

A Review on Anger Detection Module for Assisting Dementia Patients

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ABSTRACT: Dementia is a group of symptoms associated with a decline in memory and a reduction in thought process. It is a known fact that dementia patients associate a small stimulus with an elevated burst of anger and aggression resulting in harm towards the patient and the surroundings. This paper focuses on detecting anger prior to its onset and thereby alerts the surroundings and mollifies the patient. This module uses a raspberry pi interfaced with multiple sensors that measure certain physical parameter. The algorithm helps to classify as anger based on certain predefined threshold values of skin temperature, heart beat rate and body motion. Once classified as anger, an alert notification is sent to the surroundings or the care taker. The surroundings are alerted by an alarm and the caretaker is alerted by an SMS sent to the smart phone device via the algorithm.

KEYWORDS: Dementia, Anger detection, Physical parameters, Alert notification, Linear Vector Quantization (LVQ).

I. INTRODUCTION

Health-monitoring systems are used for improving the quality of human healthcare with the help of fabricated biosensors, which are mostly non-invasive 1. Internet-of-Things (IoT) plays a major role in improving the healthcare services with low-cost and reliable 2. Sensors implanted in a wearable device in a body area sensor network. Dementia is a chronic disorder that impairs the person's cognitive and intellectual ability beyond what might be expected from normal ageing. According to present age statistics, nearly 9.9 million new cases are being reported every year worldwide and Figure 1 indicates the rise in dementia patients 3.

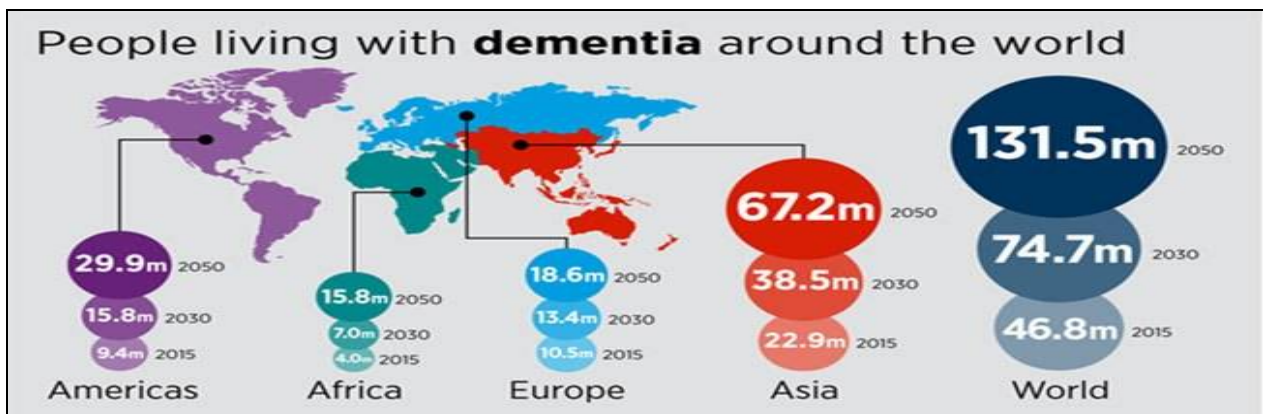


Figure 1: Rise in Number of Dementia Patients World-Wide 4

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The Figure 1 also represents the rise in dementia patients in each continent. It can be observed that by the year 2050, count of people suffering from dementia is approximately 131.5M, while the expected population is predicted as 9.6 billion. This is an exorbitant number.

| Elderly population and Prevalence of Dementia: INDIA-EUROPE-WORLD | | | | | |
|--|----------------------------|---------------------------|---------------------------|----------------------------|-----------------------------|
| | TOTAL POPULATION | ELDERLY PERCENTAGE | ELDERLY POPULATION | DEMENTIA PREVALENCE | PEOPLE WITH DEMENTIA |
| WORLD | 7 BILLION ¹ | 8% | 600 MILLION | 5.9% | 35.6 MILLION |
| EU 27 | 502.5 MILLION ¹ | 17.5% | 97 MILLION | 7.65% | 7 MILLION |
| UK | 62.5 MILLION ¹ | 16.7% | 10.4 MILLION | 7.65% | 0.8 MILLION |
| INDIA | 1.21 BILLION ² | 8% | 96.8 MILLION | 3.6% | 3.5 MILLION |

¹U S CENSUS BUREAU, International program center, international database
²Indian Census 2010

Figure 2: Comparison of Number of Dementia Patients in different Countries 5

In accordance to the Indian census Bureau 2010, 3.6% of the total elderly population accounts to the number of dementia patients as given in Figure 2. It is evident that, India being a developing country lacks the required care and hence the number is an upward curve.

