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Women Safety Device Designed using IoT and Machine Learning

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Abstract - **Women safety is a very important issue due to rising crimes against women these days. Presently there is indeed no good solution to this problem. The existing applications and devices are not much effective as they need lot of human interaction to operate. These existing devices use to read the human temperature and heartbeat to generate alarm in case of emergency. When a person runs, every human may have different body temperature and heartbeat pattern and thus keeping a fixed threshold for finding out emergency situation and then generating alarm is not correct way and this is where the existing devices are failing to correctly generate alarm in case of emergency. In this paper the device are customized to learn the individual pattern of temperature and heartbeat and then it finds out the threshold for generating alarm. Thus this paper deals to design a wearable women safety device that automatically reads and create patterns such as body temperature and pulse rate during running. If readings are higher than the normal readings then it will automatically call and message more than one person along with the location so that actions can be taken. We have used temperature and pulse sensors that will detect the activity of the woman and that data of sensors will be sent to cloud where machine learning algorithm is applied to analyse the data generated. The data is first collected by sensors in non-danger conditions to train the algorithm, after that data is used for testing to gauge the accuracy and how close it is to our trained data. More is the accuracy more is the surety of danger and the emergency alarm will be there on emergency contacts. Thirdly, this paper deals with scenarios where there is no internet facility. To overcome the problem of internet we have used ZigBee mesh network, which helped the device to send the data to multiple hop distance.**

I. INTRODUCTION

Women are still facing unfortunate incidents like molestation, rape, acid attack etc. Many applications and devices are already there in the market but those are ineffective as they need to be manually operated. Since the mental state of the women is affected in danger conditions and sometimes it's not possible to operate them manually. So a solution was required which could eliminate the human effort to operate the device. So we came up with the idea of using machine learning algorithm to detect the danger automatically on the basis of biological changes like temperature change and pulse rate change that occur in human body when it is in danger. So our device contains temperature and pulse sensors that continuously collect data and send that to cloud for computations. Cloud contains machine learning algorithm (logistic regression) which is trained with the actual data of danger and non-danger conditions and compute the incoming data on the basis of the training given to algorithm. On the basis of prediction done by computations, if danger is there then automatically an emergency alert message and call is sent to emergency contacts along with the location of the victim. This paper deals with scenarios where there is no internet facility. To overcome the problem of internet we have used ZigBee mesh network, which helped the device to send the data to multiple hop distance. By using zigbee mesh network, the proposed device can even work in any remote location where there is no internet.

II. LITERATURE SURVEY

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Various work that are existing this area are as follows:

A. Design and Development of "Suraksha"-A Women Safety Device- This paper explains the basic idea underlying suraksha which is to flash a warning giving an instant location of the distressed victim to the police so that the incident could be prevented and the culprit apprehended [1].

B. One touch alarm system for women's safety using GSM- This paper describes about a one touch alarm system for women's safety using GSM. In the light of recent outrage in Delhi which shook the nation and woke us to the safety issues for women, people are finding up in different ways to defend. Here we introduce a device which ensures the protection of women. This helps to identify protect and call on resources to help the one out of dangerous situations. Anytime you senses danger, all you had to do, is hold on the button of the device. The device consists of a PIC microcontroller, GSM module, GPS modules. The system resembles a normal watch which when activated, tracks the place of the women using GPS (Global Positioning System) and sends emergency messages using GSM (Global System for Mobile communication), to sos contacts and the police control room [2].

C. SHE (Society Harnessing Equipment): It is a garment embedded with an electronic device. This garment has an electric circuit that can generate 3800kV which can help the victim to escape. In case of multiple attacks it can send around 80 electric shocks.

D. ILA security: The co-founders of this system, have designed three personal alarms that can shock and disorient potential attackers and hence safeguard the victim from perilous situations.

E. AESHS (Advanced Electronics System for Human Safety) It is a device that helps track the location of the victim when attacked using GPS facility [3].

F. VithU app: This is an emergency app initiated by a popular Indian crime television series "Gumrah" aired on Channel [V]. When the power button of the Smartphone is pressed twice consecutively, it begins sending alert messages with a link of the location of the user every two minutes to the contacts.

G. Smart Belt: This system is designed with a portable device which resembles a normal belt. It consists of Arduino Board, screaming alarm and pressure sensors. When the threshold of the pressure sensor crosses, the device will be activated automatically. The screaming alarm unit will be activated and send sirens asking help [4].

Comparison: Main drawback of these devices and applications is that all of them come under non-automated systems and therefore in situations like sudden unconsciousness due to fear, weakness or when you are sleeping if someone attacks on you, you won't be able to protect yourself with these things neither anyone will aware of your trouble but our body temperature and pulse rate will definitely undergo some changes indicating any attacks. That is the reason we come up with this idea. Earlier solutions were not capable of working both in internet and non-internet conditions. Also the earlier devices involved more human involvement for initiating the emergency alarm whereas in our solution we have tried to make the device self-capable of taking decision for the user. Our device can be trained by the user with its own individual data i.e. it is a customized solution which will work differently for different people.

