WIRELESS STRESS DETECTION HEALTH MONITORING SYSTEM

A PROJECT REPORT

Submitted by

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ABSTRACT

This project presents a system that amalgamates a Health Monitoring System with a Stress Detection System to utilize the physiological data acquired for monitoring the private health of someone to detect mental stress levels of that person and reduce the assembly cost of the involved systems. Furthermore, the Accuracy of this approach to stress detection is relatively high because it involves collective analysis of stress-related data, and brainwaves, which are representations of the person's psychological state within the style of patterns of electrical pulse activity that are studied using ECG. Since stress has become a very important phenomenon that nearly everybody goes through, its management or detection should be ascertained for reliability. Ultimately, this project's proposal of a high-accuracy approach to stress detection alongside health monitoring might be more relevant and useful within the current scenario.

LIST OF ABBREVIATIONS

- TTL - Transistor-transistor Logic
- UART- The Universal Asynchronous Receiver/Transmitter
- SDIO - Secure Digital Input/Output Interference
- PWM - Pulse Width Modulation
- IOT - Internet Of Things
- DTE - Data Terminal Equipment
- DCE - Data Communication Equipment
- EEG - Electroencephalographic Electrodes
- SC - Skin Conductance
- HR - Heart Rate
- ECG - Electrocardiogram

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CHAPTER 1

INTRODUCTION

Mental Stress, as a psychological phenomenon or emotional pressure, has a lot to deal with neurological and physiological aspects of the human body. There are experiments to determine stress using heart rate sensors (or) using physiological signals based on soft computing techniques (or) implementing wearable sensors around the body. However, the problem of wearing the sensors and electrodes around the body for a long time is present. These methods are not accurate as well. They are of invasive type. Our method is also of invasive type, but the accuracy is comparatively high as it implements Electroencephalographic electrodes (EEG). Using EEG, the mental state of a person can be easily studied with the help of brainwaves. Also, there is an effective formula for stress detection involving Evaluation Parameters (True Stress Detection Rate and True Non-Stress Detection Rate) and Temporal Parameters (Template Time and Acquisition Time). The physiological signals proposed by this paper are Galvanic Skin Response (GSR), also known as Skin Conductance (SC), and HeartRate (HR). These two signals were selected based on their properties regarding noninvasivity when being acquired and because of their variation is strongly related to stress stimuli.

1.1 EXISTING SYSTEM

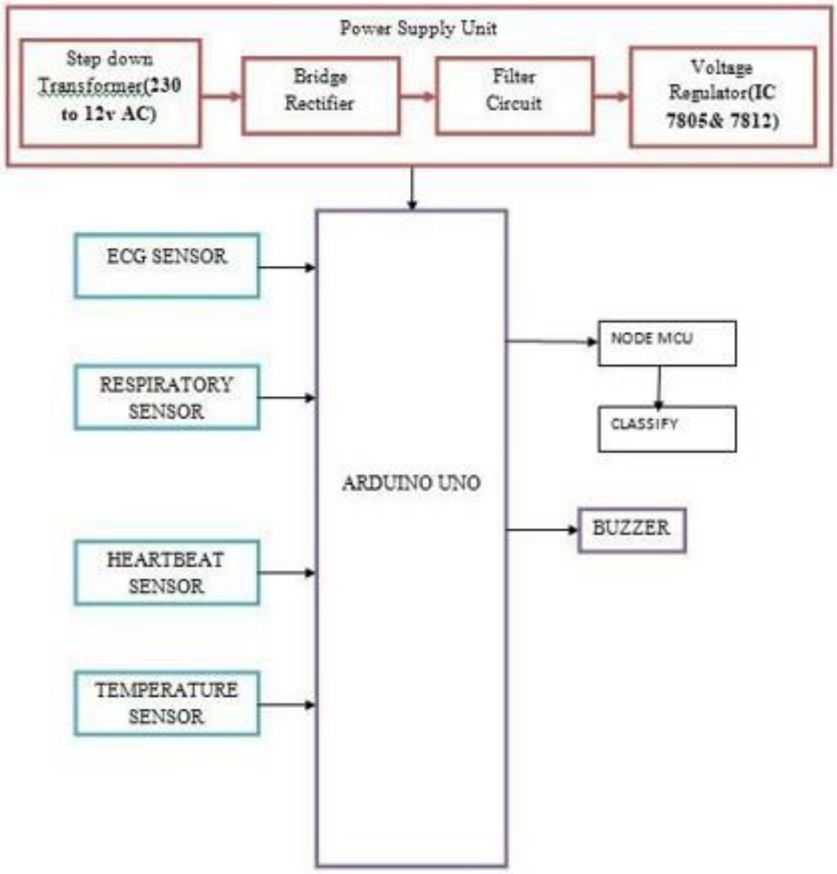
In the existing system, we use active network technology to network various sensors to a single PMS. Patients' various critical parameters are continuously monitored via single PMS and reported to the Doctors or Nurses in attendance for timely response in case of critical situations.

1.2 PROPOSED SYSTEM

Our approach of stress detection involves measuring various health parameters such as the heart rate, body temperature, blood pressure, and skin conductance using appropriate biosensors and analyzes them to detect the stress level. Since these health parameters are also identified as stress markers, we use them all for this purpose alongside the health monitoring part of our project. We use Arduino UNO for the micro-controller which processes all the input data from various biosensors, analyzes and forwards the stress level along with a few health parameters as a Display Report (Analyzed Report) to the user. The "Stressed-out," condition is notified to the user using an Alert System.

1.3 BLOCK DIAGRAM

The Block Diagram of the project is shown below



1.4 POWER SUPPLY UNIT

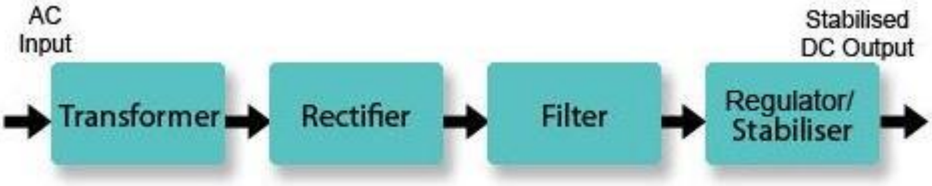


Figure 1.1: Power Supply Unit

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

1.4.1 STEP DOWN TRANSFORMER

Basic power supplies the input power transformer has its primary winding connected to the mains (line) supply. A secondary winding, electro-magnetically coupled but electrically isolated from the primary is used to obtain an AC voltage of suitable amplitude, and after further processing by the PSU, to drive the electronics circuit it is to supply. The transformer stage must be able to supplythe current needed. If too small a transformer is used, it is likely that the power supply's ability to maintain full output voltage at full output current will be impaired. With too small a transformer, the losses will increase dramatically as full load is placed on the transformer. As the transformer is likely to be the costliest item in the power supply unit, careful consideration must be given to balancing cost with likely current requirement. There may also be a need for safety devices such as thermal fuses to disconnect the transformer if overheating occurs, and electrical isolation between primary and secondary windings, for electrical safety.

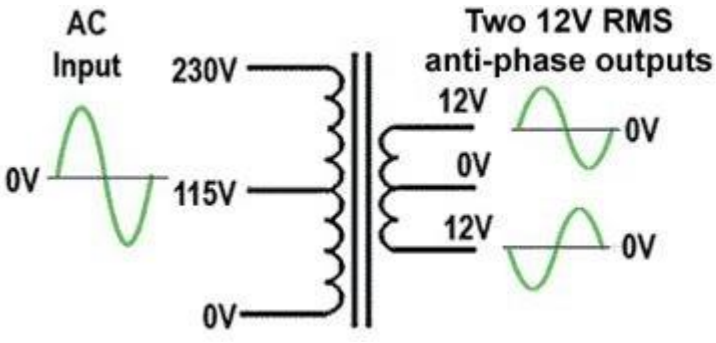


Figure 1.2: Step Down Transformer

1.4.2 THE RECTIFIER STAGE

Rectifier circuit is used, to convert the AC input is converted to DC. The full wave bridge rectifier uses four diodes arranged in a bridge circuit to give full wave rectification without the need for a center-tapped transformer. An additional advantage is that, as two diodes are conducting at any one time, the diodes need only half the reverse breakdown voltage capability of diodes used for half and conventional full wave rectification. The bridge rectifier can be built from separate diodes ora combined bridge rectifier can be used.

It can be seen that on each half cycle, opposite pairs of diodes conduct, but the current through the load remains in the same polarity for both half cycles.

1.4.3 FILTER

A typical power supply filter circuit can be best understood by dividing the circuit into two parts, the reservoir capacitor and the low pass filter. Each of these parts contributes to removing the remaining AC pulses, but in different ways.

