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Measurement of Physiological & Psychological Parameters for soldiers through smart clothes.

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Abstract - In a combat situation or any state affairs related crisis one of the most important aspects for an armed force is to keep a track record of soldier's heath parameters. In this proposed report a small insight of how to achieve real time monitoring of soldier's health parameter, which can be accessed from any remote-control room so immediate action could be initiated if any uncertainty occurs in the field. In such situations, advance sensor plays a vital role in collecting the data and the control unit accumulates this data for storage. The data will be directly sent from soldier's vest to remote control room. In control room monitoring of real time body parameter of soldier's which include Electrocardiograph (ECG), Electromyography (EMG), Blood Oxygen level, Body Temperature, Pulse rate, Heart Rate, Respiration Rate, Blood Pressure.

Key words: *vital role, real time monitoring*

I. INTRODUCTION

In military operations, one of the main priorities is to keep the soldiers in peak condition regardless of the surrounding conditions. In such case base station can monitor health status of solider, this project can play a vital role to keep a track on the health status thus help in saving a soldier's life by getting their- real time data regarding their health and mental condition. Most of the advanced sensor are placed below vest which consist of smart sensing with battery backups using various power source rechargeable battery, piezoelectric, thermoelectric, solar pads. Here in this project, it is proposed to keep piezoelectric sensors in the shoes of the soldier so that maximum pressure can be gained and required power is generated. This vest usually worn under the soldier's body Armor which is manufactured of Nylon-Polyester material that will be comfortable for the soldiers to wear in any environmental condition. Also, a camera with inbuilt night vision facility is installed on the soldier's helmet so that live footage of soldier's current location, surrounding can be monitored in the surveillance room and instruction can be provided to the soldier's accordingly and also a soldier can also monitor the vision with the help of PDA (Personal Digital Assistant) provided to him.

II. BLOCK DIAGRAM

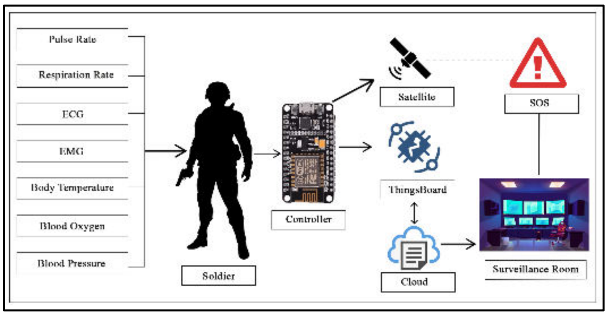

Fig. 1 Block Diagram

Fig no. 1 depicts block diagram to demonstrate how various physical parameter measured and communicated in surveillance room. In this paper physical parameters include motion, stress, temperature, heart rate, cardiovascular diseases, muscular issue etc. Temperature measurements on human skin can provide a lot of useful information on health conditions such as stroke, heart attack etc. Human motion is affected by many factors, including physiological, psychological and social effects. Mobility is also affected by abnormal physical and emotional conditions. A wearable electrocardiograph can be used for initial short time assessment of heart functionalities and wearable electromyogram can also use for measuring muscular activity. A pulse oximeter used to measure the oxygen level at live interval. For generation of power using physiological parameter piezoelectric sensor is used which converts body temperature into voltage.

In this paper various physiological measuring sensors such as Pulse rate (PR) and Blood Oxygen (MAX30100) sensor, ECG (AD8232) sensor, EMG (Myoware), Body Temperature (MLX90614ESF) IR non-contact sensor, Blood pressure

(Piezoelectric) sensor, EEG sensor is used. These all sensors are placed on the soldier's body to measure physiological and psychological parameter. Data sensed and is sent to controller. To monitor the parameter data is displayed and stored in cloud server for future reference. The monitoring of the parameter is done in the control room.

