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Person Emotion Detection and Point of Care Using Context Recurrent Neural Network Model

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ABSTRACT

Nowadays, people suddenly fall on the road and cannot provide the first aid at a specific time leading to severe and sometimes death. With the present system finding people and healthcare emotions are very much important. With the development of new intelligent sensors and the internet of things, anyone can quickly predict or monitor people's feelings during abnormal conditions. The proposed framework consists of three phases (i) Dataset collection using three physiological sensors such as Galvanic Skin Response (GSR), Blood Volume pressure (BVP) and Sweat sensor, (ii) By using the long, short term memory algorithm the different types of emotions are predicted and sent an alert to the user if any abnormality is detected. (iii) The SMOTP protocol is used to transfer the sensor data to the cloud and be visible for web dashboards and mobile applications. The GSR sensor measures the skin's electrical conductance to bring out one of the intense emotions. The threshold value increases when a person gets panics and peak to peak voltage reaches high. BVP is used to find the heart rate and stimulus of infra-red light against a skin surface and measures the amount of reflected light. When people get panic, it automatically stimulus sweat by using sweat sensors. The proposed work by LSTM has been achieved 99% compared to the other literature.

KEYWORDS: GSR (Galvanic Skin Response), Body Temperature Sensor, BVP Sensor, Skin Sweating Sensor, GSM (Global System for Mobile Communication), GPS (Global Positioning System), Thingspeak IoT, LSTM.

1.INTRODUCTION

Currently, the importance of human emotion is becoming increasingly recognized across a wide range of disciplines, including computer science. This is a real thing, since human activity and excitement can be detected through measurements of voice, face, body, and physiology when expressing emotion. A wide range of life activities, such as entertainment and education, could benefit from the ability to detect human emotion. Classification and clustering are two steps in the data mining process that include detection. Machine learning algorithms that can be used for classification and clustering are at least ten in number so far. Wearable stress sensors have been developed by a number of researchers over the past few decades. To extract the visual evidence like facial expressions, wearable emotion monitoring using skin temperature, skin conductance and pulse wave, they used a variety of techniques, including computer vision techniques. Wearable sensors, such as a glove containing a skin temperature and GSR sensor, have also been used to quantify stress levels based on measures of heart-rate variability (HRV) using reliable, high-precision instrumentation and synchronized measurements. Recently, a system with repositionable chest straps has been reported for cardiac and respiration recordings. Many other researchers used a variety of methods to gauge various aspects of the body, including heart rate, respiration rate, blood pressure, and skin conductance, among others. Only a few studies have examined how hunger affects the body in the same way that stress does.

In our daily lives, emotions play a significant and powerful role. There is a great deal of interest in developing automated methods for computers to recognize emotional expressions because of the importance of emotions. Computers should take into account the emotions of their human conversation partners for a wide range of applications, including human-robot interaction, computer-assisted tutoring, interactive games that take into account emotions, neuromarketing, and socially intelligent software apps. Emotion detection has been aided by speech analytics and facial expression analysis. Humans from various cultures were able to categorically recognize six distinct facial expressions (fear, anger, sadness, disgust, happiness, and surprise) When people want to hide their emotions, using only speech or facial expression signals is not a reliable method of detecting them. As opposed to facial expression, physiological signals are a more reliable method for monitoring the internal cognitive and emotional changes of users.

The proposed methodology consists of parts

- Emotion Dataset Generation with the help of three sensors
- Real-time testing with wearable sensor with live location monitoring

The proposed system has three sensors namely GSR (galvanic skin response) Sensor, BVP (Blood Volume Pulse) Sensor, Skin Sweating sensor, ESP32, GPS (Global Positing System) and GSM (Global System for Mobile Communication). In the proposed IoT protocols (STOMP), ultralow latency of 1/2 ms is achieved and also offers improved reliability in comparison to state of the art . an integrated IoT framework that enables wireless communication.