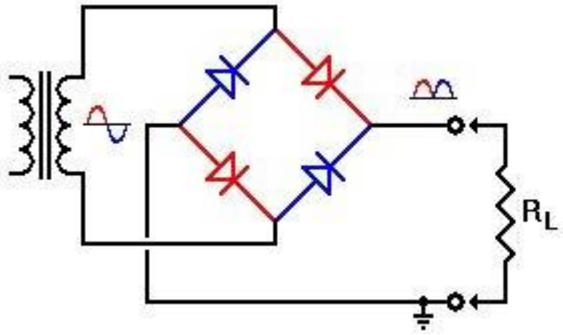


Figure 1.3: Bridge Rectifier

Electrolytic capacitor used as a reservoir capacitor, so called because it acts as a temporary storage for the power supply output current. The rectifier diode supplies current to charge a reservoir capacitor on each cycle of the input wave. The reservoir capacitor is large electrolytic, usually of several hundred or even a thousand or more microfarads, especially in mains frequency PSUs. This very large value of capacitance is required because the reservoir capacitor, when charged, must provideenough DC to maintain a steady PSU output in the absence of an input current; i.e. during the gaps between the positive half cycles when the rectifier is not conducting.

The action of the reservoir capacitor on a half wave rectified sine wave. During each cycle, the rectifier anode AC voltage increases towards Vpk. At some point close to Vpk the anode voltage exceeds the cathode voltage, the rectifier conducts and a pulse of current flows, charging the reservoir capacitor to the value of Vpk.

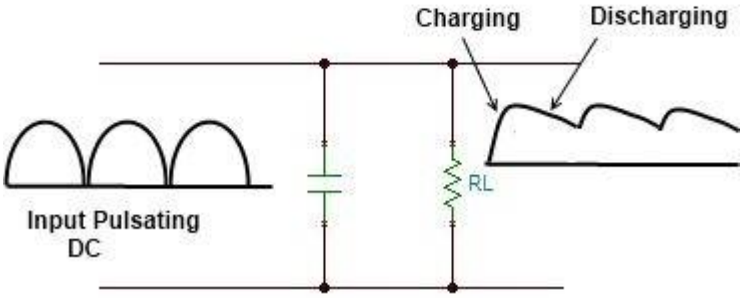


Figure 1.4: Filter Current

Once the input wave passes Vpk the rectifier anode falls below the capacitor voltage, the rectifier becomes reverse biased and conduction stops. The load circuit is now supplied by the reservoir capacitor alone.

Of course, even though the reservoir capacitor has large value, it discharges as it supplies the load, and its voltage falls, but not by very much. At some point during the next cycle of the mains input, the rectifier input voltage rises above the voltage on the partly discharged capacitor and the reservoir is re-charged to the peak value Vpk again.

1.4.4 VOLTAGE REGULATOR

Voltage regulator ICs are available with fixed or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available,mainly for use in dual supplies. Most regulators include some automatic protection from excessive current and overheating.

The LM78XX series of three terminal regulators is available with several fixed output volt- ages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, Hi-Fi, and other solid state elec- tronic equipment. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and current.

1. Positive regulator(Input Pin,Ground Pin,Output Pin)
2. It regulates the positive voltage
3. Negative regulator
4. Ground pin
5. Input pin
6. Output pin

It regulates the negative voltage. The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

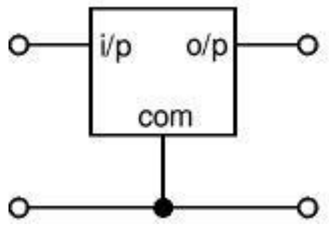


Figure 1.5: Regulator Circuit

1.5 ARDUINO

An Arduino is actually a microcontroller-based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open-source hardware feature. It is basically used in communications and in controlling or operating many devices.It was founded by Massimo Banzi and David Cuartielles in 2005.

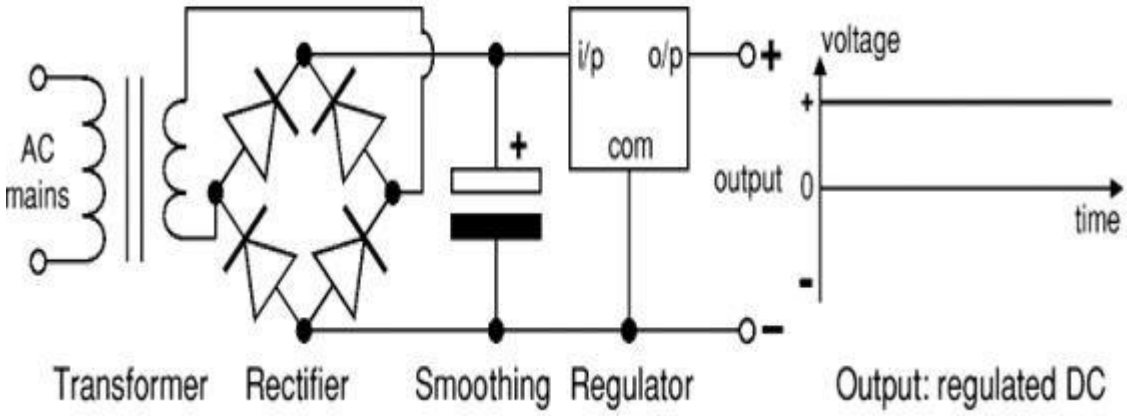


Figure 1.6: Power Supply Circuit

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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 with a USB cable or power it with a 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 Atmega8U2 programmed as a USB-to-serial converter.UNO means one in Italian and isnamed to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward.

The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

1.5.1 ARDUINO ARCHITECTURE

Arduino’s processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory.The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.

The most important advantage with Arduino is the programs can be directly loaded to the device without requiring any hardware programmer to burn the program. This is done because of the presence of the 0.5KB of Bootloader which allows the program to be burned into the circuit. All we have to do is to download the Arduino software and writing the code.

Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP

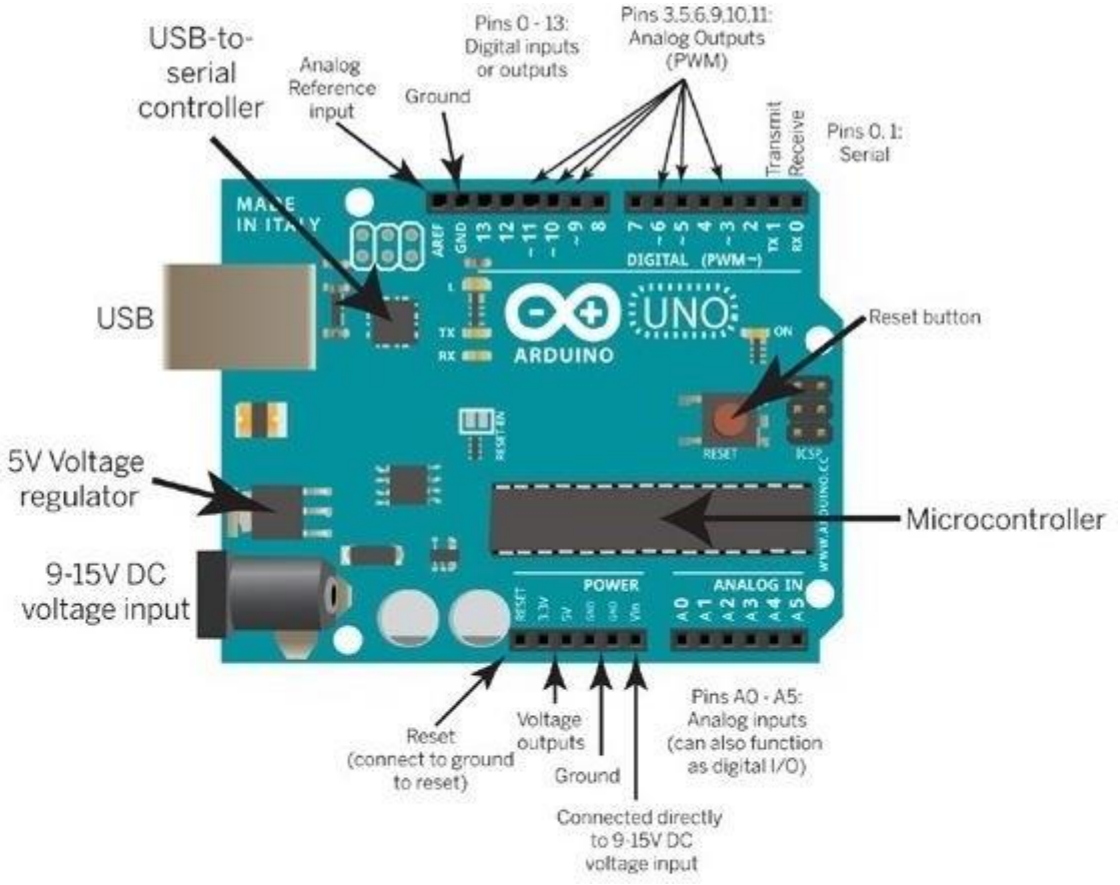


Figure 1.7: Aurdino Pin Diagram

header, and a reset button.

1.5.2 POWER JACK

Arduino can be power either from the pc through a USB or through external source like adaptor or a battery. It can operate on a external supply of 7 to 12V. Power can be applied externally through the pin Vin or by giving voltage reference through the IORef pin.The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging. The board can operate on an external supply of6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts andthe board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

It consists of 14 digital inputs/output pins, each of which provide or take up 40mA current. Some of them have special functions like pins 0 and 1, which act as Rx and Tx respectively, for serial communication, pins 2 and 3-which are external interrupts, pins 3,5,6,9,11 which provides pwm output and pin 13 where LED is connected.