When a sensor works in some environments to detect certain parameters, it may encounter three different inputs: **[1]**
1)**Target input**: the parameter which is decided to be measured
2)**Interfering input:** the parameter to which sensor is unintentionally sensitive

3)**Modifying input:** the parameter that causes a change in the input-output relation of the target input & interfering input

III. HARDWARE

The list of the hardware (sensors) given below:

Sr no	Hardware	Types
1	Arduino	Nodemcu
2	Sensor	1) MLX90614 IR sensor 2) MAX30100 Pulse oximeter 3) Myoware EMG sensor 4) AD8232 ECG sensor 5)Piezoelectric sensor for Blood Pressure measurement

IV. SPECIFICATION & WORKING

1. NODEMCU:

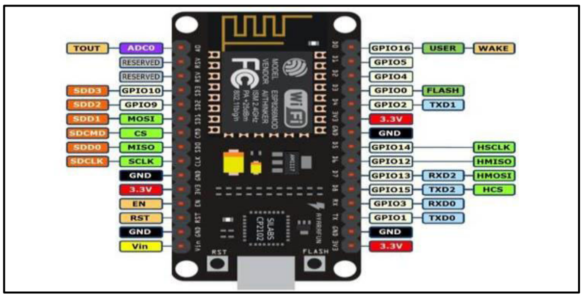

Fig 2. NODEMCU

Specification:
Microcontroller ESP-8266 32-bit
Operating Voltage 3.3V
Input Voltage 4.5V-10V
Flash Memory/SRAM 4 MB / 64 KB
Digital I/O Pins 11
Analog Input Pins 1
Temperature Range -40°C to 125°C

Working:
NodeMCU is an open-source firmware for which open-source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source. **[2]**

2. MLX90614ESF:

Fig 3. MLX90614ESF IR sensor

Specification:
Operating Voltage 3.6V to 5V
Supply Current 1.5mA
Object Temperature Range -70° C to 382.2°C
Ambient Temperature Range -40° C to 125°C
Accuracy 0.02°C
Distancebetween objects and sensor 2cm to 5cm

Working:
For measurement of body temperature, we are using MLX90614ESF IR non-contact temperature measuring sensor, the change in temperature causes a change in resistance of the sensor, which is finally converted into an electrical signal. Body temperature is the desired output. Several physiological parameters are almost constant or very slowly called static characteristics. The body temperature of a human remains almost constant except for an increase in the case of fever.**[3]**

3. AD8232:

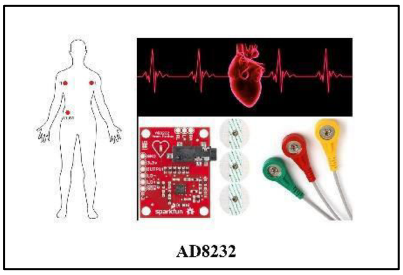

Fig 4. AD8232 ECG sensor

Specification:

Power Supply	3.3V
CMRR	80dB
Size	30mm’30mm
Net weight	10gm
Output	Analog
The electrode interfaces	3.5mm

Working:

The AD8232 ECG sensor is a commercial board used to calculate the electrical movement of the human heart. This action can be chart like an Electrocardiogram and the output of this is an analog reading. Electrocardiograms can be very noisy, so to reduce the noise the AD8232 chip can be used. The working principle of the ECG sensor is like an operational amplifier to help in getting a clear signal from the intervals simply.**[4]**

Heart diseases are becoming a big issue for the last few decades and many people die because of certain health problems. Therefore, heart disease cannot be taken lightly. By analyzing or monitoring the ECG signal at the initial stage this disease can be prevented. So, we present this project, i.e. ECG Monitoring with AD8232 ECG Sensor & Arduino with ECG Graph.

The AD8232 is a chip used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram. Electrocardiography is used to help diagnose various heart conditions.

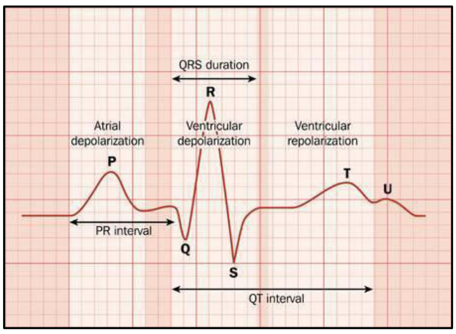

Fig 5. ECG Waveform

An ECG is a paper or digital recording of the electrical signals in the heart. It is also called an Electrocardiogram. The ECG is used to determine heart rate, heart rhythm, and other information regarding the heart’s condition. ECGs are used to help diagnose heart arrhythmias, heart attacks, pacemaker function, and heart failure. ECG can be analyzed by studying components of the waveform. These waveform components indicate cardiac electrical activity.