I. BLOCK DIAGRAM

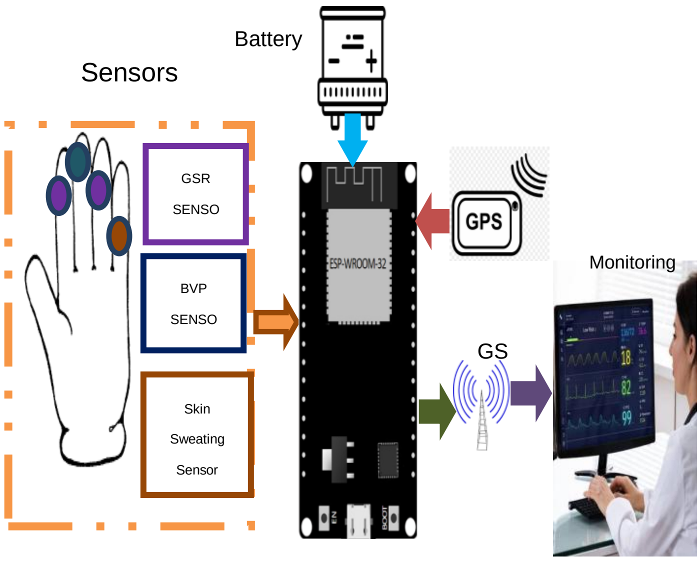

Fig 1. BLOCK DIAGRAM

A. ESP 32S MICROCONTROLLER

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth. The good thing about ESP32, like ESP8266 is its integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components.

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility, and reliability in a wide variety of applications and power scenarios. Another important thing to know about ESP32 is that it is manufactured using TSMC's ultra-low-power 40 nm technology. So, designing battery operated applications like wearables, audio equipment, baby monitors, smart watches, etc., using ESP32 should be very easy. Good hardware like ESP32 will be more user friendly if it can be programmed (writing code) in more than one way. And not surprisingly, the ESP32 supports multiple programming environments. ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

B. GSR SENSOR

GSR is a method of measuring the electrical conductance of the skin. Strong emotion can cause stimulus to your sympathetic nervous system, resulting in more sweat being secreted by the sweat glands. GSR allows you to spot such strong emotions by simple attaching two electrodes to two fingers on one hand.

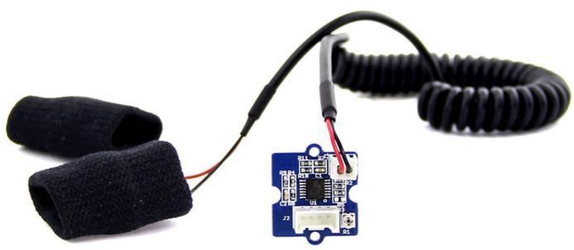

Fig 2 .GSR SENSOR

C. BVP SENSOR

The Blood Volume Pulse (BVP) sensor is an optical, non-invasive sensor that measures changes in arterial translucency using the light emitter and detector built into its finger-clip housing. When the heart pumps blood, the arteries become opaquer, allowing less light to pass from the emitter on the sensor through to the receiver on the other side of the finger clip.

D. SWEAT SESNOR

The device was attached to “smart” wristbands and headbands. The data collected was then processed send to controller for converting the analog to digital values. The galvanic skin response (GSR), also known as Skin Conductance (SC), refers to changes in sweat gland activity, which reflect the intensity of participants’ emotional state – or ’emotional arousal’. Our level of emotional arousal changes in response to the environment.

E. GSM

Global System for Mobile communication (GSM). It requires a SIM (Subscriber Identity Module) card just like mobile phones.
GSM is used to…,

- Receive, send or delete SMS messages in a SIM.
- Read, add, search phonebook entries of the SIM.
- Make, Receive, or reject a voice call

F. GPS

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The GPS system concept is based on time. The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time.

G. THINGSPEAK IoT

The Internet of Things (IoT) in education includes data storage, processing, and data visualization. ThingSpeak has a simple interface that makes it easy to learn cloud analytics and teach IoT. Then use ThingSpeak communities to provide support for your cloud education curriculum. ThingSpeak also supports and integrates with Arduino, RPI, and other hardware.

