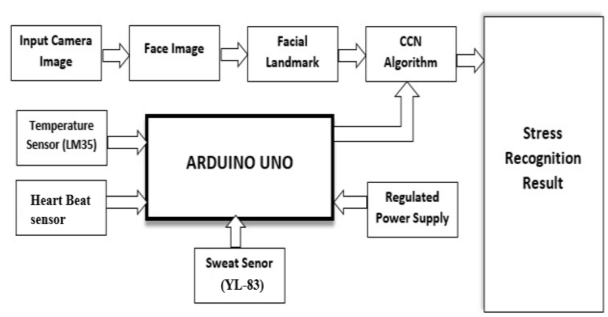

Fig. 1. Block diagram

3. Hardware and Software Design

A. *Arduino Uno R3*

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz

*Corresponding author: shwethashrees11@gmail.com crystal, a USB connection, an influence jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. We can tinker with Arduino UNO without worrying too much about doing something wrong. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is that the first during a series of USB Arduino boards and therefore the reference model for the Arduino platform; for an in-depth list of current, past or outdated boards see the Arduino index of boards.

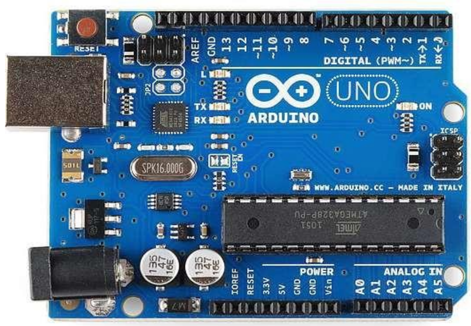

Fig. 2. Arduino Uno board

B. Regulated Power Supply

A voltage regulator with only three terminals appears to be a simple device, but it is in fact a very complex integrated circuit. It converts a varying input voltage into a continuing regulated output voltage. Voltage Regulators are available in a variety of outputs like 5V, 6V, 9V, 12V and 15V. The LM78XX series of voltage regulators are designed for positive input. For applications requiring negative input, the LM79XX series is used. Using a pair of voltage-divider resistors can increase the output voltage of a regulator circuit. It is not possible to obtain a voltage lower than the stated rating. You cannot use a 12V regulator to make a 5V power supply. Voltage regulators are very robust. These can withstand over-current draw due to short circuits and also over-heating. In both cases, the regulator will cut off before any damage occurs. The only way to destroy a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator almost instantly.

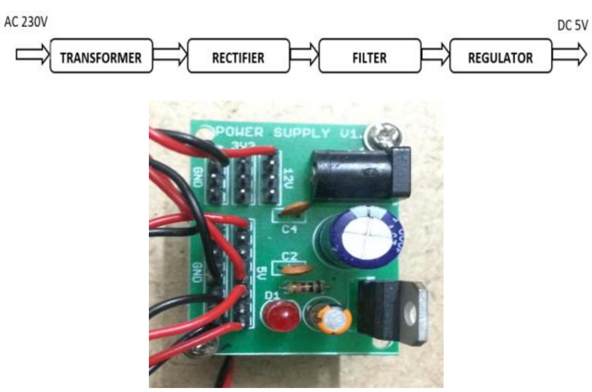

Fig. 3. Regulated power supply

C. Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°Cat room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the water level.

Fig. 4. Temperature sensor

D. Pulse Sensor

Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart- rate data into their projects. It also includes an open-source monitoring app that graphs your pulse in real time. This sensor is used to watch the blood through a finger. As the heart services blood through the blood vessels within the finger, the blood amount in the finger changes with reference to time. Heartbeat sensor shines a light-weight lobe through the finger to measure the light communicated to the LDR. The signal gained from the LDR is modified by the amplifier and will be cleaned and provided to the ADC.

Fig. 5. Heartbeat sensor

E. Sweat Sensor

YL-83 can be used as a sweat sensor. The module features, a sensor board and therefore the control panel that's separate for more convenience, power indicator LED and features a built-in potentiometer for sensitivity adjustment of the digital output. The analog output is used in detection of drops in the amount of sweat. The sensor has a power LED that lights up when the sensor is turned on and a digital output LED. Connected to 5V power supply, the LED will activate when induction board has no sweat, and output is high. When dropping a little amount of sweat, output is low, the switch indicator will turn on. When restored to the initial state, outputs high level. Basically, the resistance of the collector board varies accordingly to the amount of sweat on its surface.

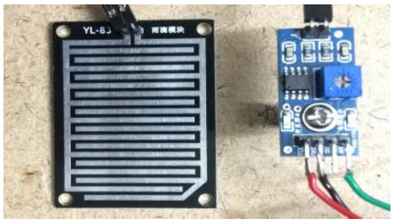

Fig. 6. Sweat sensor

F. Convolutional Neural Networks

Convolution is that the first layer to extract features from an input image. Convolution preserves the connection between pixels by learning image features using small squares of input file. It is a mathematical process that takes two inputs like a picture matrix and a filter or kernel.