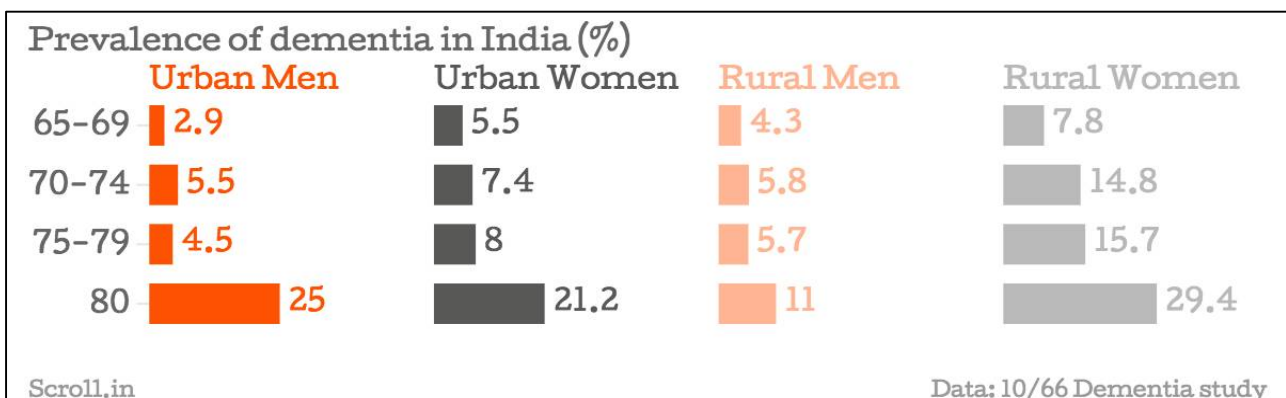


Figure 3: Prevalence of Dementia with respect to Age and Sex 6

The Figure 3 concludes that maximum number of dementia patients reside in rural areas. The main reason behind this trend is the high expenditure on dementia treatment. Figure 4 shows that the directly attributable cost for dementia treatment exceeds most disorders and is second only to ischemic stroke treatment. For the betterment of the society, the developed module shall provide a low-cost solution for controlling aggression and ensure safe living for the patient and the surroundings.

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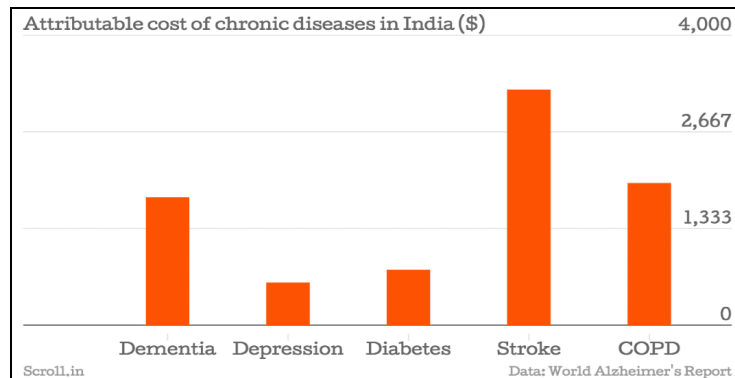


Figure 4: Cost of Treatment for Dementia Compared to other Diseases 6

Dementia patients often suffer from subtle short-term memory changes, mood swings, apathy, confusion and increased aggression. Aggressive behaviours can be verbal or physical and the onset can be from a frustrated situation (small stimuli) or for no apparent reason. This aggressive behaviour has adverse effects towards caretaker and the patient. Thus, anger detection is extremely important, its symptoms can be identified by analysing psychological, behavioural and physiological parameters. It is found that, there are changes in physiological parameters which are a result of human body's reaction to different emotions and mood swings. These parameters through various bio-sensors are integrated with an Arduino controller 7.