III. PROPOSED SYSTEM

Automatic danger detection system that can call people and send message to emergency contacts when woman is in danger and also works in case of no internet. It contains a push button as well for alarm generation for the cases where it's possible for women to operate.

This proposed system consists of wearable device that contains sensors that read body temperature and pulse rate continuously and sends it to Arduino board that is also there in the device. Arduino sends this data to gateway. From gateway, all this data is sent to cloud and gets stored in cloud. All computations and machine learning algorithms execute in cloud continuously. Initially we had collected some of the training data with the help of mobile apps that can measure temperature and pulse rate in various danger and non-danger conditions. We used logistic regression algorithm for machine learning and used this training data to teach our algorithm about various danger and non- danger conditions and how to behave. Than prediction on actual data is done whether danger is there or not. Cloud sends this

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information back to gateway and from gateway, it comes back to Arduino. At Arduino, GSM Modem (Global system of mobile communication) is present. That GSM Modem calls and sends messages to the emergency contacts if prediction of danger is there along with the location of the victim that is taken using GPS that is there in the device.

IV. ARCHITECTURE OF PROPOSED SYSTEM

The IOT architecture which this paper uses is as follows: It starts from sensors (pulse and temperature sensor) that collect the data and then send it to microcontroller unit (Arduino) that sends that the data to a gateway. The whole communication forms a mesh network. The gateway sends that data to cloud and then machine learning algorithm is applied to analyse the data. After all the computations are done on cloud the accuracy is received which tells whether the women is in danger or not.

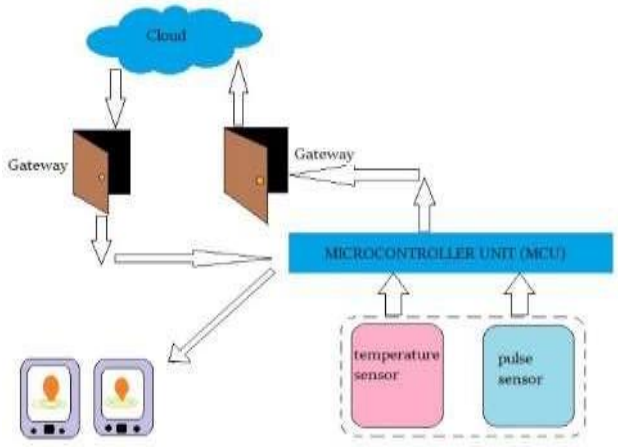

Fig. 1: Shows Architecture of Proposed System

That result is sent to gateway and which is attached to Node MCU. The NodeMCU contains a GSM Modem that sends the result to emergency contacts. As we already discussed that in a scenario when there is no internet and what will happen if women feels treat in that point of time. The solution to this problem lies in Zigbee where the information send by women can be escalated to larger distance using the multiple hop communication facility of zigbee. The IoT architecture for the same is given below: According to the IoT Reference Model published by the IoT World Forum, this paper sticks to the architecture given below and has following layers:

Physical Devices & Controllers: The primary function of the sensors is to generate data and being capable of being queried or controlled over a network. Connectivity: This layer is required for communications between different sensors in Layer 1 and reliable delivery of information across the network. ZigBee modules are used for connecting devices. Edge Computing: This layer is needed to evaluate and reformat data collected from the sensors for processing at higher levels and assessing the data for alerts and notifications. Data Accumulation: This layer captures the data and stores it so that it can be used by applications whenever necessary. Data Abstraction: This layer reconciles multiple data formats and ensures consistent semantics from various sources. In this paper there is no data abstraction as we are receiving the data as the data send by the ZigBee module.

V. PROPOSED ALGORITHM

Machine Learning Algorithm

In this paper we have used Logistic regression to predict the danger more accurately which is based on many parameters. As the training data was already prepared by using the sensor values generated by individual person and the danger and non-danger conditions were taken into account for the person who is wearing the band. This algorithm enabled us to predict the danger on the basis of the data provided to it. Thus, the accuracy also depends on the trained data the sensor is providing.

Logistic Regression Using Python

Logistic Regression is a classification algorithm. It is used to predict a binary outcome (1 / 0, Yes / No, True / False) given a set of independent variables. To represent binary / categorical outcome, we use dummy variables. This section will provide us a brief background on the statistical technique that we have used to predict the danger. The danger indicator is categorical (binary) and has values Yes (danger is there) or No (danger is not there). The probability of danger(P) is to be modelled as a function of the independent variables pulse rate and body temperature. This function cannot be linear since, theoretically, the predictions can range from -∞to +∞but probabilities lie between 0 and 1.Hence a non-linear transformation , log odds (Logit), is applied to

the dependent variable which is then expressed as a linear function of the independent variables in the following manner:

$$Log\left(\frac{\Pi}{1-\Pi}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 \qquad (1)$$

The corresponding probabilities of enrolling can be obtained by transforming back the estimated Logit equation to the following probability form:

$$\Pi = \frac{e^{\alpha+\beta_1 x_1+\beta_2 x_2}}{1+e^{\alpha+\beta_1 x_1+\beta_2 x_2}} \qquad (2)$$

x_1, x_2 in equation (2) are input variables (pulse rate and body temperature.