It has 6 analog input/output pins, each providing a resolution of 10 bits.It provides reference to the analog inputs and resets the micro-controller when low.

CHAPTER 2

LITERATURE SURVEY

ShrutiGedam and Sanchita Paul[1] et.al said that Stress is an escalated psycho-physiological state of the human body emerging in response to a challenging event or a demanding condition. Environmental factors that trigger stress are called stressors. In case of prolonged exposure to multiple stressors impacting simultaneously, a person's mental and physical health can be adversely affected which can further lead to chronic health issues. To prevent stress-related issues, it is necessary to detect them in the nascent stages which are possible only by continuous monitoring of stress. Wearable devices promise real-time and continuous data collection, which helps in personal stress monitoring. In this paper, a comprehensive review has been presented, which focuses on stress detection using wearable sensors and applied machine learning techniques. This paper investigates the stress detection approaches adopted in accordance with the sensory devices such as wearable sensors, Electrocardiogram (ECG), Electroencephalography (EEG), and Photo plethysmography (PPG), and also depending on various environments like during driving, studying, and working. The stressors, techniques,results, advantages, limitations, and issues for each study are highlighted and expected to provide a path for future research studies. Also, a multi modal stress detection system using a wearable sensor-based deep learning technique has been proposed at the end.

Ali Tazarv[2] et.al said that Since stress contributes to a broad range of mental and physical health problems, the objective assessment of stress is essential for behavioral and physiological studies. Although several studies have evaluated stress levels in controlled settings, objective stress assessment in everyday settings is still largely under-explored due to challenges arising from confounding contextual factors and limited adherence for self-reports. In this paper, we explore the objective prediction of stress levels in everyday settings based on heart rate (HR) and heart rate variability (HRV) captured via low-cost and easy-to-wear photo plethysmography (PPG) sensors that are widely available on newer smart wearable devices. We present a layered system architecture for personalized stress monitoring that supports a tunable collection of data samples for labeling, and present a method for selecting informative samples from the stream of real-time data for labeling. We captured the stress levels of fourteen volunteers through self-reported questionnaires over periods of between 1-3 months, and explored binary stress detection based on HR and HRV using Machine Learning methods. We observe promising preliminary results given that the dataset is collected in the challenging environments of everyday settings. The binary stress detector is fairly accurate and can detect stressful vs non-stressful samples with a macroF1 score of up to 76%. Our study lays the groundwork for more sophisticated labeling strategies that generate context-aware, personalized models that will empower health professionals to provide personalized interventions.

Talha Iqbal and Pau Redon-Lurbe[3] et.al discuss Stress is known as a silent killer that contributes to several life-threatening health conditions such as high blood pressure, heart disease, and diabetes. The current standard for stress evaluation is based on self-reported questionnairesand standardized stress scores. There is no gold standard to independently evaluate stress levels despite the availability of numerous bio physiological stress indicators. With an increasing interest in wearable health monitoring in recent years, several studies have explored the potential of various bio-physiological indicators of stress for this purpose. However, there is no clear understanding of the relative sensitivity and specificity of these stress-related bio-physiological indicators of stress in the literature. Hence this study aims to perform statistical analysis and classification modelling of bio-physiological data gathered from healthy individuals, undergoing various induced emotional states, and to assess the relative sensitivity and specificity of common bio physiological indicators of stress.In this paper, several frequently used key indicators of stress, such as heart rate, respiratory rate, skin conductance, RR interval, heart rate variability in the electrocardiogram, and muscle activation measured by electromyography, are evaluated based on a detailed statistical analysis of the data gathered from an already existing, publicly available WESAD (Wearable Stress and Affect Detection) data-set. Respiratory rate and heart rate were the two best features for distinguishing between stressed and unstressed states.

Sara Aristizabal[4] et.al said that Workplace-related stressors, economic strain, and lack of access to educational and basic needs have exacerbated feelings of stress in the United States. Ongoing stress can result in an increased risk of cardiovascular, musculoskeletal, and mental health disorders. Similarly, workplace stress can translate to a decrease in employee productivity and higher costs associated with employee absenteeism in an organization. Detecting stress and the events that correlate with stress during a workday is the first step to addressing its negative effects on health and wellbeing. Although there are a variety of techniques for stress detection using physiological signals, there is still limited research on the ability of behavioral measures to improve the performance of stress detection algorithms. In this study, we evaluated the feasibility of detecting stress using deep learning, a subfield of machine learning, on a small data set consisting of electrodermal activity, skin temperature, and heart rate measurements, in combination with self-reported anxiety and stress. The model was able to detect stress periods with 96% accuracy when using the combined wearable device and survey data, compared to the wearable device dataset alone (88% accuracy). Creating multi- dimensional datasets that include both wearable device data and ratings of perceived stress couldhelp correlate stressinducing events with feelings of stress at the individual level and help reduce intra-individual variabilities due to the subjective nature of the stress response.

Katarzyna Barana[5] et.al discuss The high level of stress in modern life is one of the huge problems of the 21st century society, especially in the context of the Covid-19 pandemic. With the pandemic, the need for inexpensive, portable and easy-to-use health monitoring tools (mental and physical) has increased. Of particular importance here is mobile (smartphone) thermography, as it enables the initial detection and self-control of stress, which being intensified nowadays, is the cause of many diseases, depression and health problems. The smartphone thermal imaging camera responds to the strict sanitary guidelines, offering contact-free, painless and non-invasive operation. Additionally, it is included in the group of low-cost solutions available for home use. It is an alternativeto commonly used (often expensive and unavailable to everyone): EMG, ECG, EEG, GSR or other high-cost stress detection tools. Thermal imaging by analyzing abnormalities or temperature changes allows for detection application. Therefore, the aim of this work is to determine the possibilities ofa low-budget mobile thermal imaging camera in detecting stress, detecting and analyzing stress by identifying the characteristics of psychophysiological signals with the individual characteristics of the participants, along with the correlation. The participants' reactions to the film introducing stress ten- sion up to the climax of the action were recorded thermographically. Data was processed in OpenCV. In the usual observation, stress often remained unnoticed. However, the thermographic analysis pro- vided detailed information on the impact of the film's stressful situation on the participants, withthe possibility of distinguishing the stages of stress. The results of the preliminary pilot study were presented, which indicated the variability of temperature and heart rate as important indicators of stress–with the simultaneous significance of individual characteristics of the participant. Smartphone stress thermography is a promising method of monitoring human stress, especially at home.

M. Rajeshwari, and T. Janumala[6] et.al said that In today's date, not one day goes bywithout the word 'stress'. Stress is the body's response when subjected to a stimulus, initiating a 'fight or flight'. Stress is a physical, mental, emotional factor, causing tension. There are innumerable signs, symptoms, causes and disorders that are stress-related, especially the post-traumatic stress disorder, the acute stress disorder and comparatively higher mortality and morbidity rates, up to50%. Thus, means to measure stress must be developed in a quick, cost effective manner.The current research deals with a sensor based biological method of stress measurement, performed by detecting the levels of biomarkers for stress – salivary amylase assay usinga chromogenic substrate, measurable at 405nm in biosensor equipment's, miniature spectrophotometers and light resistance detectors – andcorrelating it to the normal unstressed levels of the enzyme biomarker present in the individual.

CHAPTER 3

METHODOLOGY

3.1 Data Set Collection

The first step is collecting the dataset related to this project. A data set in machine learning is, quite simply, a collection of data pieces that can be treated by a computer as a single unit for analytic and prediction purposes. This means that the data collected should be made uniform and understandable for a machine that doesn't see data the same way as humans do. It contains values of Temperature, ECG, Heartbeat, Respiratory.

3.2 Pre-Processing Phase

After collecting the data, it's important to preprocess it by cleaning and completing it, as well as annotate the data by adding meaningful tags readable by a computer. Moreover, a good dataset should correspond to certain quality and quantity standards. For smooth and fast training, you should make sure your dataset is relevant and well-balanced. Data preprocessing is a process of preparing the raw data and making it suitable for a machine learning model. It is the first and crucial step while creating a machine learning model.

When creating a machine learning project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean it andput in a formatted way. So for this, we use data pre processing task.

Before applying our dataset to algorithm need to split the data for Training and Testing. In machine learning data preprocessing, we divide our dataset into a training set and test set. This is one of the crucial steps of data preprocessing as by doing this, we can enhance the performance of our machine learning model.

Suppose, if we have given training to our machine learning model by a dataset and we test it by a completely different dataset. Then, it will create difficulties for our model to understand the correlations between the models.

