IoT Course Project (**Literature Survey Based**)

On

Title of the project

BY

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EEE F411 – IoT

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HYDERABAD CAMPUS

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I. A Wearable Healthcare Monitoring System Using Arduino and IoT

A. Problem Statement

Internet of Things (IoT) is greatly improving the field of healthcare, by enabling remote health monitoring using smart wearables, and thus reducing costs and ensuring better medical help.

The aim of this paper is to develop a complete health monitoring wearable system with the help of sensors and Arduino, which will monitor various health parameters of a person, and transmit the extracted data via the internet on the Thingspeak website, while also displaying it on an LCD, so that the doctors and medical staff can also have access to the data remotely.

The paper also aims at developing a buzzer system which goes on in case the critical health parameters cross a particular defined threshold to alert the hospital authorities.

B. Methodology and Results

Methodology

Here, it is planned to monitor the temperature and oxygen level of the body using the monitoring system, using the temperature sensor and SpO2 sensor respectively, along with the temperature and humidity of the environment as these factors may also impact the health of a patient. Arduino Uno will be used to process the data from the sensors. If the parameters cross the set threshold levels, indicating unstable health status, the buzzer will turn ON to alert the hospital authorities. The same parameter values will be displayed on the LCD near the patient and on the thingspeak website with the help of the internet. The block diagram below shows the architecture of the transmitting part. The ESP8266 Wi-Fi module will aid us in connecting to the internet via wi-fi and transmitting the data to thingspeak.

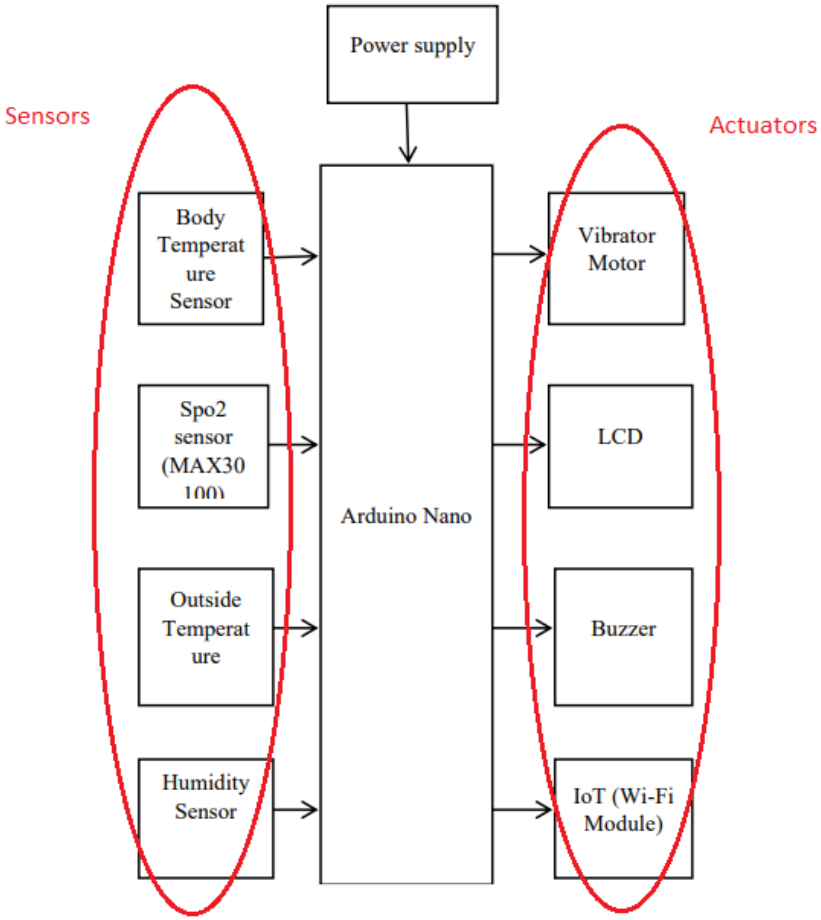


Figure: Block Diagram

Hardware Components

1. **Arduino Uno** : The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. It has a set of digital and analog pins along with a Mini B-USB port. It is characterized by :-
    a. SRAM 2 KB
    b. Operating voltage 5V
    c. Clock speed 16 MHz
    d. Input voltage 6 to 20v
    e. Microcontroller – Microchip Atmega328P

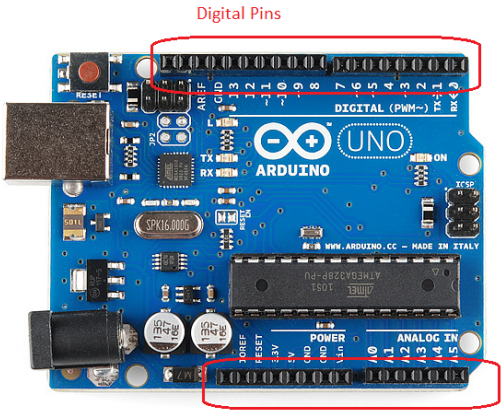


Figure : Arduino UNO

2. **LM35 Sensor** : It is a precision temperature sensor with output voltage linearly proportional to the Celsius temperature. It is used to measure the body temperature of the patient and also the ambient temperature. It's range lies between -55°C to 150°C. VDD, GND, and DQ are its three pins. It can function with both 3.3V and 5V power sources.

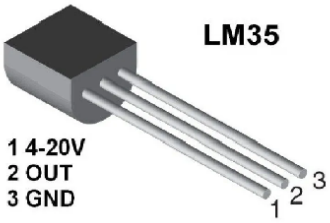


Figure : LM35 Temp sensor

3. **SpO2 Sensor** : This sensor is used to measure the oxygen levels of the body. Oxygen is contained in the hemoglobin in the blood. Spo2 sensor gives a measure of the percentage of blood saturated with oxygen. A reading of 95 to 100% indicates normal health conditions, whereas below 95% may indicate the patient is suffering from COVID or any other disease. The sensor used here is MAX30100 that acts as a pulse oximeter along with a heart rate monitor. It can function with 1.8V and 3.3V power sources.

Figure : MAX30100 Sp02 sensor

4. **Liquid Crystal Display** : A 16x2 LCD display is used to display the data on screen. It is cost effective and easy to program.

5. **Wi-Fi Module** : ESP8266 WiFi Module is used to connect the setup to the internet using its in built TCP/IP suite. It is a low cost solution and works at a clock speed of 80kHz and a power supply of 3.3V.