- The first upward of the ECG tracing is the P wave. It indicates atrial contraction.
- The QRS complex begins with Q, a small downward deflection, followed by a larger upwards deflection, a peak (R), and then a downwards S wave. This QRS complex indicates ventricular depolarization and contraction.
- Finally, the T wave, which is normally a smaller upwards waveform, representing ventricular re-polarization

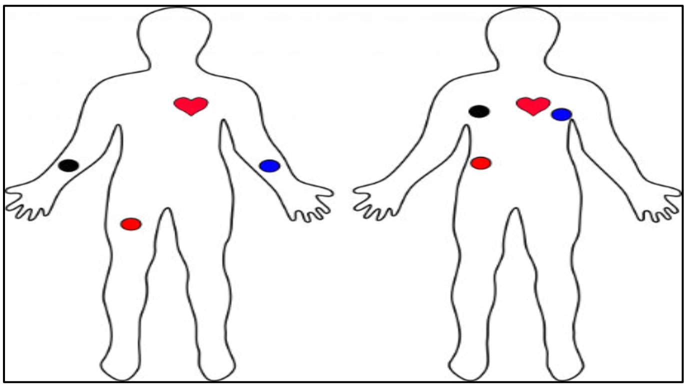

Fig 5.1 ECG placement **[5]**

4. Myoware:

For measurement of the health condition of muscles and the nerve cells, we are using Electromyography (EMG) sensor MyoWare. They transmit electrical signals that cause muscles to contract and relax.

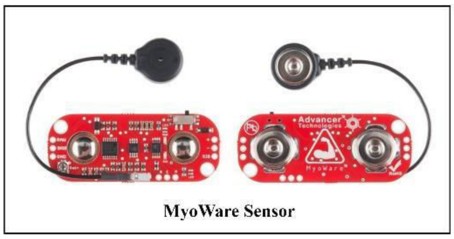

Fig 6. Myoware EMG sensor

Specification:

Wearable	Design
Supply	+2.9V to +5.7V
Output Modes	Raw EMG

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LED Indicators
Specially Designed for Microcontrollers
Adjustable Gain
Size 0.82" x 2.06"

Working:
The MyoWare board acts by measuring the filtered and rectified electrical activity of a muscle. It gives the output from 0 to Vin Volts depending on the amount of activity in the selected muscle.
The electrical activity picked up by the electrodes is displayed on an oscilloscope. An audio amplifier is used so the activity can be heard. EMG measures the electrical activity of muscle during rest, slight, contraction, and forceful contraction Muscle tissue does not normally produce electrical signals during rest. When an electrode is placed, a brief period of activity can be seen on the oscilloscope. **[6]**

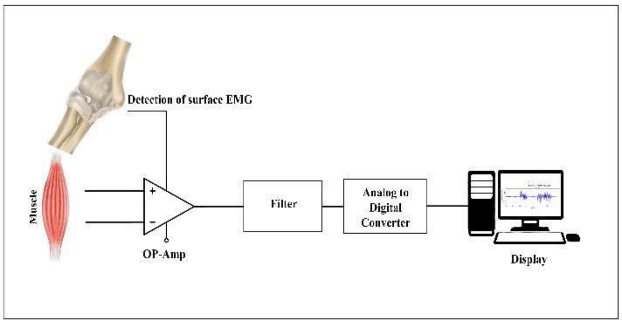

Fig 7. EMG electrode placement

Surface EMG assesses muscle function by recording muscle activity from the surface above the muscle on the skin. Surface electrodes can provide only a limited assessment of muscle activity. Surface EMG can be recorded by a pair of electrodes or by a more complex array of multiple electrodes. More than one electrode is needed because EMG recordings display the potential difference between two separate electrodes.