If we train our model very well and its training accuracy is also very high, but we provide a new dataset to it, then it will decrease the performance. So we always try to make a machine learning model which performs well with the training set and also with the test dataset. Here, we can definethese datasets as:

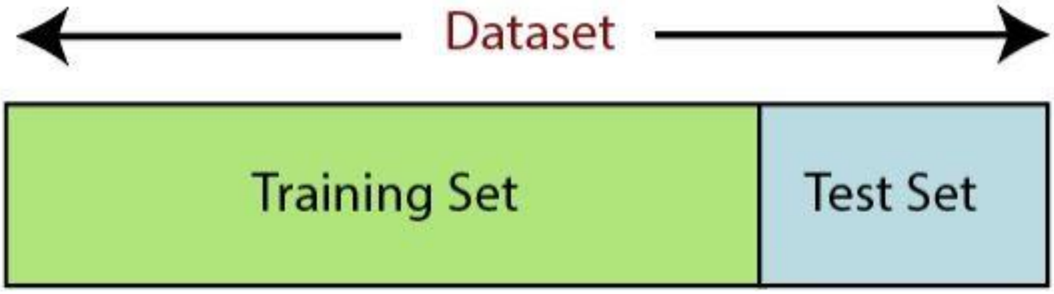


Figure 3.1: Data Set

3.3 Model Creation

The extracted ratings are directly applied to this stage and have to categorise them into different classes like Normal, Stressed etc. This classification and prediction process is done in this stage.

You will need to train the data sets to run smoothly and see an incremental improvement in the prediction rate. Remember to initialize the weights of your model randomly -the weights are the values that multiply or affect the relationships between the inputs and outputs- which will be automatically adjusted by the selected algorithm the more you train them.

3.4 Logistic Regression

Logistic Regression isa Machine Learning classification algorithm that is used to predict the probability of a categorical dependent variable. In logistic regression, the dependent variable is a binary variable that contains data coded as 1 (yes, success, etc.) or 0 (no, failure, etc.).

3.5 Ada Booster

AdaBooster also called Adaptive Boosting is a technique in Machine Learning used as an Ensemble Method. The most common algorithm used with AdaBoost is decision trees with one level that means with Decision trees with only 1 split. These trees are also calledDecision Stumps.

3.6 Random Forest Algorithm

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning,which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

As the name suggests,“Random Forest is a classifier that contains a number of decision trees on various subsets of the given data-set and takes the average to improve the predictive accuracy of that data-set.“Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

3.7 Decision Tree Classifier

Decision Tree Classifier is a class capable of performing multi-class classification on a data- set. In case that there are multiple classes with the same and highest probability, the classifier will predict the class with the lowest index amongst those classes.

3.8 Flowchart

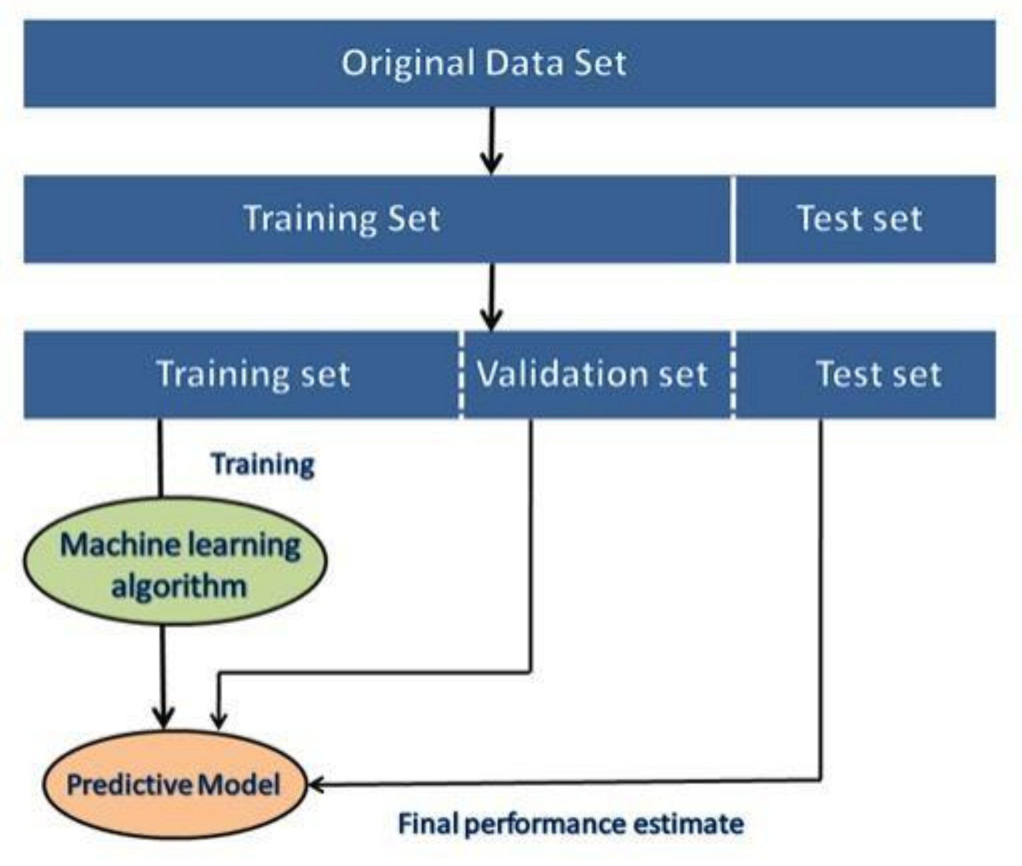


Figure 3.2: Flow Chart

3.9 UART

The Universal Asynchronous Receiver/Transmitter (UART) controller is the key component of the serial communications subsystem of a computer. UART is also a common integrated feature in most microcontrollers. The UART takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes.

Serial transmission of digital information (bits) through a single wire or other medium is much more cost effective than parallel transmission through multiple wires. Communication can be "full duplex" (both send and receive at the same time) or "half duplex" (devices take turns transmitting and receiving).

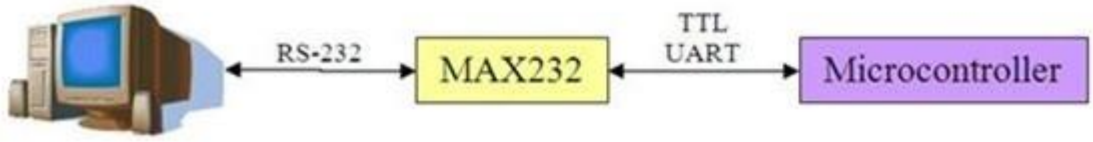


Figure 3.3: UART

3.9.1 THE ASYNCHRONOUS RECEIVING AND TRANSMITTING PROTOCOL

Asynchronous transmission allows data to be transmitted without the sender having to send a clock signal to the receiver. In this case, the sender and receiver must agree on timing parameters (Baud Rate) prior transmission and special bits are added to each word to synchronize the sending and receiving units. In asynchronous transmission, the sender sends a Start bit, 5 to 8 data bits (LSB first), an optional Parity bit, and then 1, 1.5 or 2 Stop bits.

When a word is passed to the UART for asynchronous transmissions, the Start bit is added at beginning of the word. The Start bit is used to inform the receiver that a word of data is about to be send, thereby forcing the clock in the receiver to be in sync with the clock in the transmitter.

After the Start bit, the individual bits of the word of data are sent, beginning with the Least Significant Bit (LSB). When data is fully transmitted, an optional parity bit is sent to the transmitter. This bit is usually used by receiver to perform simple error checking. Lastly, Stop bit will be sent to indicate the end of transmission.

When the receiver has received all of the bits in the data word, it may check for the Parity Bits (both sender and receiver must agree on whether a Parity Bit is to be used), If the Stop Bit does not appear when it is supposed to, the UART considers the entire word to be garbled and will report a Framing Error to the host processor when the data word is read.

3.9.2 THE PHYSICAL LAYER STANDARDS

There are actually quite a number of different standards that utilizes similar protocol. For instances, TTL level UART, RS-232, RS-422, RS-485 and etc. We will only discuss about TTL level UART and RS-232 in this article.

3.9.3 TTL level UART

Most microcontrollers with UART use TTL (Transistor-transistor Logic) level UART. It is the simplest form of UART. Both logic 1 and 0 are represented by 5V and 0V respectively. The TTL level UART is commonly used in the communications between microcontrollers and ICs. Only 2 wires are required for the full duplex communications as illustrated in the Fig 3.4 below.

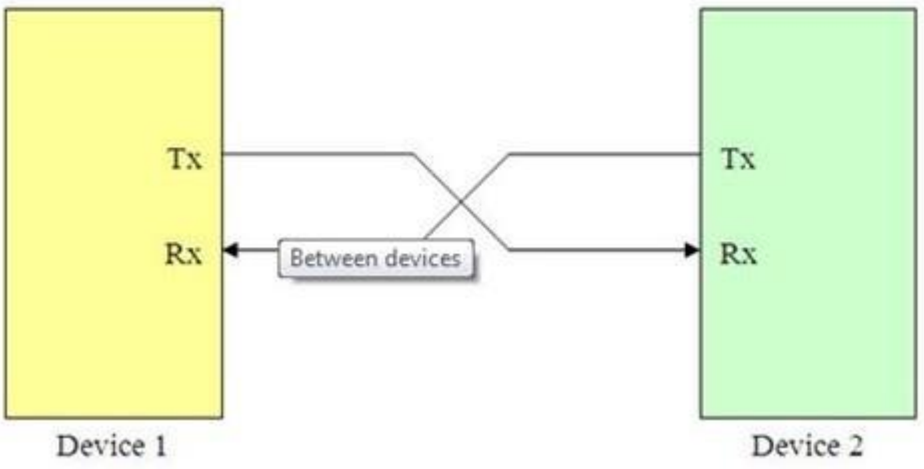


Figure 3.4: RS-232

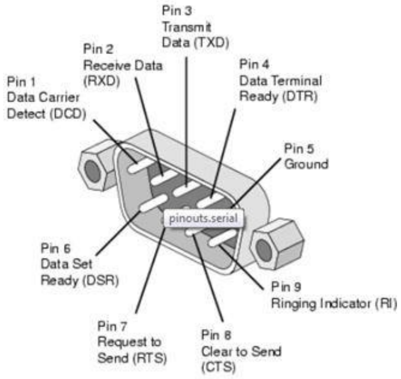


Figure 3.5: dB-9

RS-232 (Recommended Standard 232) is a standard for serial binary data signals connecting between a Data Terminal Equipment (DTE) and a Data Communication Equipment (DCE). It is commonly used in computer serial ports. One of the significant differences between TTL level UART and RS-232 is the voltage level. Valid signals in RS-232 are ±3 to – ±15V, and signals near 0V is not a valid RS-232 level.