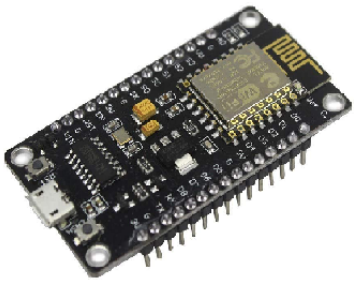


Figure : ESP8266 WiFi Module

Results

The sensors and processor were incorporated in a smart wearable band to be worn on the wrist. The sensors were programmed such that the Buzzer would turn on if the body temperature went above 99°C or if the oxygen levels would drop below 95%. Following are the observations of health parameters of different age groups:-

S.no	Subjects	Ages	Temperature	Humidity	Body Temperature	Heart Beat	Oxygen level	Time
1	Subject1(female)	41	30	73	35	95	98	3:20PM
2	Subject 2 (male)	17	32	64	37	93	95	11:25PM
3	Subject 3 (female)	23	29	69	36	77	98	10:10AM
4	Subject 4 (male)	13	27	75	34	84	99	7:10PM
5	Subject 5 (female)	26	33	60	37	77	96	9:30AM
6	Subject 6 (male)	47	29	78	35	93	98	8:00PM

Figure : Results on Thinkspeak : Readings of temperature, humidity, so02, and heart rate

C. Conclusion

Thus, a smart wearable complete health monitoring system is successfully developed with the help of Internet of Things (IoT). It is also able to successfully send data across the internet and make it available remotely to hospital authorities and doctors. Hence, the use of IoT in healthcare and health monitoring reduces the cost and makes healthcare convenient by making the records available remotely using IoT. It also enables early detection of symptoms and heart and lung diseases which leads to better treatment.

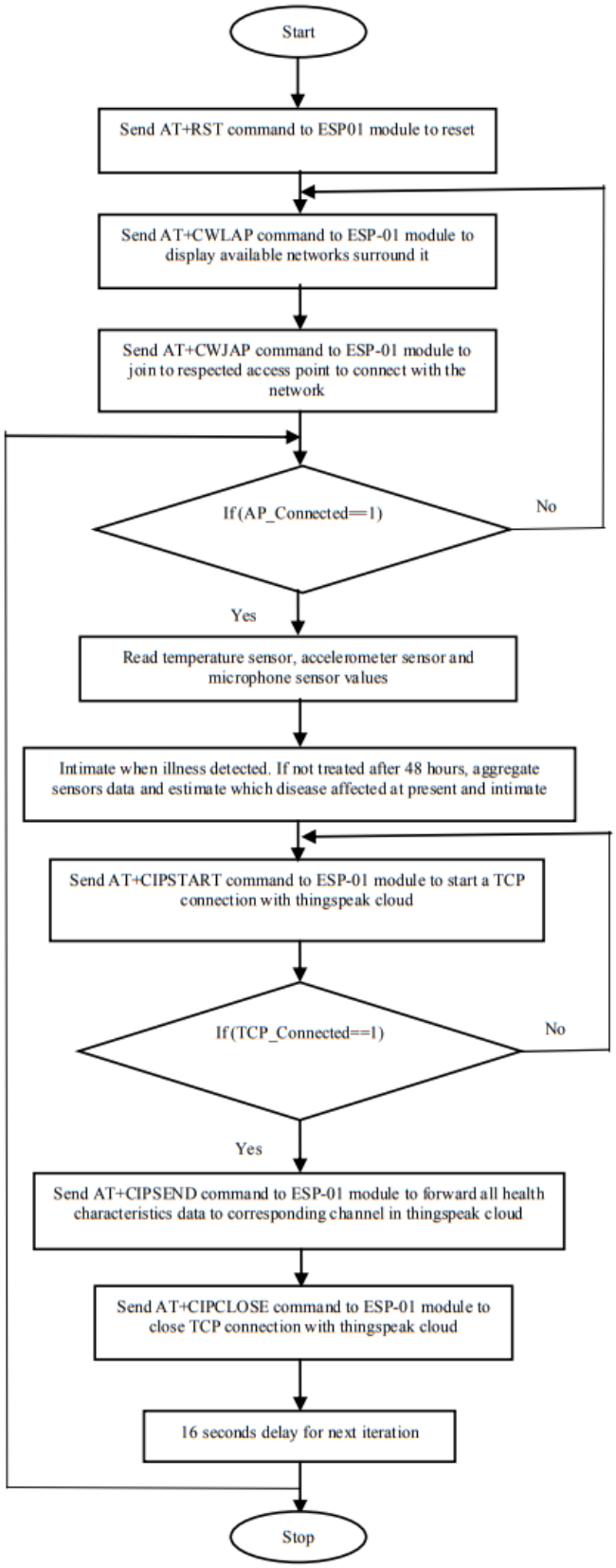
II. Implementation of Smart Infrastructure and NonInvasive Wearable for Real Time Tracking and Early Identification of Diseases in Cattle Farming using IoT

A. Problem Statement

The Internet of Things (IoT) is improving various aspects of livelihood, for instance, smart homes, cities, smart transportation and in many other ways. Cattle Farming is one of the most important economic activities in India as nearly 67% of India's population relies on it for their livelihood. In the past years, there have been a lot of unexpected cattle deaths due to diseases like pneumonia, congestion, foot and mouth disease, fire accidents, irregular feeding, and many other reasons.

The aim of this paper is to bring the benefits of the Internet of Things to cattle farming. Using various sensors, this paper aims to improve various aspects of cattle farming and make it convenient, safer and cost effective and minimize human intervention. Some of the objectives of this paper are:-

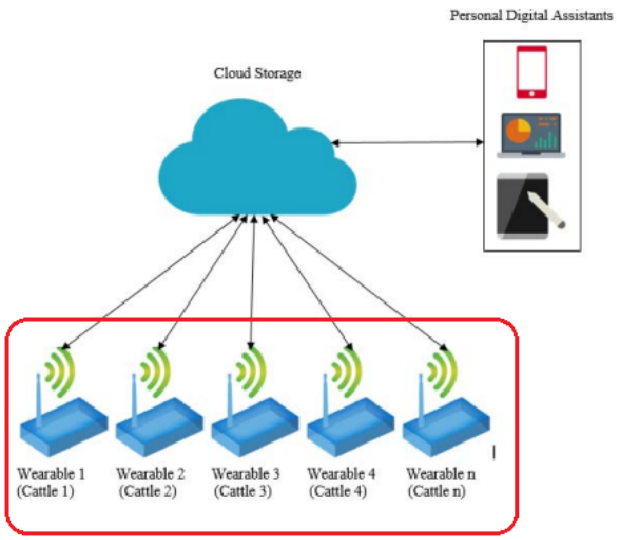
1. **Health Monitoring of cattle using smart wearables** : Heart rate, body temperature and other healthcare parameters are to be continuously monitored using IoT.
2. **Continuous tracking** : Individual cattle are to be tracked continuously using Global Positioning System (GPS).
3. **Detecting Pregnancy** : An increase in body temperature of the cattle from 5th to 12th day after insemination will indicate pregnancy
4. **Smart Lighting** : Sensors can be programmed to detect presence of any cattle in a region and automatically switch street lights on and off accordingly.
5. **Smart Water Supply** : Wells used in the farm can be fitted with water sensors at different levels to find out how much water is present in it and the system can be programmed to switch on the pump as soon as the well starts getting empty.
6. **Smoke Detection** : Smoke sensors can be used in the farms to prevent unexpected loss due to fires.