The different bio-sensors used in the module measures physical parameters such as pulse rate, skin temperature and body motion is shown in Figure 5. The pulse sensor used in the module is a plug-and-play heart beat sensor that records heart rate. These heart rate recordings can be used to identify the stress levels of the patient and thus help classify anger from other emotions. But this alone is not enough to determine the state as anger. Therefore, skin temperature sensor is introduced. It is a known fact that, skin temperature rises above normal when in anger. The collective functionality of both these sensors can to a certain extent help classify the emotion to be anger. For a body under strenuous exercise or any other activity, same fluctuations were observed. Therefore, we need to differentiate between the movements in exercise and anger. This is achieved by a motion sensor (accelerometer). The fluctuations are monitored in continuum and the caretaker is alerted when the algorithm predicts the behaviour as anger.

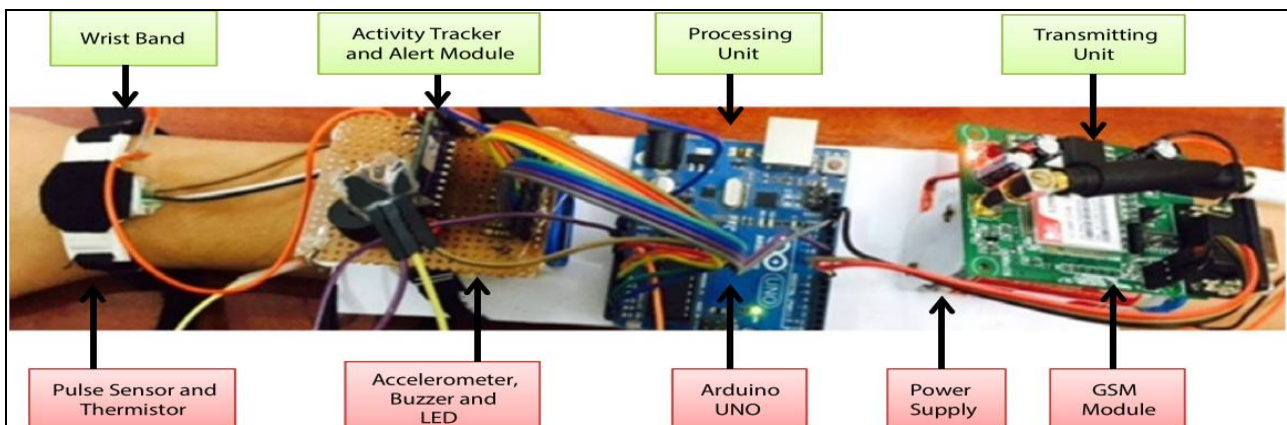


Figure 5: General Block Diagram of the Developed Module 7

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II. DATA COLLECTION

The module consists of three sensors; skin temperature sensor - DS18B20, Accelerometer - ADXL345, Heartbeat sensor- SEN 11574.

Skin temperature sensor is used in the study of variations in skin temperature during various emotional states in human beings. Each emotional state has different variations in temperature. In happy state, skin temperature varies from 28-31°C with a room temperature of about 18-19°C. In normal state the skin temperature varies between 29.5-32°C. During anger, the skin temperature is between 30-35°C with the room temperature being 22-22.5°C 7 as shown Figure 6.

DS18B20 Digital thermometer provides 9 to 12 bit configurable temperature readings which indicate the temperature of the device. The sensor is capable of measuring temperatures from -55°C to +125°C. It has a power supply range between 3-5.5V. It requires a zero standby power mode 7.

According to National Institute of Health 8, heart rate for normal adults is 60-100bpm and for athletes it's 40-60 bpm. Scientifically, an average person will have a pulse rate of about 72-75 bpm. The data analysis results so obtained facilitates in determining the variation in pulse rate under different emotional states. In happy state, pulse rate varies from 70-100 bpm and in normal state it is 60-80 bpm. When in anger, it varies from 95-120 bpm.

SEN 11574(pulse sensor) is a low-cost optical heart rate sensor which provides analog outputs. Therefore, it is operated alongside an ADC9 as shown in Figure 7.