Besides voltage level, the RS-232 also has a few extra pins specifically designed for the communication between PC and modem. The pinots of the DB-9 and their functions are shown in Fig 3.5.

3.10 RESPIRATORY SENSOR

The Respiration Sensor is used to monitor abdominal or thoracic-ally breathing, in biofeed-back applications such as stress management and relaxation training. Besides measuring breathing frequency, this sensor also gives you an indication of the relative depth of breathing. The Respiration Sensor for Nexus can be worn over clothing, although for best results we advise that there only be 1 or 2 layers of clothing between the sensor and the skin. The Respiration Sensor is usually placed in the abdominal area, with the central part of the sensor just above the navel. The sensor should be placed tight enough to prevent loss of tension.

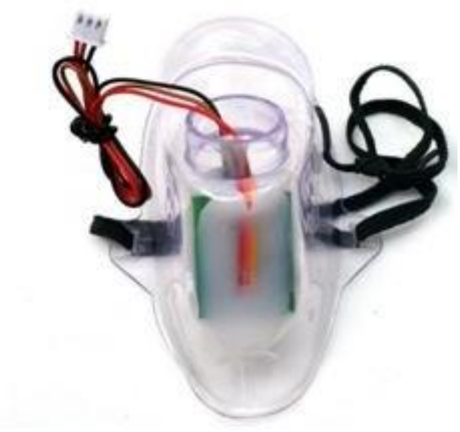


Figure 3.6: Respiratory Sensor

First Sensor develops and manufactures highly reliable sensors and customized sensor systems as a strategic partner to medical product manufacturers in the area of breathing and respiration. The first step in this process is breathing in air, or inhaling. The taking in of air rich in oxygen into the body is called inhalation and giving out of air rich in carbon dioxide from the body is called exhalation. The second step is gas exchange in the lungs where oxygen is diffused into the blood and the carbon dioxide diffuses out of the blood. The third process is cellular respiration, which produces the chemical energy that the cells in the body need, and carbon dioxide. Finally, the carbon dioxide from cellular respiration is breathed out of body from the lungs.

3.10.1 FEATURES

- Input voltage: 5v
- Output voltage: 5v
- Output: Analog
- Range: 30% – 65%

- Size (Approx.):132cm (52” Long)

3.10.2 APPLICATIONS

- Medical purpose
- Environmental Control System
- Emergency response System

3.11 TEMPERATURE SENSOR

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrial applications. A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

In the temperature functional module we developed, we use the LM34 series of temperature sensors. The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration. It is easy to include the LM34 series in a temperature measuring application.

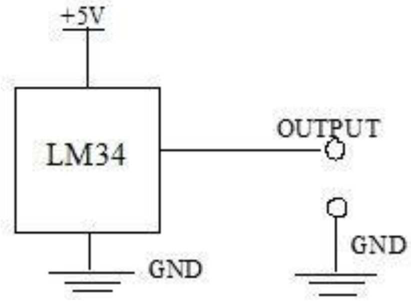


Figure 3.7: LM34 Sensor

The LM34 series is available packaged in hermetic TO-46 transistor packages, while the LM34C, LM34CA and LM34D are also available in the plastic TO-92 transistor package.

The temperature sensor functional module consists of two parts: the function module box and the probe head. The LM34 temperature sensor is mounted on the probe head. By replacingthe LM34 with another precision integrated-circuit temperature sensor LM35 , we can easily get an output voltage proportional to the centigrade temperature.

3.12 ECG

When cell membranes in the heart depolarise, voltages change and currents flow. Because a human can be regarded as a bag of salt water and in other words, a volume conductor changes in potential are transmitted throughout the body, and can be measured. When the heart depolarises, it's convenient to represent the electrical activity as a dipole a vector between two point charges. Remember that a vector has both a size and a direction. By looking at how the potential varies around the volume conductor, one can get an idea of the direction of the vector. This applies to all intra-cardiac events, so we can talk about a vector for P waves, the QRS complex, T waves.

In order to be able to record myocardial activity, the electrocardiograph needs to be able to detect tiny changes in potential on the body surface. We are talking about signals that are often around 1mV, and may be smaller. In addition, we need some reference point to which we relate the potential changes.

ECG paper is traditionally divided into 1mm squares. Vertically, ten blocks usually corre- spond to 1 mV, and on the horizontal axis, the paper speed is usually 25mm/s so one block is 0.04s. Note that we also have big blocks which are 5mm on their side.

Always check the calibration voltage on the right of the ECG, and paper speed. The following image shows the normal 1mV calibration spike.

Note that if the calibration signal is not ”squared off” then the ECG tracing is either over or under-damped, and should not be trusted.

3.13 HEART BEAT SENSOR

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

3.13.1 FEATURES

- Microcontroller based SMD design
- Heat beat indication by LED
- Instant output digital signal for directly connecting to microcontroller
- Compact Size
- Working Voltage +5V DC

3.13.2 APPLICATIONS

- Digital Heart Rate monitor
- Patient Monitoring System
- Bio-Feedback control of robotics and applications

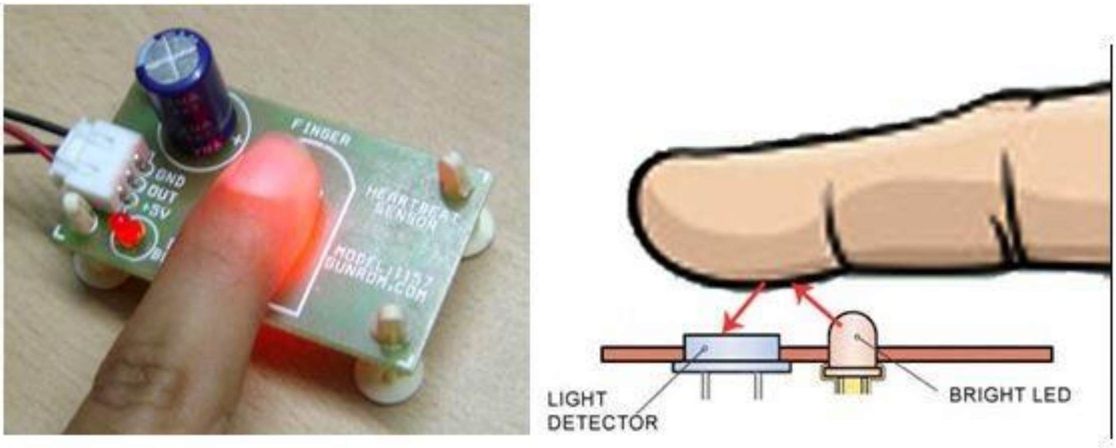


Figure 3.8: Heart Rate Sensor

Medical heart sensors are capable of monitoring vascular tissue through the tip of the finger or the ear lobe. It is often used for health purposes, especially when monitoring the body after physical training.

Heart beat is sensed by using a high intensity type LED and LDR. The finger is placed between the LED and LDR. As Sensor a photo diode or a photo transistor can be used. The skin may be illuminated with visible (red) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of the raw signal. The new signal processing approach presented here combines analog and digital signal processing in a way that both parts can be kept simple but in combination are very effective in suppressing disturbance signals.

The setup described here uses a red LED for transmitted light illumination and a LDR as detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts. The detectors photo current (AC Part) is converted to voltage and amplified by an operational amplifier (LM358).

3.14 NODE MCU – ESP8266

The Internet of Things (IoT) has been a trending field in the world of technology. It has changed the way we work. Physical objects and the digital world are connected now more than ever.

Keeping this in mind,Espressif Systems(A Shanghai-based Semiconductor Company) has released an adorable, bite-sized Wi-Fi enabled microcontroller –ESP8266, at Low Cost.

3.14.1 ESP-12E Module

The development board equips the ESP-12E module containing ESP8266 chip havingTensilica Xtensa 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS.

There’s also 128 KB RAM and 4MB of Flash memory(for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.The ESP8266 Integrates 802.11b/g/n HT40 Wi-Fi transceiver,so it can not only connect to a Wi-Fi network and interact with the Internet, but it can also setup a network of its own, allowing other devices to connect directly to it. This makes the ESP8266 NodeMCU even more versatile.