Start
Send AT+RST command to ESP01 module to reset
Send AT+CWLAP command to ESP-01 module to display available networks surround it
Send AT+CWJAP command to ESP-01 module to join to respected access point to connect with the network
If(AP_Connected==1)
No
Yes
Read temperature sensor, accelerometer sensor and microphone sensor values
Intimate when illness detected. If not treated after 48 hours, aggregate sensors data and estimate which disease affected at present and intimate
Send AT+CIPSTART command to ESP-01 module to start a TCP connection with thingspeak cloud
If(TCP_Connected==1)
No
Yes
Send AT+CIPSEND command to ESP-01 module to forward all health characteristics data to corresponding channel in thingspeak cloud
Send AT+CIPCLOSE command to ESP-01 module to close TCP connection with thingspeak cloud
16 seconds delay for next iteration
Stop

B. Methodology and Results

Methodology

A smart wearable and an end node are designed for individual cattle. The smart wearable will measure the body parameters of the cattle and the end node will measure the ambient parameters needed for the problem. Both of these will follow the device to cloud architecture as shown in figure.



Smart wearables for cattle

Figure : Block diagram of proposed system

Components of Wearable Sensor Node

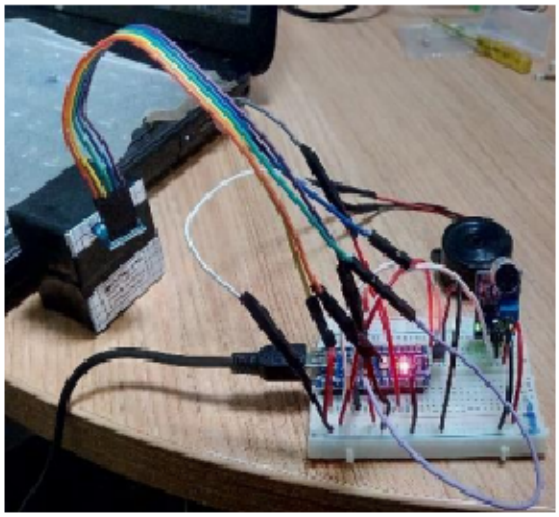
This node detects various body parameters and transmits the data to the internet or cloud. It consists of :-

- **Sensing Unit** : It contains various sensors like:-
    - LM35 Sensor : It is located near the tympanic membrane of cattle to measure its body temperature. It operates at 60μA between -0.2 to 35V. It can measure temperatures from -55℃ up to 150℃.
    - Accelerometer Sensor : Two acceleration sensors (ADXL335) are used to track the cattle activities and detect pregnancy. One is tied under the jaw and the other is tied on the collar of the cattle. It operates at 350μA between 3.3V to +5.0V.
    - Microphone Sensor : It is used to detect the sound intensity.

- **Processing Unit** : Arduino Uno is used as the processor to analyze the data obtained from the sensors and detect diseases, pregnancy or other abnormalities. It is easy to program and consumes low power. It is operated at 5V.

- **Communication Unit** : TCP/IP capabilities are provided by the Wi-fi module ESP01-8266 to aid the node to send the data across the internet/cloud.

- **Power Unit** : A rechargeable battery of 5V is used to power up the node.



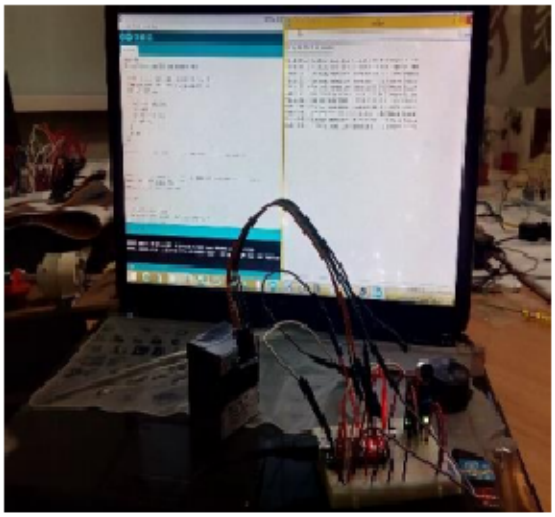


Figure : Hardware implementation of wearable device and arduino code to program it

Functions of Wearable Sensor Node

1. **Early detection of diseases** : For many diseases like pneumonia, congestion and laminitis, the first symptom is a rise in body temperature or fever. For cattle, body temperature is measured from the tympanic membrane near the ear. Data from the temperature sensor is analyzed at the microcontroller to calculate the rise in temperature which can be used to deduce whether or not the cattle has fever.

2. **Early detection of other anomalies** : For healthy cattle, average walking speed is 2.7km/hr and average lying time is 12 hours daily. Microcontroller is used to analyze the accelerometer readings and calculate the lying time, walking time, distance traveled and speed. Analysis of these parameters can indicate lethargy, or other diseases in cattle.

3. **Detection of Emergency** : Microphone sensor on the wearable can detect prominent mooing sound of the cattle which indicates an emergency situation like cattle separated from its group, been fed insufficiently, losing its calf or any form of disease.

4. **Detection of Location** : Location of individual cattle is tracked using GPS.

5. **Early detection of calving time** : Pregnancy period of cattle is from 279 to 287 days. After detection of pregnancy due to increase in body temperature from 5th to 12th day, a counter is automatically set on the wearable which shows the number of days of pregnancy. After the 283rd day, if the speed of cattle is slower than minimum average speed of cattle, then we can detect that the cattle is about to give birth and can prepare for the same in advance.