The accelerometer is used as add-on functionality. The ADXL345 sensor used is a triple axis accelerometer with sensitivity levels that can be set at ±2, ±4, ±8 and ±16 g. The lower range is used during slow motion and higher range is used in high speed movement. The gravity and motion-based components were computed from the accelerometer's raw signal which was used to derive user motion 10.

The signals obtained from the pulse rate and the temperature sensors are compared with their respective threshold values. If both the signals rise above the pre-defined threshold values, the module checks for continuous body motion using the accelerometer. If the continuous body motion occurs for more than 80s then, the module assumes the activity to be exercise and it refrains from sending any alert notification. If there is slight body motion for less than 80s, it is detected as anger and the module sends an alert SMS via a GSM module. The Table 1 shows the variations in different parameter with respect to different activities 7.

Table 1: Variations in Parameters for Different Activities

| Activities | Heart rate | Temperature level | Body motion |
|------------|------------|-------------------|-------------|
| Anger | High | High | Rare |
| Exercise | High | High | High |
| Bath | No | High or Low | Low |
| Walk | No | Very Low | High |
| Fear | High | Low | Possibility |

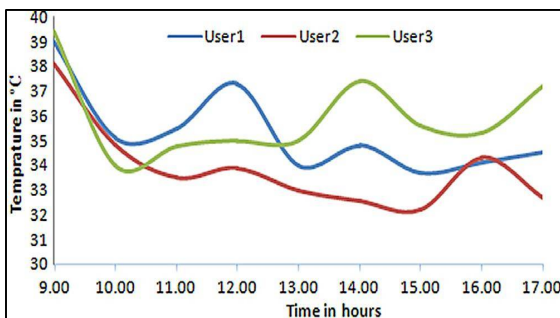


Figure 6: Skin Temperature Variations 7

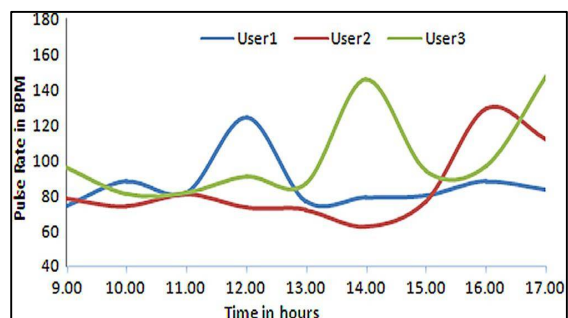


Figure 7: Pulse Rate Variations 7

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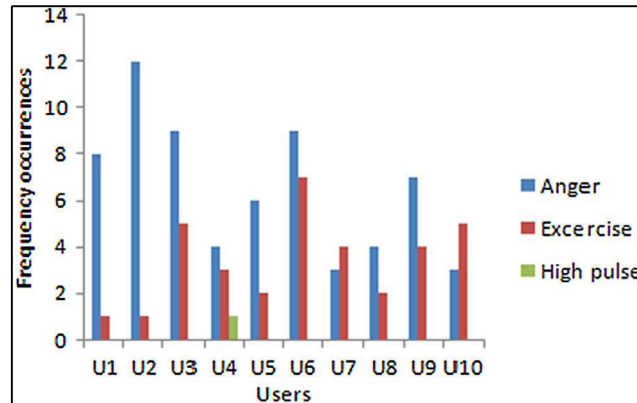


Figure 8: Heart Rate Variations 7

III. MICRO CONTROLLER

The heart of the anger detection module is the microcontroller i.e. Arduino UNO. Arduino UNO has 14 GPIO pins, a 16 MHz crystal oscillator, a USB connector, flash memory of 32 KB, SRAM of 2 KB, and EEPROM of 1 KB. It has a clock speed of 16MHz. it is 2.7 inches x 2.1 inches 11.

Raspberry pi microcontroller is a better option when compared to Arduino UNO. The Arduino UNO microcontroller used is larger in size and has a slow clock speed. It does not support wireless connections like Bluetooth and Wi-Fi. But the raspberry pi controller has a single core, 1GHz CPU. It has an in-built RAM of 512 MB. The controller can be wirelessly connected using in-built Wi-Fi (802.11n) or in-built Bluetooth (4.1). This feature is extracted to alert the caretaker 12.