3.14.2 ESP8266 NodeMCU Pinout

The ESP8266 NodeMCU has total 30 pins that interface it to the outside world. The connections are as follows:

- Power Pins There are four power pins viz. one VIN pin three 3.3V pins. The VIN pin canbe used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.

- GND is a ground pin of ESP8266 NodeMCU development board.

- I2C Pins are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmat- ically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

- GPIO Pins ESP8266 NodeMCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

- ADC Channel the NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

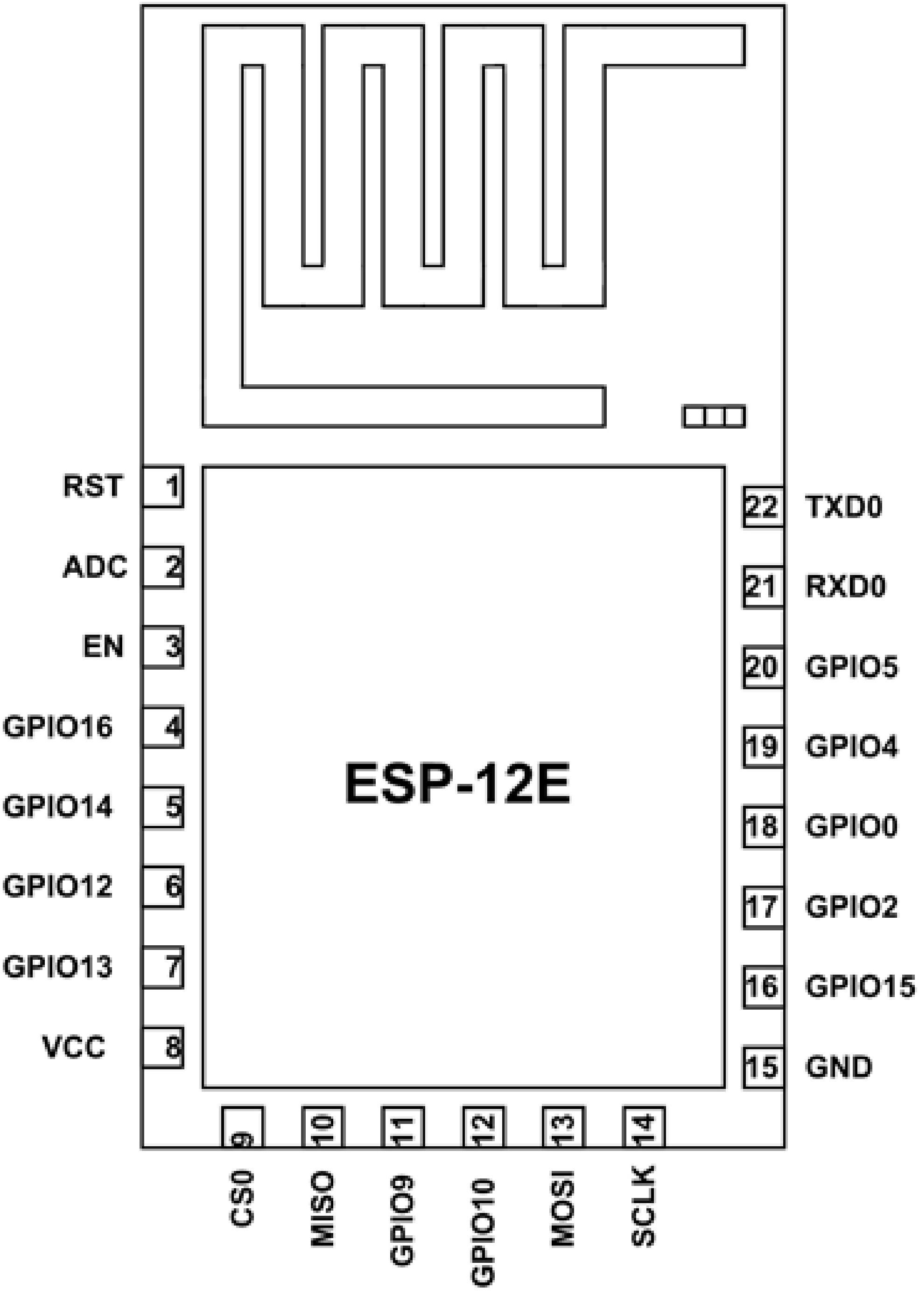


Figure 3.9: ESP12E-Pinout

- UART Pins ESP8266 NodeMCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

- SPI Pins ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer

- Up to 80 MHz and the divided clocks of 80 MHz

- Up to 64-Byte FIFO

- SDIO Pins ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

- PWM Pins The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 us to 10000 us, i.e., between 100 Hz and 1 kHz.

- Control Pins are used to control ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- EN pin – The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.

- RST pin – RST pin is used to reset the ESP8266 chip.

- WAKE pin – Wake pin is used to wake the chip from deep-sleep.

CHAPTER 4

RESULT

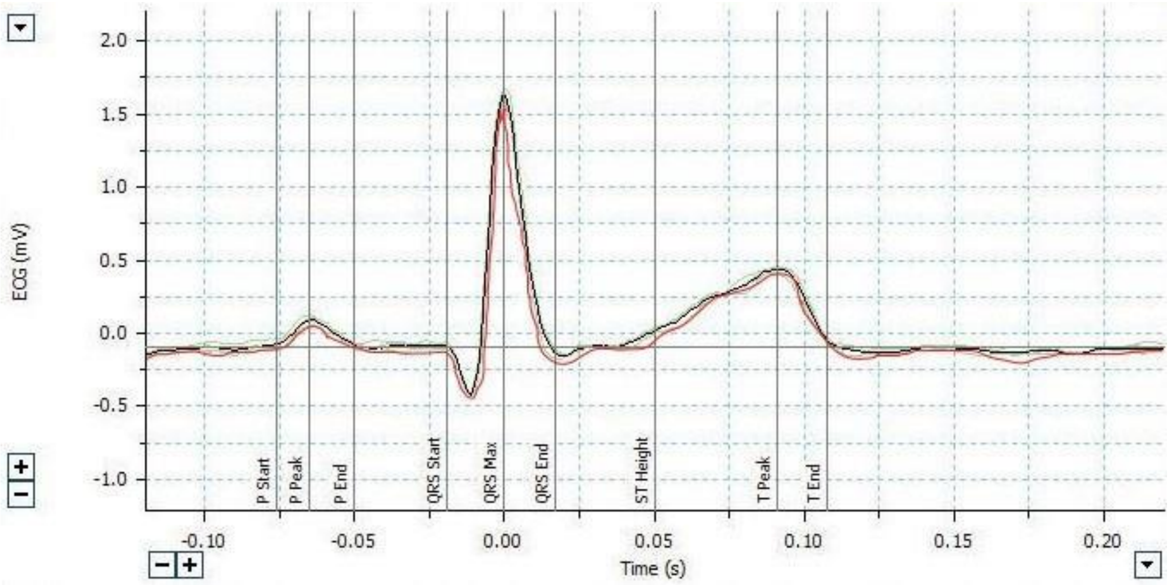


Figure 4.1: ECG Graph

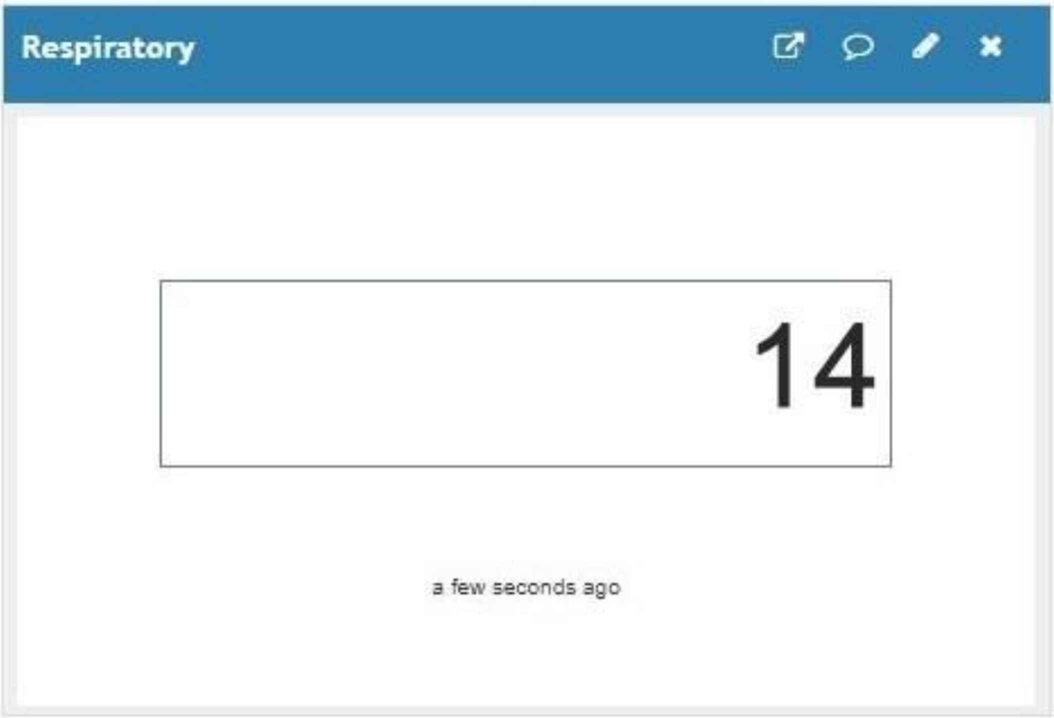


Figure 4.2: Values from Hardware of respiratory in Real Time Uploading to Think Speak Cloud Storage