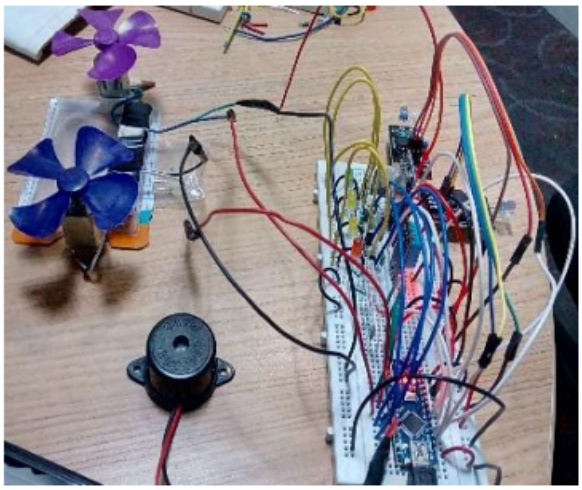
Components of Sink Node

This node consists of a processing unit, communication and power unit exactly the same as the wearable node. However, the sensing unit has a different set of sensors:-

- **Sensing Unit** : The various sensors include
    - LDR Sensor : It is used for measuring real time light intensity in the farms for smart lighting implementation. It operates at 75mA on 5V voltage supply.
    - Infrared Sensor : It is used to detect the presence of each cattle to estimate the occupancy of the farm. This data is useful for programming smart ventilation systems and smart lighting. The sensor operates at 10mA from 3.3 to 5V.
    - LM35 Sensor : It is used to monitor the ambient temperature in the farms. It operates in the range of -55℃ up to 150℃ at 60μA between -0.2 to 35V.
    - DHT11 Humidity Sensor : It is used to measure the ambient humidity of the farms for smart ventilation, where output voltage is directly proportional to humidity.

- MQ-02 Smoke Sensor : It is used to detect any fires in the farms and prevent unexpected loss due to fires. Its output is directly proportional to smoke.

- **Processing Unit**
- **Communication Unit**
- **Power Unit**



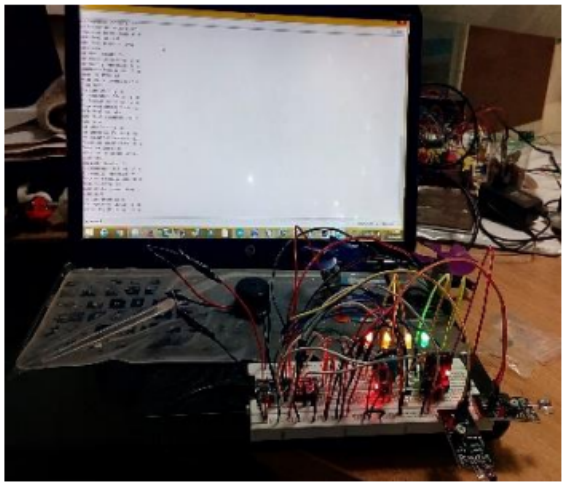


Figure : Hardware implementation and arduino code for sink node

Functions of Sink Node

1. **Smart Lighting Module** : The sink node consists of sensors to measure the daylight intensity inside the farms. There are IR sensors installed at the exit of each gate. With the help of the microcontroller, the IR sensors gather data as to the number of cattle leaving and entering the farm and hence, the total occupancy of the farm is calculated. The smart lights are programmed to function according to occupancy of the farm and the intensity of daylight at the given moment.

2. **Smart Ventilation Module** : For a healthy cow, the average body temperature is 38.6℃ and the ideal environmental relative humidity is 40-60%. To maintain the temperature and humidity of the farms, a measure of the heat stress of the cattle is calculated as :

$$TH_{index} = \left(1.8T_{ambient} - \left(\left(1 - R_{humidity}\right) * \left(T_{ambient} - 14.3\right)\right) + 32\right)$$

Where

TH_{index} - Temperature Humidity Index

$T_{ambient}$ - Ambient temperature (ºC)

$R_{humidity}$ - Relative humidity (%)

When heat stress of the cattle crosses a minimum threshold, the ventilation system is automatically activated.

3. **Smart Watering Module** : The smart wells are installed with water sensors at different levels to detect the amount of water in the well. The pump is programmed to get activated as soon as the water level crosses a minimum threshold in the well.

4. **Smart Smoke Detection Module** : Smoke detectors detect the amount of smoke in the farm and the fire alarms and sprinklers get activated as soon as the smoke level crosses a maximum threshold.

Results

The smart wearables and sink nodes were successfully able to detect all the intended parameters and actuate after processing the data using the microcontroller as illustrated above. The real time readings of the wearable device are :-

Core body temperature (°C)	Standing time (min)	Lying time (min)	Distance walked (KM)	Mooing sound (db)
38.2	20	40	0.020	121
38.2	15	45	0.025	145
38.2	18	42	0.040	246
38.3	5	55	0.010	101
38.3	12	48	0.030	189
38.3	6	54	0.020	156
38.3	12	48	0.033	185
38.3	17	43	0.035	194
38.2	50	10	2.609	122
38.2	48	12	2.632	149
38.2	45	15	2.671	188
38.2	47	13	2.685	126

C. Conclusion

The suggested system was successfully able to improve the infrastructure of cattle farms and to identify, notify, and manage illnesses, abnormalities, and emergencies at an earlier stage. Using the Internet of Things we were able to diagnose problems, detect calving times, and illnesses. All livestock can now be more accurately tracked using wearable GPS technology. The inclusion of multiple sensors in wearables, such as temperature, microphone, and accelerometer sensors, enhances output reliability, consistency, and resolution. Wearables and sink nodes using the Arduino Nano and ESP-01 8266 Wi-Fi module drastically reduce in size and cost without sacrificing performance. The protection of livestock and cattle farms from fire accidents is improved by smoke detection and warning systems. Water is always available to all livestock thanks to intelligent watering. Smart lighting and ventilation reduce electricity usage, which results in significant financial savings. This technology ensures enhanced cattle health and excellent productivity while saving the farmer time and maintenance expenses.

III. Smart Wearable Device for Women Safety Using IoT

A. Problem Statement

The number of crimes against women have been considerably increasing like eve-teasing, and molestation. These days, the safety of women is the main focus, therefore it is very crucial to develop safety equipment that can function as a rescue and protect from injury in the case of a threat.

The aim of this paper is to develop a smart device for women's protection that automates the emergency alarm system by employing a pressure sensor, pulse-rate sensor, and temperature sensor to automatically detect a potential atrocity using outlier detection. Without the need for a woman's engagement during urgent situations, this technology sends notifications to her family members with her position coordinates and notifies them of an emergency.

B. Methodology and Results

Methodology

A wearable for women that has pressure, temperature, and pulse-rate sensors is part of our suggested system.

Block Diagram

In our proposed system, 3 sensors, that are pressure sensor, temperature sensor and pulse rate sensor are used to detect if any external pressure is applied to a woman. If there is any abnormality in the body temperature of the women and if there is any abrupt rise or fall of pulse respectively. Besides these sensors, a push button is used which can alert the people around her if she feels some danger, and GSM and GPS are used to send messages and her live location to her family members.