IV. DATA PROCESSING - SOFTWARE AND ALGORITHM FOR CLASSIFICATION

The cardinal element of the data processing unit is the neural network. To improve the accuracy of the neural network in recognizing emotions, normalization of the training data sets is necessary. This technique is used to minimize the effects differences in age, gender, ethnicity and changes in hormone cycles in patients. This was achieved by reducing the recorded data with the minimum baseline value (threshold value) and dividing by the baseline range according to the equation given. The most pivotal thing in recognizing the emotional physiological data is through signal features extraction. Classification of data set is done by Linear Vector Quantization (LVQ). LVQ is a competitive network which uses supervised learning. The architecture is the *Kohonen Self-Organizing Maps (KSOM)*. LVQ is mainly used in biometric and biomedical systems 13.

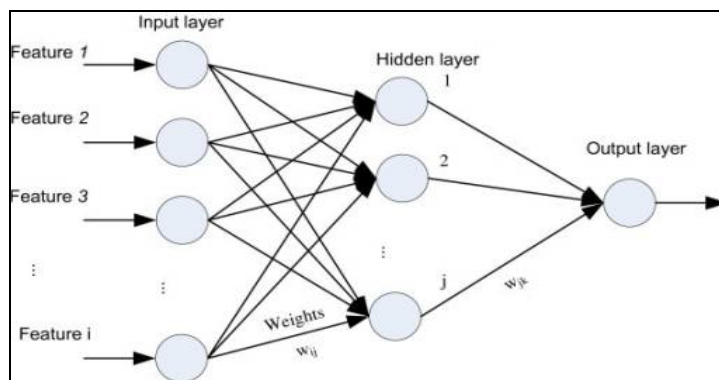


Figure 9: LVQ Architecture [13]

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Typically, LVQ network has three layers; Input, Hidden and Output layer. The input layer has M training sets and the output is a two-dimensional vector (N) depicting the number of classes. The reference vector categorizes the output as a standard for each class which is represented by the Euclidean distance approach [13].

$$\{X^{(N)}, F^{(N)}\} \tag{1}$$

$$N^{(1)} = \left[\begin{array}{c} \|X - W_1^{(1)}\| \\ \|X - W_2^{(1)}\| \end{array} \right] \tag{2}$$

Supervised learning concept is used to identify the target by determining delegated vector quantized of the input vector.

(3)

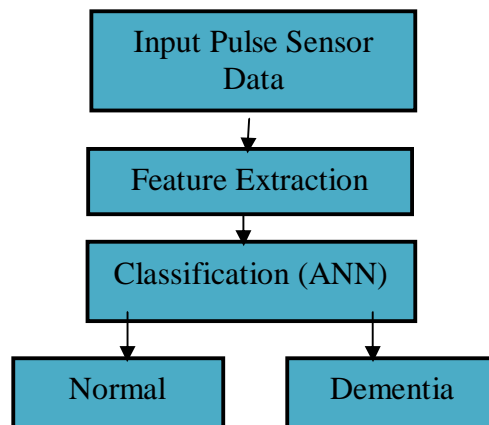


Figure 10: Neural Network Block Diagram 13

V. ALERT NOTIFICATIONS

Wireless communication between raspberry-pi and the cellular device is via MQTT broker/client protocol. This is a protocol that specifically sends data from devices of Internet of Things and is supported by most micro-controllers and systems. MQTT is a machine-to-machine connectivity protocol which uses publish/subscribe messaging transport. It contains three different components: Publisher - Sends the message, Broker - Forwards messages to registered subscribers, Subscriber - Receives messages through the broker. After the data processing is completed, the raspberry pi transmits an alert notification (SMS) via the MQTT protocol [15].

VI. EXPERIMENTAL RESULTS

The following table presents data of 13 tested users. From the cases, two were classified as anger, two cases of high heart rate and one case of exercise. These results were obtained with an accuracy rate of 91%, with the use of neural networks higher accuracy can be achieved [77].