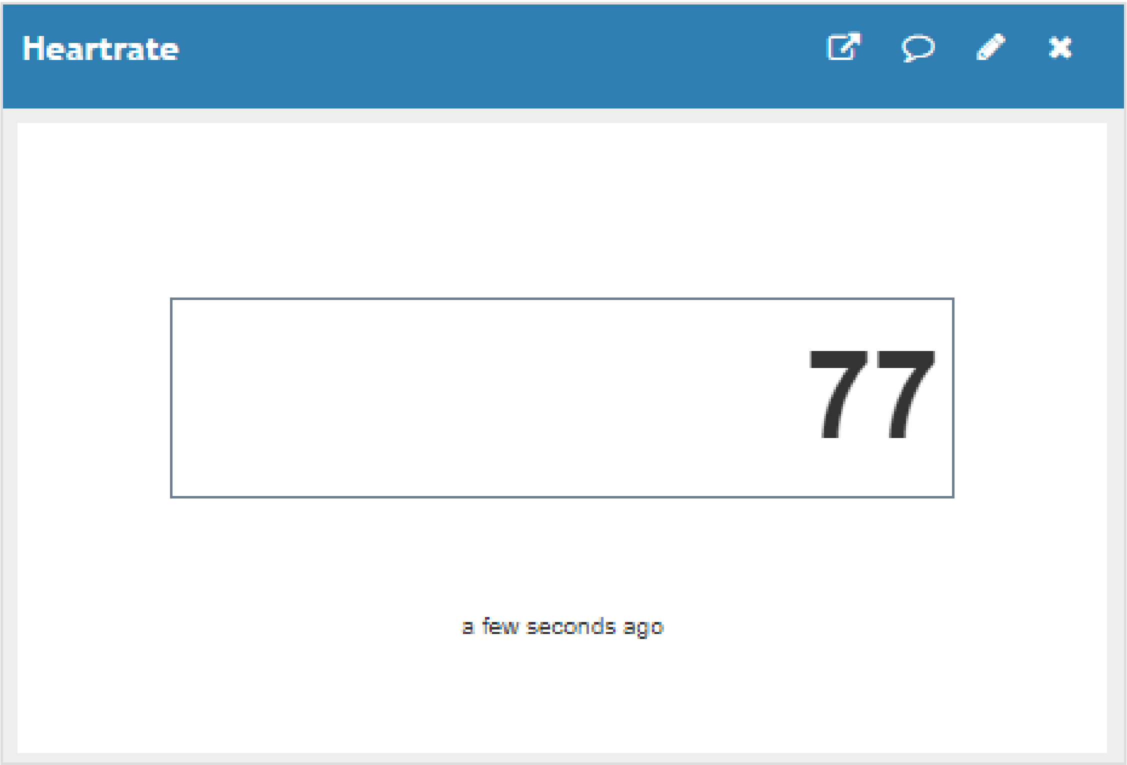
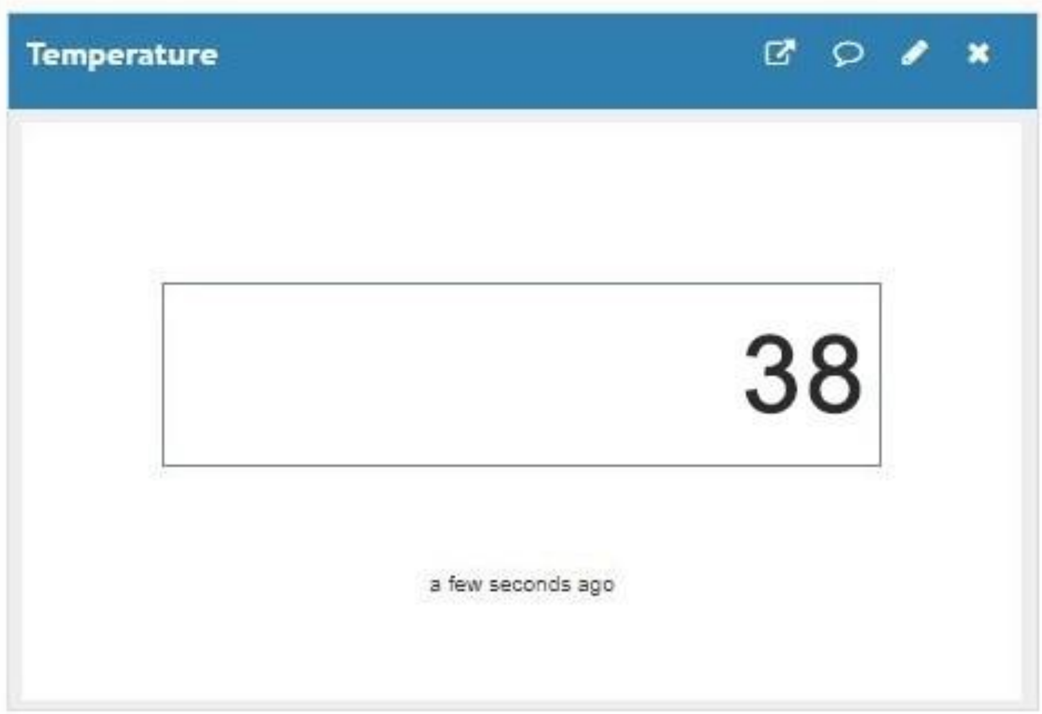


Figure 4.3: Values from Hardware of Heart Rate in Real Time Uploading to Think Speak Cloud Storage



Temperature

38

a few seconds ago

Figure 4.4: Values from Hardware of Temperature in Real Time Uploading to Think Speak Cloud Storage

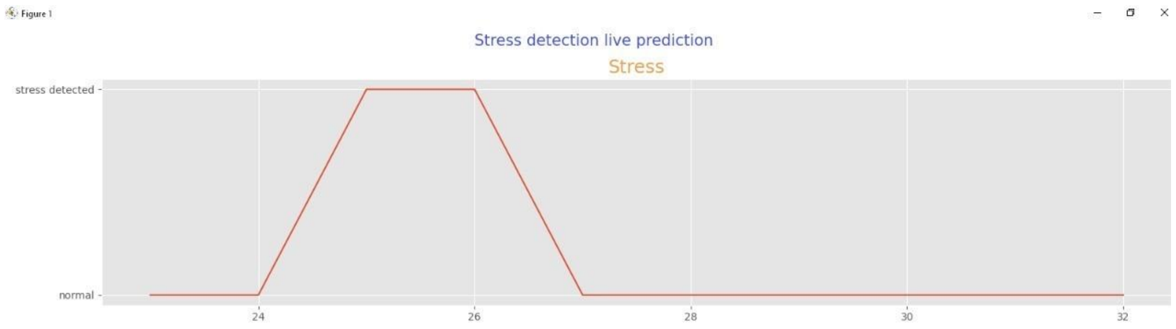


Figure 4.5: Graphical Representation

CHAPTER 5

CONCLUSION

As of now, even with our technological advancements, there is no low-cost reliable solution available for detecting stress. Although there are many mobile applications available regarding e- Health, there is no application to measure stress accurately. Our work uses previously identified stress markers to determine the stress level with low-cost hardware and comparatively higher accuracy.Since this approach involves EEG, we analyze the exact mental condition of the user with the help of their brain rhythms. This is the reason behind improved accuracy and, in the near future, there will be unobtrusive solutions to detect stress levels with less hardware. We have reduced the hardware modules required by coding effective programs to analyze the stress level and by hitting a tradeoff with higher accuracy at the expense of sophisticated devices.