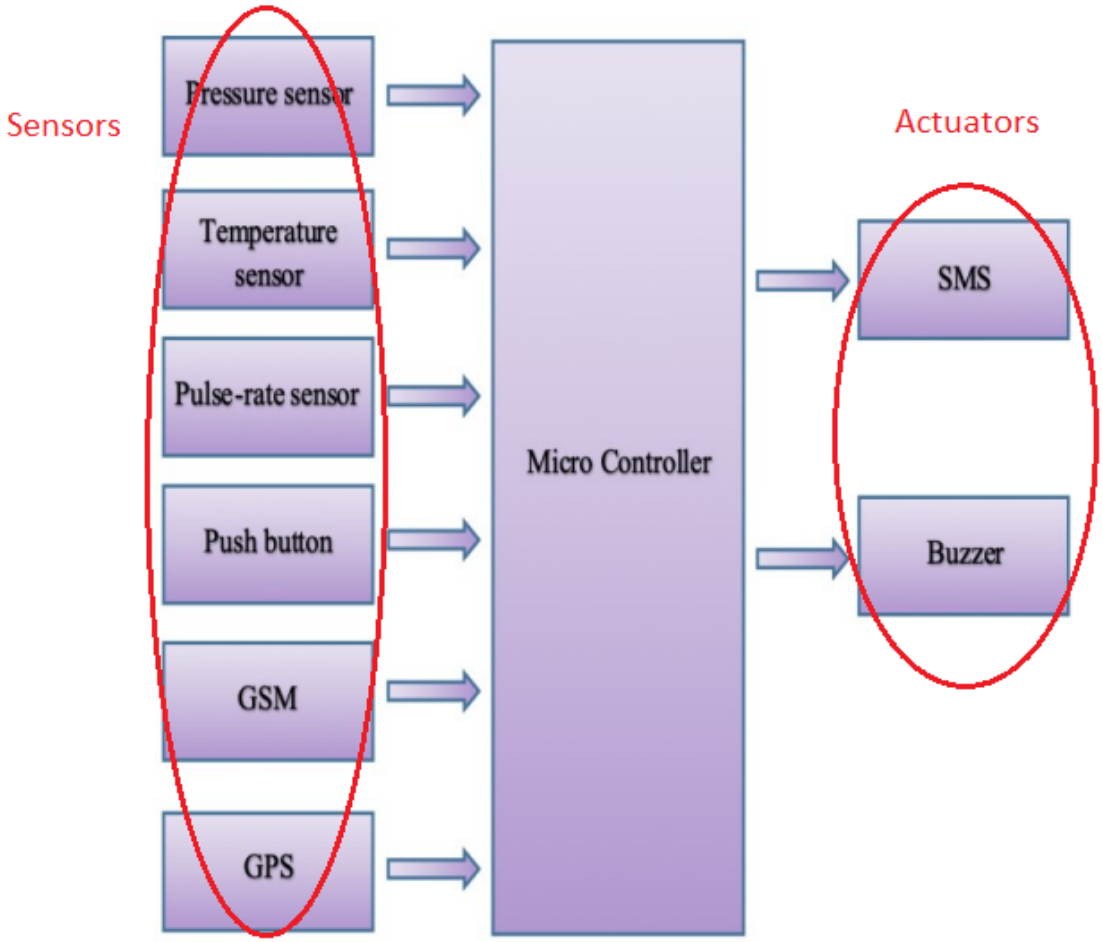


Figure : Block diagram of the proposed solution

Components

1. **Pressure Sensor**: It uses the concept of resistance to detect how much pressure is being applied on the woman. Its resistance is inversely proportional to the pressure applied.
2. **Pulse-rate Sensor**: This sensor is used generally with GSM and GPS to notify her family and detect her live location as soon as any abrupt changes in the pulse rate is observed. Also this can be used with a push button to send an alert manually by pressing that button. This sensor helps in getting the pulse rate reliably and very fast. It is used with Arduino.
3. **Temperature Sensor** : This sensor is used to detect the body temperature of the woman and has a detection range of 20 to 80 degree Celsius.
4. **Push Button**: This button is generally a switch and when pressed completes the loop of circuit and gets activated to either activate the buzzer to alert people around her or send her current location to her friends/family.

5. **GPS-GSM Module**: In this module, both GPS and GSM are used in accordance with each other. A quad band is used for the GSM module and a satellite navigator is supported by the GPS Module. Whenever the buzzer is pressed, this module gets activated.
6. **Buzzer** : The push button when pressed activates the buzzer which then generates an audible tone and it works on 5V supply.
7. **Microcontroller**: This is an IC which connects all the switches, buzzers and sensors together. Its main function is to take a decision call upon receiving various signals from all the sensors and triggering output sensors.
8. **Power Supply** : This whole IoT system is a passive setup so to provide power to the entire module/IoT system, a 12V rechargeable Li-ion battery is used.

Working

There are 3 mechanisms in the proposed solution :-

1. **Manual Mechanism** : This mechanism contains a buzzer and a push button and whenever a woman senses danger around her, she uses the push button to activate the buzzer and alert the people around her about her danger. In this way, the alert mechanism gets activated.

2. **Automated Mechanism** : This mechanism comes into use whenever a woman is low in her senses and is not able to use the manual mechanism. So, in this mechanism, all three sensors – pulse rate sensor, temperature sensor and pressure sensor are used simultaneously and whenever any of the 2 sensors sense danger this mechanism gets activated automatically.

   We set the upper and lower threshold values of all the sensors. Pulse rate above 90 bpm is considered abnormal and hence, marked as threshold. For the pressure sensor, a force greater than 5N is considered dangerous and any force above that leads to activating the alert.