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| Experimental results obtained during user trial. | | | | | | | | | | | | |
|--|----------------|----------------|-------------------|------------------|---------------|---------------------|------------------|------------------------|--------------|----------|-------------|---------------------|
| Cases | Heart rate old | Heart rate new | Change heart rate | Normal temp (°C) | New temp (°C) | Change in temp (°C) | Regular activity | Activity time interval | Alarm signal | Text SMS | Data on web | Emergency situation |
| 1 | 76 | 98 | 22 | 31 | 31.5 | 0.5 | No | - | No | No | Yes | No |
| 2 | 66 | 98 | 32 | 30 | 30.5 | 0.5 | Yes | >80 s | No | No | Yes | No |
| 3 | 72 | 114 | 42>Th | 32 | 32 | 0 | No | - | No | No | Yes | No |
| 4 | 88 | 121 | 33 | 32 | 33.5 | 1.5≥Th | No | - | No | No | Yes | No |
| 5 | 72 | 113 | 41>Th | 33 | 35 | 2>Th | No | - | Yes | Yes | Yes | Yes (Anger) |
| 6 | Any | 160 | Any | Any | Any | Any | No | - | Yes | Yes | Yes | Yes (High HR) |
| 7 | 72 | 114 | 42>Th | 32 | 33 | 1 | Yes | >80 s | No | No | Yes | No |
| 8 | 88 | 121 | 33 | 32 | 34 | 2>Th | Yes | >80 s | No | No | Yes | No |
| 9 | 72 | 112 | 40≥Th | 33 | 35 | 2>Th | Yes | >80 s | No | No | Yes | No |
| 10 | Any | 160 | Any | Any | Any | Any | Yes | Any | Yes | Yes | Yes | Yes (High HR) |
| 11 | 72 | 114 | 42>Th | 32 | 33 | 1 | Yes | <80 s | No | No | Yes | No |
| 12 | 88 | 121 | 33 | 32 | 34 | 2>Th | Yes | <80 s | No | No | Yes | No |
| 13 | 72 | 112 | 40≥Th | 33 | 34.5 | 1.5≥Th | Yes | <80 s | Yes | Yes | Yes | Yes (Anger) |

Table 2: Experimental Results.7

VII. PROPOSED METHOD

The module built using the three sensors lacks the ability to minimize the effects of differences in age, gender, ethnicity and changes in hormone cycles. Therefore, this module is too generalized and not person specific. Physiological parameters vary from person to person and completely depending on these values are not favourable.

The Linear Vector Quantization algorithm was implemented only on a pulse sensor. This can be extended to the other two specified sensors (skin temperature and body motion). The pulse sensor will measure the heart beat rate and classification of emotions based on only this parameter will not provide accurate results. The module measures sudden increase in pulse and predicts the behaviour as anger. Emotions such as fear, anxiety have the same trends in heartbeat. The module hence fails to differentiate anger from other emotions.

We propose to augment both the methods and develop an efficient model that incorporates Linear Vector Quantization algorithm to all the three sensors. The below block diagram represents the proposed method.