CHAPTER 6

CODES REQUIRED

6.1 Python Code

```
import matplotlib.pyplot as plt
import matplotlib.animation as animation
from matplotlib import style
import time
import sklearn
import pickle
from sklearn.linear model import LogisticRegression
model=pickle.load(open(”stress.pkl”,”rb”))
import pyrebase

config={
      ’apiKey’: ‘ ‘AIzaSyAvXWruKntlOHGQ−QkHfwesqnRqcBnu6ko ” ,
   ’authDomain’: ‘‘stress−44580.firebaseapp.com”,
   ’databaseURL’: ‘‘https://stress−44580−default−rtdb.firebaseio.com”,
   ’projectId’: ‘‘stress−44580”,
   ’storageBucket’: ‘‘stress−44580.appspot.com”,
   ’messagingSenderId’: ‘‘551426428115”,
   ’appId’: ”1:551426428115:web:5e8a68c31465c2ed64d826”,
   ’measurementId’: ”G−BE07EPGDSP”
}


firebase=pyrebase.initializeapp(config)
db=firebase.database()

style.use(‘‘ggplot”)
#fig = plt.figure(figsize=(10,5))
fig, axis = plt.subplots(2,4)

ax1 = plt.subplot2grid((2, 4), (1, 0), colspan=1)
```

```
ax2 = plt.subplot2grid((2, 4), (1, 1), colspan=1)

ax3 = plt.subplot2grid((2, 4), (1, 2), colspan=1)

ax4 = plt.subplot2grid((2, 4), (1, 3), colspan=1)

ax5 = plt.subplot2grid((2, 4), (0, 0), colspan=4)


lines=[]

Tempval_list=[]
Heartval_list=[]
ECGval_list=[]
Respval_list=[]
Stress_list=[]
xar=[]

x=1


font1 = {‘family’: ‘DejaVu Sans’, ‘color’:‘#f59c42’, ‘size’:18}
font2 = {‘family’: ‘DejaVu Sans’, ‘color’: ‘green’, ‘size’:18}
font3 = {‘family’: ‘DejaVu Sans’, ‘color’:‘#42a7f5’, ‘size’:18}
font4 = {‘family’: ‘DejaVu Sans’, ‘color’: ‘red’, ‘size’:18}
font5 = {‘family’: ‘DejaVu Sans’, ‘color’: ‘blue’, ‘size’:18}



def animate(i):
    global x
    x+=1
    xar.append(x)
    data=db.get()

    stressdat=dict(data.val())
    print(stressdat)
    print(int(stressdat[‘ECG’]))
    print(int(stressdat[‘Heart beat ’]))
    print(int(stressdat[‘Respiratory ’]))
    print(int(stressdat[‘Temp’]))

    Tempval=int(stressdat[‘ECG’])
    Heartval=int(stressdat[‘Heart beat ’])
    ECGval=int(stressdat[‘Respiratory ’])
    Respval=int(stressdat[‘Temp’])

    Tempval_list.append(Tempval)
    Heartval_list.append(Heartval)
    ECGval_list.append(ECGval)
    Respval_list.append(Respval)

    result=model.predict([[Tempval, Heartval ,ECGval, Respval]])



    if result[0]==1:
        a=‘‘normal”
        Stress_list.append(a)

        print(a)
    else:
        a=‘stress detected ’
        Stress_list.append(a)

        print(a)

    ax1.clear()
    ax1.plot(xar[−10:],Tempval_list[−10:])
    ax2.clear()
    ax2.plot(xar[−10:],Heartval_list[−10:])
    ax3.clear()
    ax3.plot(xar[−10:],ECGval_list[−10:])
```

```
        ax4.clear()
        ax4.plot(xar[-10:], Respval_List[-10:])
        ax5.clear()
        ax5.plot(xar[-10:], Stress_list[-10:])




        ax1.set_title(‘‘ECG”, fontdict = font2)

        ax2.set_title(‘‘Heart beat ”, fontdict = font3)

        ax3.set_title(‘‘Respiratory ”, fontdict = font4)

        ax4.set_title(‘‘Temp”, fontdict = font5)

        ax5.set_title(‘‘Stress”, fontdict = font1)

        plt.suptitle(‘Stress detection live prediction ’, fontsize=15, color=‘#424ef5 ’
        plt.tight_layout()


    ani = animation.FuncAnimation(fig , animate , interval=1000)
    #plt.tight_layout()
    plt.show()
```

6.2 EMBEDDED C CODE

```
#define USE_ARDUINO_INTERRUPTS true
#include <PulseSensorPlayground.h>

const int PulseWire = 3;
const int LED13 = 13;
int Threshold = 550;

PulseSensorPlayground pulseSensor;
#define temp A0
#define buz 7
```

```
#define ecg A1#d
efine res A2void
setup ()
{
   pinMode ( temp , INPUT) ;
   pinMode ( buz , OUTPUT) ;
   pinMode ( res , INPUT) ;
   pinMode ( ecg , INPUT) ;
   Serial . begin (9600);
   Serial . begin (9600);


   pulseSensor . analogInput ( PulseWire ) ;
   pulseSensor . blinkOnPulse (LED13 ) ;
   pulseSensor . setThreshold ( Threshold ) ;


   if ( pulseSensor . begin ( ) ) {
      Serial . println (” PulseSensor object created !” ) ;
   }
}

void loop ()
{
   int myBPM = pulseSensor . getBeatsPerMinute ( ) ;
   if ( pulseSensor . sawStartOfBeat ( ) )
   {

   }
   int a = analogRead ( res ) ;
   int b = analogRead (temp ) ;
   int d = analogRead ( ecg ) ;
   int c = b ∗ 0.49;
   a = a / 5;
   Serial . print ( ‘ ‘T” ) ;
   Serial . print ( c ) ;
   Serial . print ( ‘ ‘H” ) ;
   Serial . print (myBPM) ;
```

```
  Serial.print(”E”);
  Serial.print(d);
  Serial.print(‘‘R”);
  Serial.print(a);
  Serial.println(‘‘Z”);
  delay(1000);
  if (c > 70)
  {
    digitalWrite(buz, 1);
    delay(1000);
    digitalWrite(buz, 0);
    delay(1000);
  }
}
```

6.3 WI-FI MODULE CODE

```
#include <ESP8266WiFi.h>

String apiKey = ‘‘MJPC34CZE1MM7IV8”;     // Enter your Write API key from Thin

const char ∗ssid = ‘‘smart”;     // replace with your wifi ssid and wpa2 key
const char ∗pass = ‘‘smart@123”;
const char ∗server=‘‘api.thingspeak.com”;
WiFiClient client;
short a_val[5], b_val[5], c_val[5], d_val[5];
short total_a = 0, total_b = 0, total_c = 0, total_d = 0;
short digit[5] = {1, 10, 100, 1000, 10000};
String myString1, myString2, myString3, myString4;
int a = 0;

void setup()
{
  Serial.begin(9600);
  delay(10);
  Serial.println(‘‘Connecting to ”);
  Serial.println(ssid);


  WiFi.begin(ssid, pass);

  while (WiFi.status() != WLCONNECTED)
  {
    delay(500);
    Serial.print(‘‘.”);
  }
  Serial.println(‘‘”);
  Serial.println(‘‘WiFi connected ”);

}

void loop()
{
  short i = 0;
  short serial1 = 1, serial2 = 0, serial3 = 0;

  char serial[100];
  while (Serial.available() > 0)
  {
    serial[i] =Serial.read();
    delayMicroseconds(1050);
    i++;
  }
  if (serial[0] == ‘T’)
  {
    total_a = 0, total_b = 0, total_c = 0, total_d = 0;
    for (serial2 = 0; serial[serial1] != ‘H’; serial1++, serial2++)
    {
      a_val[serial2] = serial[serial1] − ‘0’;
    }
    serial2 = serial2 − 1;
    for (serial3 = 0; serial2 >= 0; serial2−−, serial3++)
    {
      total_a = total_a +  a_val[serial2] * digit[serial3];
    }

    serial1 = serial1 + 1;
    for (serial2 = 0; serial[serial1] != ‘E’; serial1++, serial2++)
    {
      b_val[serial2] = serial[serial1] - ‘0’;
    }
    serial2 = serial2 - 1;
    for (serial3 = 0; serial2 >= 0; serial2--, serial3++)
    {
      total_b = total_b + b_val[serial2] * digit[serial3];
    }

    serial1 = serial1 + 1;
    for (serial2 = 0; serial[serial1] != ‘R’; serial1++, serial2++)
    {
      c_val[serial2] = serial[serial1] - ‘0’;
    }
    serial2 = serial2 - 1;
    for (serial3 = 0; serial2 >= 0; serial2--, serial3++)
    {
      total_c = total_c + c_val[serial2] * digit[serial3];
    }
    serial1 = serial1 + 1;
    for (serial2 = 0; serial[serial1] != ‘Z’; serial1++, serial2++)
    {
      d_val[serial2] = serial[serial1] - ‘0’;
    }
    serial2 = serial2 - 1;
    for (serial3 = 0; serial2 >= 0; serial2--, serial3++)
    {
      total_d = total_d + d_val[serial2] * digit[serial3];
    }

  }
```

```
Serial.print(total_a);
Serial.print(‘‘ ”);
Serial.print(total_b);
Serial.print(‘‘ ”);
Serial.print(total_c);
Serial.print(‘‘ ”);
Serial.print(total_d);
Serial.print(‘‘ ”);
if (client.connect(server, 80))  //   ‘‘184.106.153.149” or api.thingspeak.co
{

  String postStr = apiKey;
  postStr += ‘‘&field1=”;
  postStr += String(total a);
  postStr += ‘‘&field2=”;
  postStr += String(total b);
  postStr += ‘‘&field3=”;
  postStr += String(total c);
  postStr += ‘‘&field4=”;
  postStr += String(total d);
  postStr += ‘‘\r\n\r\n”;

  client.print(‘‘POST /update HTTP/1.1\n”);
  client.print(‘‘Host: api.thingspeak.com\n”);
  client.print(‘‘Connection: close\n”);
  client.print(‘‘X−THINGSPEAKAPIKEY: ” + apiKey + ‘‘\n”);
  client.print(”Content−Type: application/x−www−form−urlencoded\n”);
  client.print(‘‘Content−Length: ”);
  client.print(postStr.length());
  client.print(‘‘\n\n”);
  client.print(postStr);
  Serial.print(postStr);

}

client.stop();

Serial.println(‘‘Waiting...”);
```

```
  // thingspeak needs minimum 15 sec delay between updates
  delay (1000);
}
```

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