- See instant visualizations of data posted by your devices or equipment
- Execute MATLAB code in ThingSpeak, perform online analysis and data processing with live data, and see automatic visualizations
- Build IoT systems without setting up servers or developing web software

III. WORKING PRINCIPLE

SMOTP protocol is used in the training phase to generate a date set for all three sensors connected to the IoT Cloud. The dataset is fed into an LSTM algorithm, which generates a model for real-time emotion prediction. Sensor data is manipulated with the LSTM model using the ESP32 Controller in the testing phase, and any anomalies in the emotion are immediately sent to the concerned users. Many other researchers used a variety of methods to gauge various aspects of the body, including heart rate, respiration rate, blood pressure, and skin conductance, among others. Only a few studies have examined how hunger affects the body in the same way that stress does. Emotion prediction classifier is doing wonders with heart rate signals. The heart rate signals are monitored by showcasing the virtual images. The heart rate recording along with the emotions is also documented. Based on the data, emotions related to similar heart rate data set values are classified. In recent times, similar techniques are followed for Skin conductance too. Predicting emotions may help to handle different scenarios which may lead to difficult situation by humans. Emotions significantly influence on decision making as like intelligence and perception. A person's physiological mental state like positive emotions will mostly lead to good progressive successful decisions whereas a negative emotion or mental physiological state will mostly lead to deteriorating health or depression. Galvanic Skin Response (GSR), a method to detect the skin conductance. Medical applications with few parameters and algorithms are also discussed. In general, emotion recognition is conducted in four main steps which are signal acquisition, preprocessing, feature extraction, and classification. Galvanic skin response (GSR) is the autonomic activation of sweat glands in the skin when an individual gets triggered through emotional stimulation. Research conducted has shown that feature extraction method in time–frequency domain has the best accuracy rate overall compared to time domain and frequency domain. Current GSR-based technology also has the potential to be improved more toward the implementation of a more efficient and reliable emotion recognition system. The paper provides an overview of emotion recognition, GSR signals, and how GSR signals are analyzed for emotion recognition. The focus of this research is on the performance of feature extraction of GSR signals. Therefore, related sources were identified using combinations of keywords and terms such as feature extraction, emotion recognition, and galvanic skin response.

All three sensors are connected to the IoT Cloud via SMOTP protocol during the training phase. In order to create a real-time emotion prediction model, LSTM is applied to the dataset. As soon as an abnormality is detected in the emotion, messages are immediately sent to the concerned users. In the testing phase, all sensors equipped with GPS are connected via ESP32 Controller.

IV. LSTM ALGORITHM

Long Short-Term Memory is a kind of recurrent neural network. In RNN output from the last step is fed as input in the current step. LSTM was designed by Hochreiter & Schmid huber. It tackled the problem of long-term dependencies of RNN in which the RNN cannot predict the word stored in the long-term memory but can give more accurate predictions from the recent information. As the gap length increases RNN does not give an efficient performance. LSTM can by default retain the information for a long period of time. It is used for processing, predicting, and classifying based on time-series data.

- Deep learning speculates that a deep sequential or hierarchical model is more efficient in classification or regression tasks than shallow models.
- LSTM contains hidden states distributed across time, and this allows them to store a lot of information about the past.
- They are most commonly used in forecasting applications due to their ability to process variable length sequential data.
- Neural networks have major disadvantage that they cannot overcome vanishing gradient or exploding gradient problem and also, they can store only short-term memory because they involve hidden layer activation functions of the previous time step only.