5. MAX30100:

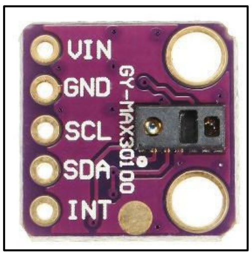

Fig 8. MAX30100 Pulse Oximeter

Specification:
Working voltage 1.8 to 5.5V
Length (mm) 19mm
Width (mm) 14.5mm
Height (mm) 3mm
Weight (gm) 2gm

Working:
In this current situation of Covid-19 Pulse Oximeter is an important instrument used to measure the blood oxygen level of a person. It will check how well your heart is pumping oxygen through your body. This MAX30100 sensor is used to measure oxygen in the body which has an IR sensor in it. **[7]**

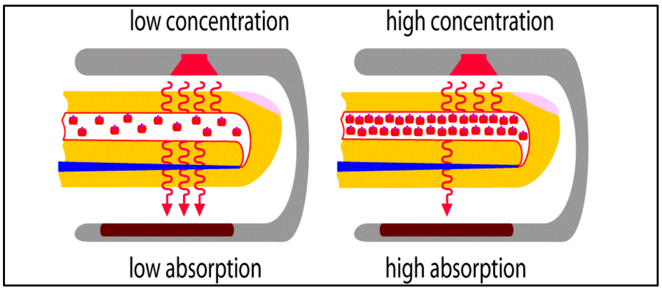

Fig 9. MAX30100 Working

The device has two LEDs, one emitting red light, another emitting infrared light. For pulse rate, only infrared light is needed. Both red light and infrared light are used to measure oxygen levels in the blood.
When the heart pumps blood, there is an increase in oxygenated blood as a result of having more blood. As the heart relaxes, the volume of oxygenated blood also decreases. By knowing the time between the increase and decrease of oxygenated blood, the pulse rate is determined.
It turns out, oxygenated blood absorbs more infrared light and passes more red light while deoxygenated blood absorbs red light and passes more infrared light. This is the main function of the MAX30100: it reads the absorption levels for both light sources and stored them in a buffer that can be read via I2C.

6. Piezoelectric Sensor:

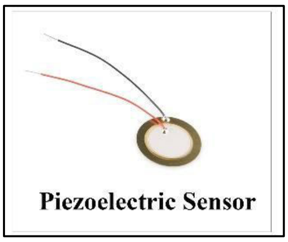

Fig 10. Piezoelectric sensor for Blood Pressure measurement

A non-invasive piezoelectric-based sheet sensor is utilized for the deliberate measurement of heartbeat rate and blood pressure. It may consist of a single sheet to capture various temporal signals or it can be formed as an array of small piezoelectric sensors to capture the temporal and spatial cardiac signals over the chest to give an added spatial granularity on top of the localized temporal signal. The mechanical activity of the heart will cause the piezoelectric sheet to deform, and thus produce a voltage signal. To count the heartbeat rate, a mechanical model has been developed using the corresponding electric waveform; a compression ratio is defined due to the delay as a result of the physical coupling mechanism. Validation of the obtained results has been performed using conventional techniques and apparatus. The quantitative assessment shows low errors when compared with other conventional meters.

•A systolic blood pressure number of 120 or higher, on repeated measurements, is hypertension, or high blood pressure.

•A diastolic blood pressure number of 90 or higher, on repeated measurements, is hypertension or high blood pressure.

[8]

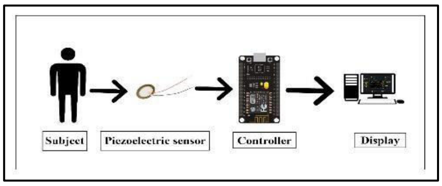

Fig 11. Piezoelectric sensor placement

In this project, we are using a piezoelectric sensor to detect and measure Blood Pressure and Heart Rate using IoT. The piezoelectric sensor is placed on the wrist of the subject. The blood flowing in the body has some pressure/force. The piezoelectric sensor converts this pressure into voltage and is then amplified using some standardized programming and will get accurate Blood Pressure.