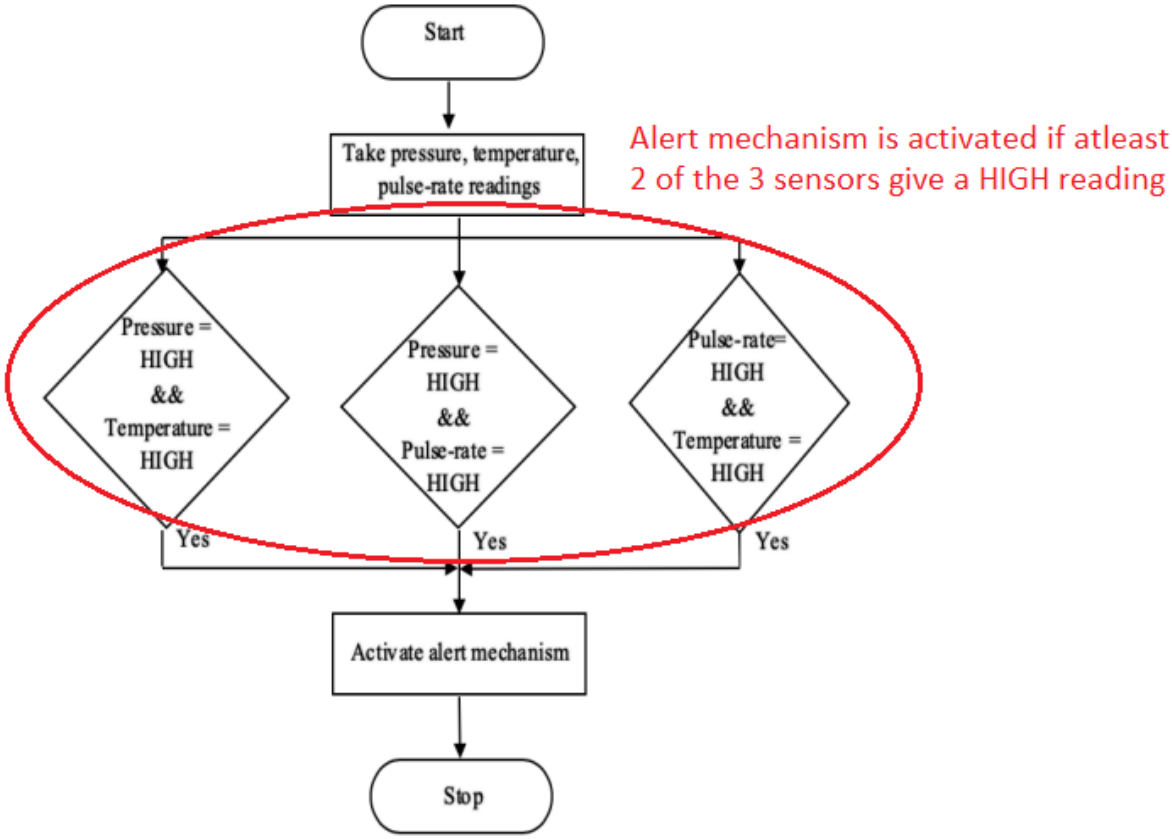
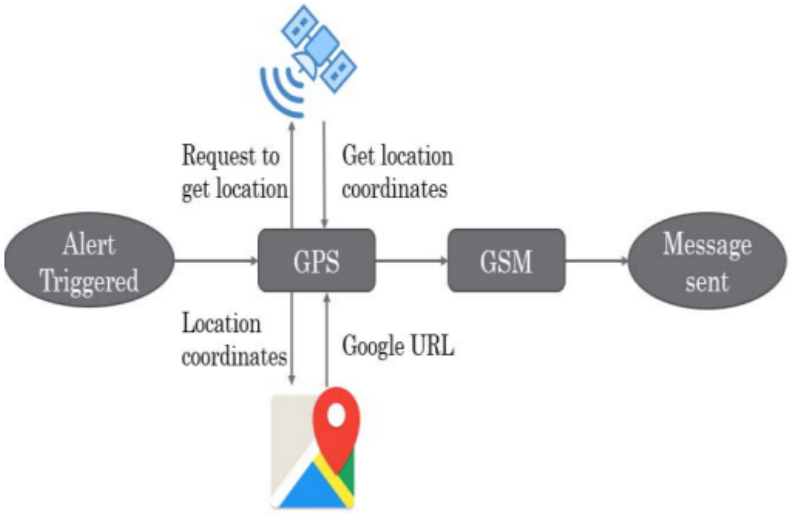


Figure : Flowchart for active alert mechanism

3. **Alert Mechanism** : This mechanism is activated after the above 2 mechanisms. Whenever there is a dangerous event, this mechanism gets triggered, and the GPS and GSM module comes into picture. GPS and GSM are used to send the location through google maps and send messages to the woman's family members.



Results

When the alert mechanism is triggered either manually or by the help of these 3 sensors, then the google maps link (victim's location) as well as a call for help was successfully sent by the system to the contact number which the victim has saved previously on the system. The automatic mechanism was successfully triggered when reading of at least two of the three sensors crossed the threshold. The notification was successfully received as follows:-

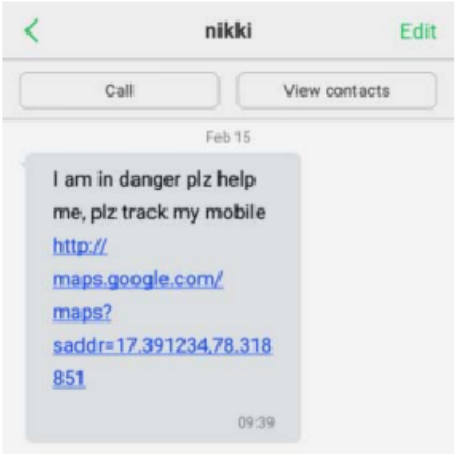


Figure : Notification successfully received from alert mechanism

This proposed system is the most preferred one as this system is very adaptable, i.e., if the victim is in her senses and is able to activate the buzzer, this system helps us to

become alert, also If she is not able to use the push button or not in her senses, then the alert mechanism of this proposed system helps her family/friends/people around her to get alert.

Major advantage of this proposed system is that this system is very light weight, easy to use and very cost-efficient. No internet connection is required in this setup as it directly contacts through satellite, the only single requirement of this system is that it need an active mobile signal for the sim card.

C. Conclusion

The proposed solution was successfully able to solve the intended problem of alerting family members of a woman if she is in danger. The advantages of such a smart wearable system is that it is lightweight, easy to use and very cost-efficient. Moreover, no internet connection is required in this setup as it directly contacts through satellite, the only single requirement of this system is that it needs an active mobile signal for the sim card.

The prototype may be transported in a purse or bag or worn as a smart watch, necklace or bracelet. It also has a lot of scope for improvement in the future. When the alarm mechanism is activated, the suggested system may be further enhanced to include features like capturing audio and video of the offender, which can then be used as evidence in court.

IV. Smart Thermal Jacket with Wearable Sensors using IoT

A. Problem Statement

The tremendous variations in climatic conditions from day to day mean that weather is never consistent in the modern world. Regardless of temperature variations, one must be prepared to travel outdoors in all types of climatic situations. Sudden fluctuations in the weather can lead to serious health issues including hypothermia and heat stroke. The aim of our project is to create a solution which will help beat the inconsistent weather conditions. Our project's major goal is to use the Internet of Things to make a smart jacket that automatically adjusts, monitors, and maintains the body temperature.