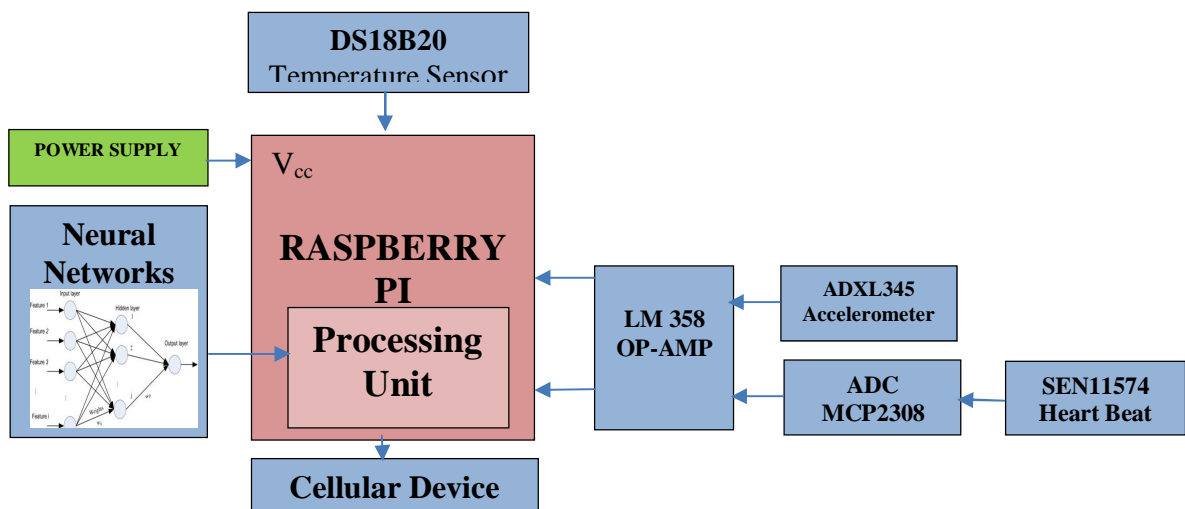


Figure 11: Detailed Block Diagram of Proposed Module

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VIII. CONCLUSION

Every year, world dementia patient count is increasing. It is essential to keep track of the victims and their behaviour to keep them and their surrounding safe. This paper concludes by achieving the goal with the help of state-of-the-art technology in sensors and microcontrollers. The use of different sensors like temperature, body motion and heartbeat, cumulatively provide accurate result from which anger in a dementia patient can be detected. Implemented in the module provides more accurate. Based on performance of the proposed system, it can be concluded that it provides a unique innovative means to effectively monitor dementia patients. In the future, we also would like to incorporate nano-sensors and sophisticated components such as Galvanic Skin Response (GSR), Electroencephalograph (EEG), and Electrocardiogram (ECG), to further build an expert wireless body area network (WBAN) 15.

REFERENCES

1. Pantelopoulos, N.G. Bourbakis, A survey on wearable sensor-based systems for health monitoring and prognosis, IEEE Trans. Syst. Man Cybern. C 40 (1) (2010) 1–12.
2. D. Metcalf, S.T. Milliard, M. Gomez, M. Schwartz, Wearables and the internet of things for health: Wearable, interconnected devices promise more efficient and comprehensive health care, IEEE Pulse 7 (5) (2016) 35–39.
3. World Health Organisation, 10 Facts on Dementia, April 2017.
4. Global Dementia Care, Statistics of Dementia patients world wide.
5. Dr Ravi Soni, senior resident, Department of Geriatric Mental Health, KGMC Demography and Epidemiology of Psychiatric Disorders in Elderly
6. Scroll.in, Charts Showing the urgency of India's burgeoning dementia problem,
7. Nupur Prakash, Vivekananda Jha, Sweta Sagar, Wearable Anger Monitoring System, emotion detection based on the physiological changes of the body is a major concern, ICT Express (2017).
8. American Heart Association (AHA) Target Heart Rates, January 2015 [Online]. Available: [www.heart.org /HEARTORG/HealthyLiving/PhysicalActivity/FitnessBasics/Target-Heart-Rates UCM 434341 Article.jsp](http://www.heart.org/HEARTORG/HealthyLiving/PhysicalActivity/FitnessBasics/Target-Heart-Rates_UCM_434341_Article.jsp).
9. World Famous Electronics, www.pulsesensor.com, Pulse sensor easy to use heart rate sensor and kit.
10. Analog devices, 3 axis, ± 2 , ± 4 , ± 8 , $\pm 16g$, ADXL345-EP, accelerometer enhanced product.
11. Hobby Electronics, Arduino UNO R3 Specifications based on ATmega328.
12. Social Compare Beta, collaborative comparison engine, Raspberry pi model comparison (23 july, 2018).
13. Akhamad Marzuki, Lantana Dioren Rumpa, Adhi Dharma Wibawa, Mauridhi Hery Purnomo, Classification of Human state Emotion from physiological Signal Pattern using Pulse Sensor Based on Learning Vector Quantization, International Seminar on Intelligent Technology and its Application, 2016.
14. Raspberry pi tutorials, Wireless communication between raspberry pi's via MQTT broker/client.
15. Vishesh S, Pradhymna M, Suchit Shavi, Sujaya HS, Suraj N, Kavya P Hathwar, WBAN and Cloud Computing-2, IJARCCCE, vol-6 issue 11 november 2017,