Structure Of LSTM:

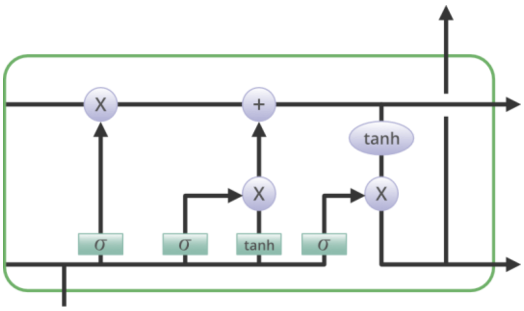

Fig 3: LSTM Algorithm Structure

LSTM has a chain structure that contains four neural networks and different memory blocks called *cells*. Information is retained by the cells and the memory manipulations are done by the *gates.*
There are three gates,

A. FORGET GATE

The information that is no longer useful in the cell state is removed with the forget gate. Two inputs x_t (input at the time) and h_t-1 (previous cell output) are fed to the gate and multiplied with weight matrices followed by the addition of bias. The resultant is passed through an activation function which gives a binary output. If for a particular cell state the output is 0, the piece of information is forgotten and for output 1, the information is retained for future use.

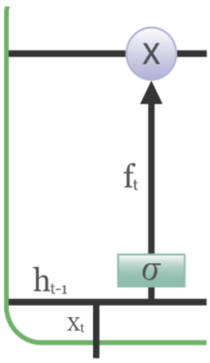

Fig 4: LSTM Algorithm – Forget Gate

B. INPUT GATE :

The addition of useful information to the cell state is done by the input gate. First, the information is regulated using the sigmoid function and filter the values to be remembered like the forget gate using inputs h_t-1 and x_t. Then, a vector is created using tanh function that gives an output from -1 to +1, which contains all the possible values from h_t-1 and x_t. At last, the values of the vector and the regulated values are multiplied to obtain the useful information

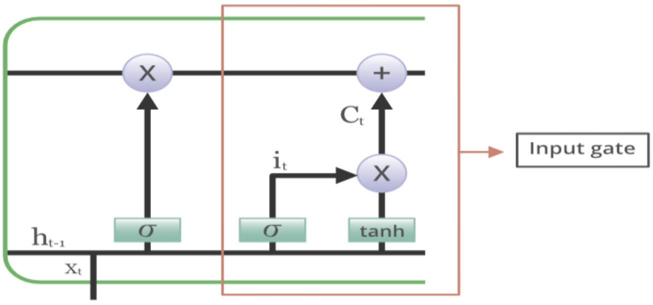

Fig 5: LSTM Algorithm – Input Gate

C. OUTPUT GATE

The task of extracting useful information from the current cell state to be presented as output is done by the output gate. First, a vector is generated by applying tanh function on the cell. Then, the information is regulated using the sigmoid function and filter by the values to be remembered using inputs h_t-1 and x_t. At last, the values of the vector and the regulated values are multiplied to be sent as an output and input to the next cell.

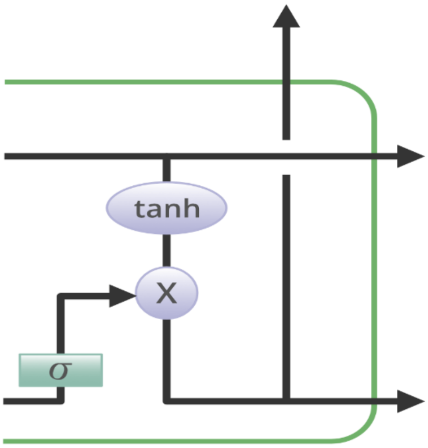

Fig 6: LSTM Algorithm – Output Gate

Some of the famous applications of LSTM includes:

1. Language Modelling
2. Machine Translation
3. Image Captioning
4. Handwriting generation
5. Question Answering Chatbots.

V. CONCULSION:

During the training phase, all three sensors were connected to the IoT Cloud via the SMOTP protocol, and a date set was generated. The dataset is fed into an LSTM model, which then generates a real-time emotion prediction model. As soon as an abnormality is detected in the emotion, messages are immediately sent to the concerned users. In the testing phase, all sensors that include GPS are connected via an ESP32 Controller.

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