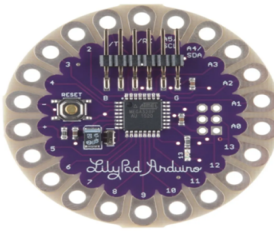
The jacket will have both cooling and heating systems. When the sun is intense, the jacket’s cooling system is stimulated and when it's too cold outside, the heating system kicks on.The jacket will also track the wearer's heart rate and alert them via an LCD and a mobile app.

B. Methodology and Results

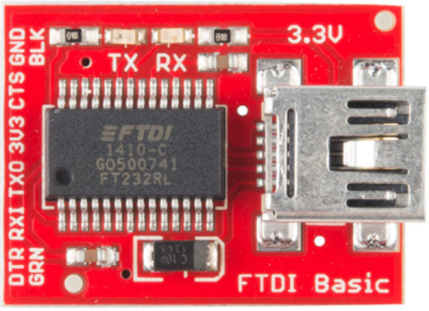
Methodology

A smart jacket is made based on lilypad ATmega328. Two separate circuits are responsible for heating and cooling mechanisms. It has the following components :-

1. **Lilypad ATmega328** :It is programmed by Arduino and incorporated with the wearable system. It runs in the 2.2V to 5.5V voltage range at 40mA and includes a 32 pin IC. For digital input and output, it contains 14 pins. It has a flash memory of 16kB.



2. **FTDI Breakout** : When directly connected, it is used to program Lilypad. The DTR pin automatically resets the Lilypad when a new code is uploaded. It operates at 3.3 to 5V.



3. **Wi-Fi Module ESP-8266** : It is used to add the complete TCP/IP capabilities to the system. This Wi-Fi module

facilitates communication between the microcontroller and the mobile application through the internet.

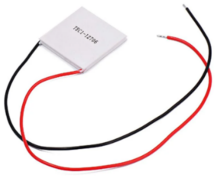
4. **Lithium-Ion battery** : Gives a 3.7V supply and is used to power up the system.

5. **Lilypad temperature sensor** : It recognises changes in ambient temperature ranging between -44℃ to 125℃.

6. **LCD Display** : This project makes use of a 16x2 LCD display where 32 crystals are used to display each character to display the temperature and heart rate readings of the person.

7. **Pulse Sensor** : It measures the heart rate of the person and is attached to the chest area.

8. **Peltier Module** : This is used to cool the body if the temperature rises above a certain threshold using thermoelectric cooling.



9. **Heating Pad** : It is used to warm the body if the temperature falls below a certain threshold.

Working

First, we use FTDI breakout to program the Lilypad. Atmega328 converts the temperature reading from binary to decimal form and displays it on the LCD screen. Next, it is checked if the temperature is greater than 30°C and if it is, then the cooling mechanism is activated. In the Peltier module, conductors are subjected to a voltage, which produces an electric current. Due to the current flowing across the joints of the two conductors, heat is removed at one junction and the cooling action is initiated.

If the temperature is less than 30°C, heating system is activated. The internal coils of the heating pad are used to control the temperature of the jacket and the temperature is also displayed on the LCD screen as well as a mobile application of the user.

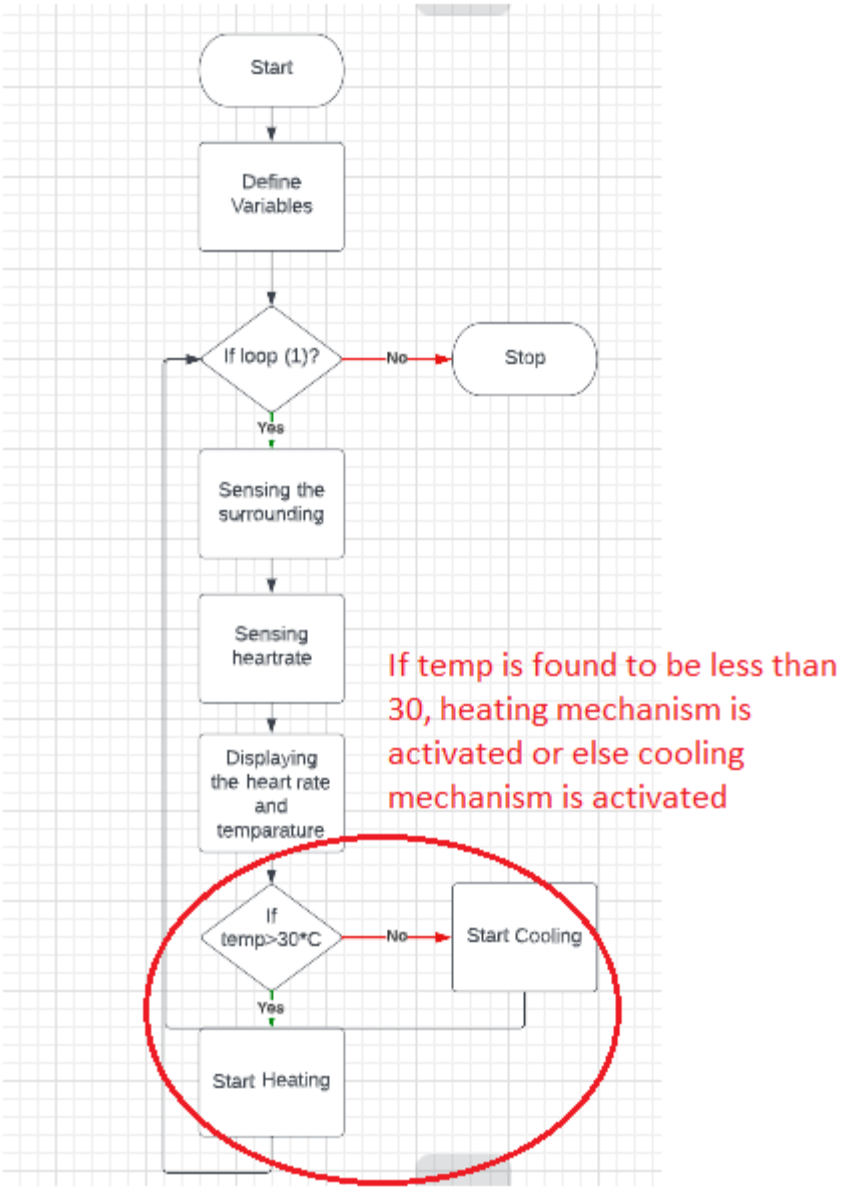


Figure : Block Diagram

Results

The jacket was successfully able to activate the heating and cooling mechanisms automatically according to the body temperature of the user detected by the temperature sensor. The LCD screen kept displaying the temperature and the jacket was also successfully controlled by the user through the mobile application :-

Figure : Results shown on mobile app

C. Conclusion

Hence, the proposed system was successfully able to monitor and control the body temperature and was proved very useful for people who have to work outdoors in extreme heat and cold temperatures. It can be further improved to monitor many more health parameters apart from temperature like humidity to make the wearable even more comfortable for the user irrespective of the weather conditions.