V. RESULTS

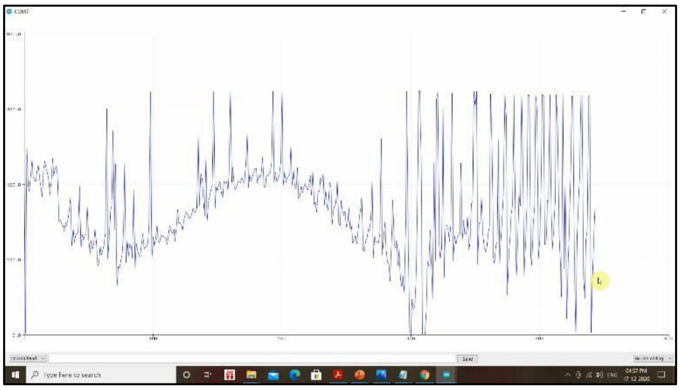

Fig 12.1 ECG Reading

ECG was taken with minimum movements of the body but ECG recording and output stability can be increased by fabricating ECG electrode on clothes or body surface

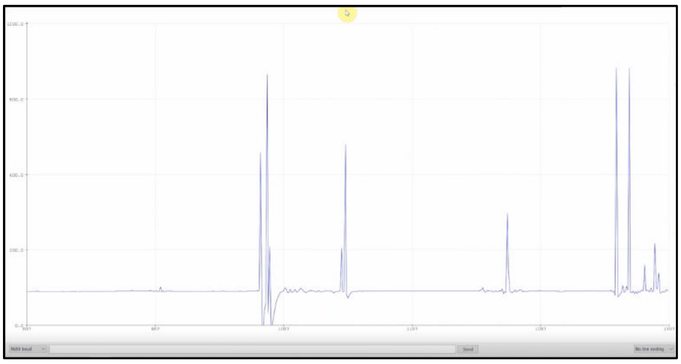

Fig 12.2 EMG Reading

EMG was taken with minimum movements of the body but EMG recording and output stability can be increased by fabricating EMG electrode on clothes or body surface

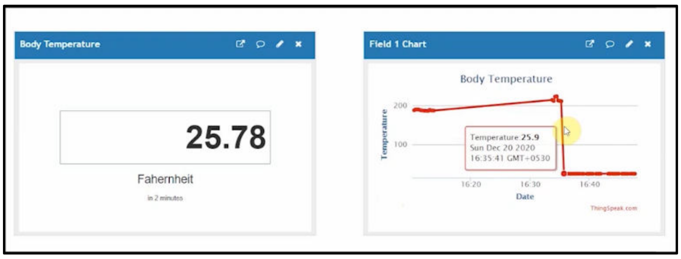

Fig 12.3 Body Temperature Reading

MLX90614ESF body temperature sensor was taken at the normal environmental condition and output stability can be increased by fabricating the sensor on clothes or body surface at an area

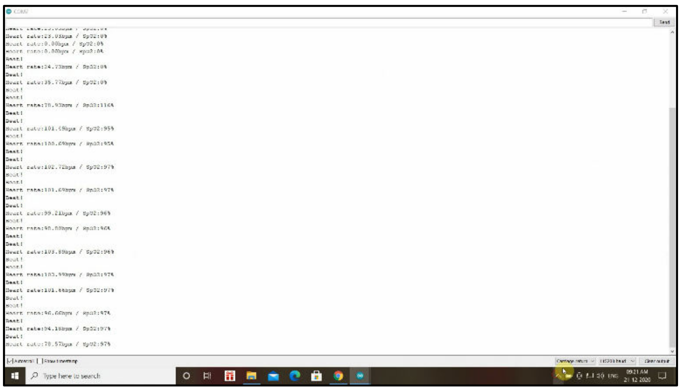

Fig 12.4 Pulse Oximeter Reading

MAX30100 Pulse Oximeter sensor reading was taken with minimum movements of body blood oxygen level recording and output stability can be increased by fabricating sensor on body surface

VI. CONCLUSION

The sensor and the controllers of all nodes are successfully interfaced with the Nodemcu and cloud server between various nodes. All observation and practical tests prove that the project is a complete solution to fulfil the requirement of the physiological and psychological parameter real-time monitoring. Implementation of this idea can take immediate action when necessary.

VII. REFERENCE

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