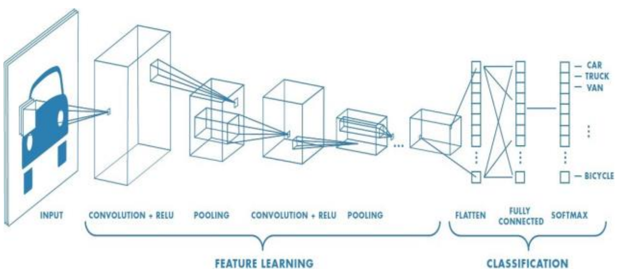

Fig. 7. Neural network with many convolutional layers

4. Working Principle

Analyzing the movement of facial features or changes in the appearance of facial features and classifying this information into expression-interpretative categories such as facial muscle activities like smile or frown; emotion categories happiness or anger. The stress meter is based on the principle that change in heart rate of one's body can be directly converted and transmitted into analog voltage levels to digital output which gives the visual indication of human stress using a proper circuitry. Continuous monitoring of the sweat, temperature and pulse from a human body is the measure in prediction of stress. When a person is stressed facial key variables like eyes mouth head positioning varies. These facial key variables detect the different emotions (like happy, sad, disgust, surprised, anger, neutral). The stressed person pulse, temperature, sweat and emotions were measured. The final results after the processing is given as stressed/not stressed.

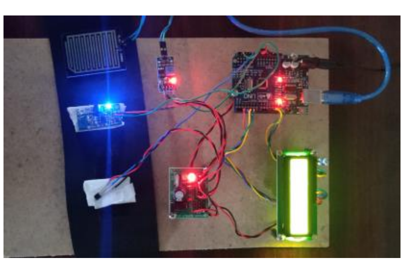

Fig. 8. Top view of the model

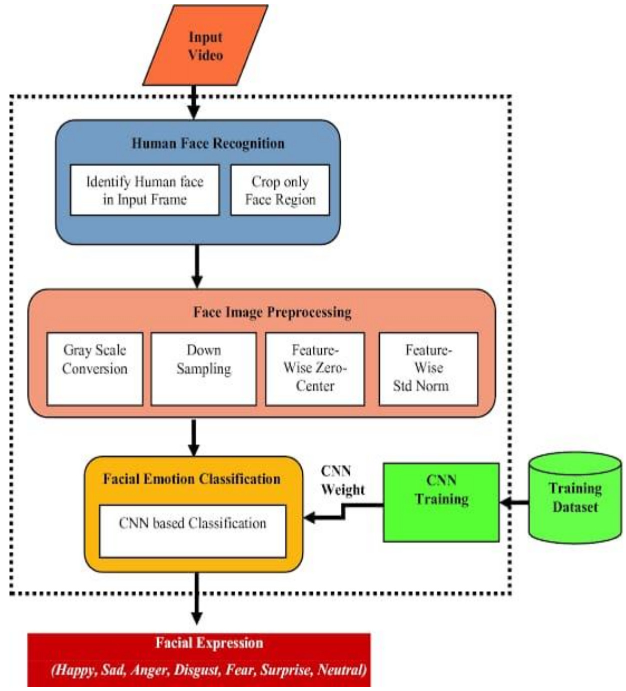

Fig. 9. Flow diagram

5. Results

As per the results obtained, we consider the key variable features from face and recognize the emotion. The sensitivity values obtained from the sensors are obtained and compared with the facial emotion recognized. The indication of the stress is displayed on the window. The results of different scenarios are shown below:

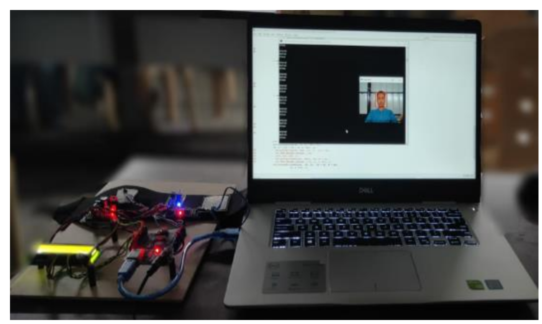

Fig. 10(a). The results which are displayed from the facial landmark is neutral and the outcome displayed by the stress meter for this person is 'STRESSED'

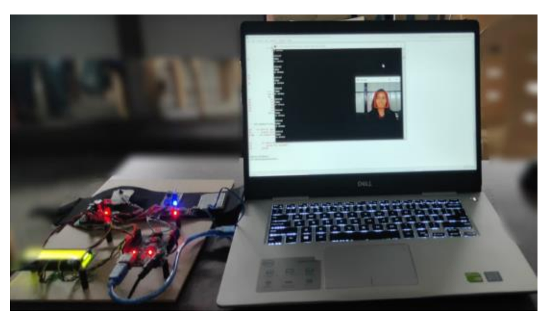

Fig. 10(b). The results which are displayed from the facial landmark is happy and the outcome displayed by the stress meter for this person is 'NOT STRESSED'

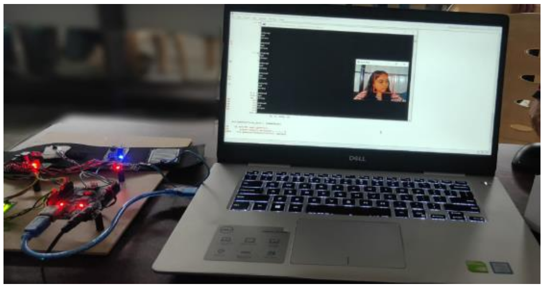

Fig. 10(c). The results which are displayed from the facial landmark is sad and the outcome displayed by the stress meter for this person is 'STRESSED'

6. Conclusion

In this work we proposed the real time stress detection meter based on CNN algorithm and sensors. To validate the proposed CNN algorithm, we designed a facial recognition algorithm with temperature sensor, sweat sensor and heartbeat sensor to induce a level of stress data. Now we analyze the different combinations of stress using CNN algorithm and based on sensor's threshold values. As a result of the proposed model, it confirms that the stress recognition performance was further improved when using facial landmarks. The stress testing accounts both the sensor's and faces key features. Future work are to improve the performance of stress recognition by using eye, mouth and head motion information from the time axis to acquire data we use wrist band and to setup a database to analyze the stress. Build application to notify the user.

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