V. Wearables and the Internet of Things (IoT), Applications, Opportunities, and Challenges: A Survey

A. Problem Statement

Smart wearable devices are devices that use Internet of Things (IoT) to collect data by sensing various parameters and analyze them using microcontrollers or cloud by connecting the system to the internet and then take appropriate action using actuators depending on the analysis.

The objective of this paper is to discuss and analyze the various applications of the smart wearable devices and discuss their advantages over other conventional electronic systems.

B. Methodology and Results

To discuss the applications of Smart IoT based wearables, their applications are divided into four main subparts :-

Healthcare

In healthcare, smart wearable devices can be used for continuous monitoring of patients, remote monitoring of patients with chronic diseases like cancer and heart diseases.

1. **Wearables for Treatment and Rehabilitation** : First example of this is a smart wearable for walking. For people who have weakness or a disability in walking, the movements of the body are detected while walking and analyzed by the system to monitor whether they are able to walk properly. Similarly, a smart wheelchair can be made using sensors which can be connected to a mobile application via the internet. The user doesn't need a helper to operate the chair and can do it himself using the mobile application.

2. **Wearables for Health Monitoring** : Various body parameters can be continuously monitored using smart wearables. Pulse rate can be detected by smart wearable devices worn on the chest or wrists by changing pressure associated with the inhalation and exhalation during respiration. Body

temperature can be continuously monitored using temperature sensors like LM35. Average change in the body temperature may indicate whether or not the user has fever. Similarly, oxygen level in the blood and blood pressure are also monitored.

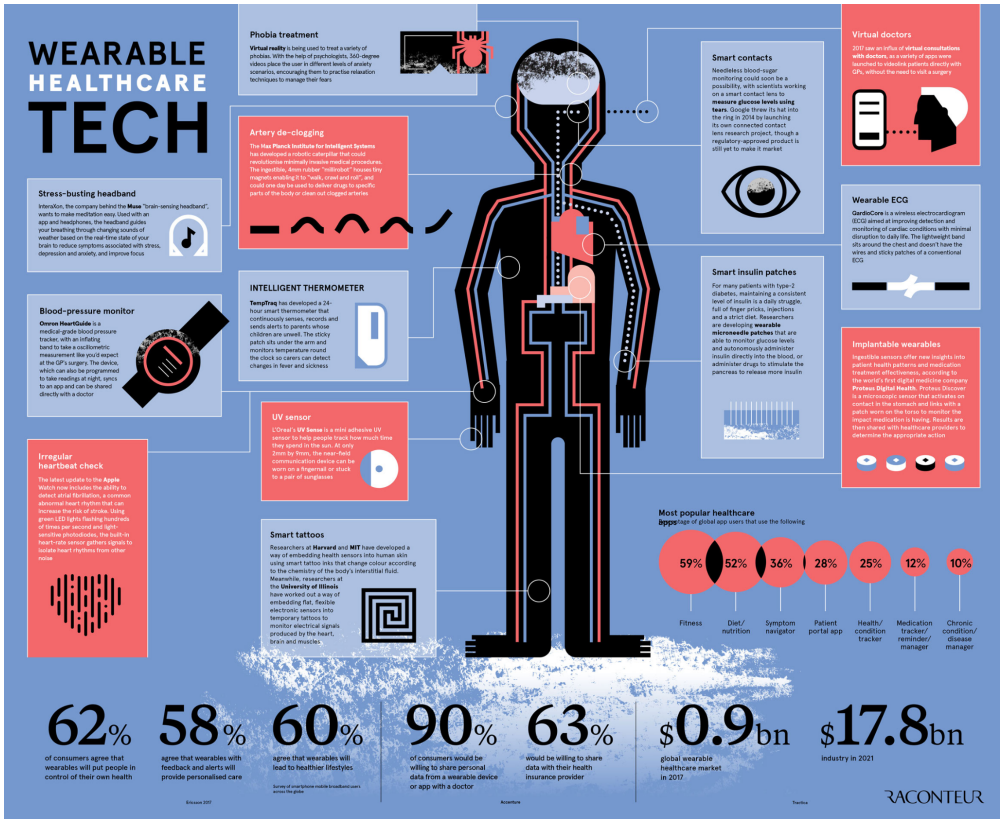


Figure : Smart wearables in healthcare

Sports/Activity Detection

Smart wearables can be used to monitor the physical activity of a person continuously such as the distance walked, calories burned to monitor the physical wellbeing of the person. Along with this, these wearables can also use machine learning and classification algorithms to train models using the daily data of activities and classify them as different activities such as walking, running, cycling, weight lifting and others.

These wearables also prove to be very useful in sports. The health parameters and activity parameters of various body parts of athletes are monitored. These are used by the coach to train them better, and they can also indicate whether or not the athlete is fit. This data can also be used to analyze and train the athletes better, using parameters like speed of the athlete, angle of bend, force and timing.

Figure : Smart wearables in fitness and sports

Continuous Tracking

IoT smart wearables can be embedded with GPS trackers. These can be used to continuously track humans, animals or assets. The GPS sensors collect the latitude and longitude readings and send the data through the internet. This data is available in the form of visual maps on the mobile applications.

Fall Detection

For elderly people, accidental falls are very common. It is very important that they receive help immediately if it happens. Fall detection wearables have accelerometers and gyrometers. They are trained to differentiate between normal day to day activities and an abnormal event such as fall.

Results

Thus, we conclude that the IoT based smart wearables are very useful in various aspects of life. However, after analyzing the various types of wearables, we conclude that the various challenges related to the wearables are :-

1. **Resolution of Sensors** : Smart wearable devices have low power capacity and hence, the sensors used often have low resolution which makes it difficult to take precise measurements.
2. **Power** : For continuous monitoring of parameters, the wearables should have a wireless power source providing sufficient battery life, which is difficult to find.
3. **Comfort** : As humans will be wearing these wearables for long hours, it is extremely important to incorporate the sensors and other components in a compact and comfortable material.
4. **Privacy** : Smart wearable devices continuously gather personal information and send them through the internet for analysis. It should be made sure that only authorized data is being shared with consent from the user.

C. Conclusion

Thus, we conclude that smart wearables are extremely useful. They provide cost effective and lightweight solutions in various aspects of life. However, there are still a lot of challenges that need to be overcome to create usable, comfortable and compact wearables for various functions using IoT. With further research and development, smart wearable devices can go a long way for mankind.

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