VI. EXPERIMENT AND SIMULATION SETUP

Various hardware used for this research are as follows:

Arduino ATmega328 Board

The Arduino can be programmed with the Arduino software. It has its own programming language which is very easy and also can be coded with java, c ++.

TEMPERATURE SENSOR

Human body temperature is of vital importance to maintain the health and therefore it is necessary to monitor it regularly. We can measure the body temperature using various temperature sensors. For instance, LM35 series are precision integrated circuit sensors whose output voltage is linearly proportional to the Celsius temperature. It operates linearly +10.0mV/°C scale factor with 0.5°C accuracy. In emergency cases body temperature varies drastically which can trigger module for rescue [6].

PULSE RATE SENSOR:

Heart beat sensor gives digital output of heart beat. When heart beat detector is working the led flashes for every heartbeat. This digital output will be connected to microcontroller directly to calculate the beats per minute (BPM) rate. It works on the principle of light modulation of networked satellites and are tracked to uplinks data for synchronization. The system uses four frequencies in the L band which ranges from 1.2 to 1.6 GHz [7].

GPS MODULE

Global positioning system (GPS) is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from various satellites to reach the receiver. In six different orbits approximately 12,500 miles above the earth, 24 MEO (Medium-Earth Orbit) satellites revolve around the earth 24 hours and transmit location every second as well as present time from atomic clocks and by monitoring blood flow through skin when is in contact with the wrist band at each pulse [8].

GSM MODEM:

GSM is used to send data from control unit to base unit .We can use GSM 300 which operates at frequency 900MHz. It has up link band of 890MHz to 915MHz and down link Band of 935MHz to 960 MHz GSM takes advantages of both FDMA & TDMA. In 25MHz BW, 124 carriers are generated with channel spacing of 200 KHz (FDMA). Each carrier is split into 8 time slots (TDMA). At any given instance of time 992 speech channels are made available in GSM 300 [8].

Fig. 3 shows the connectivity of the hardware, used in this paper. For temperature sensor and pulse sensor we have taken analog input. And to connect GSM SIM800 Modem and GPS to Arduino, we connected Rx and Tx of GSM and GPS with Tx and Rx of Arduino respectively.

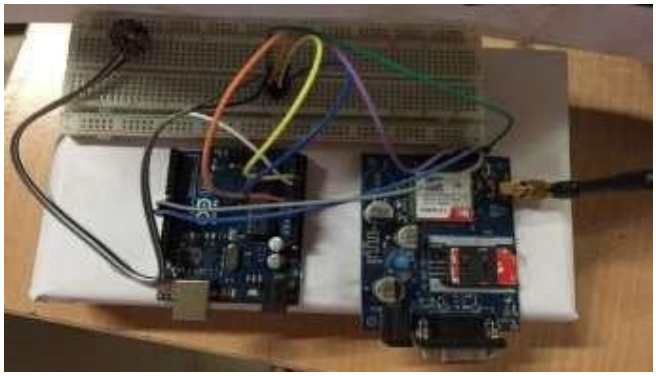

Fig. 2: Connections between sensors, Arduino and GSM modem

Procedure for creating Mesh Network

The same working model of the paper shown in fig.3 are built over zigbee module which are placed at 4 different places. To create a low-powered mesh network, we make use of the ZigBee boards, commercially known as Xbee boards. To use Xbee, we have to configure it and set some parameters which are necessary to create a network. For this paper, we

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make use of ZigBee S2C module. The new module is powerful with both UART & SPI communication.
ZigBee defines three types of devices:
The Coordinator: This device starts the network, selecting the channel and PAN ID and distributes the address using which other devices connect to the network.The Router: A router is a full featured ZigBee node. This device can join existing networks and send, receive, and route information. Routing involves acting as a messenger for communications between other devices that are too far apart to convey information on their own.

The End Device: An end device is essentially a reduced version of a router. This device can join existing networks and send and receive information, but cannot act as messenger between any other devices and also cannot allow other devices to join the network.We can configure a ZigBee module in any of the three modes described above. The ZigBee module being used in this paper is of XB24C Product family with firmware version 405F.

Collecting Data set

Temperature and pulse rate were checked using different applications at different conditions as shown in fig.3.

Fig. 3: Data of pulse and temperature of a person after running under some specific circumstances were collected from two different mobile applications (android/iPhone) .That data was used to train our machine learning algorithm.

We collected 500 data entries as shown in figure below that were used in algorithm for training and testing.

PULSE READING	BODY TEMPERATURE(CELSIUS)	DANGER(1)/NO DANGER(0)
82	37	0
85	38	0
140	37	1
81	35	0

Fig. 4: Type of data collected for training and testing machine learning algorithm

The Zigbee module used will only operate if at all there is no internet. The data will travel from end devices to routing devices and from there to PAN coordinator. The end devices send the data to router and from there PAN coordinator within mesh. It can be noted that we can attach as many routing devices working over Zigbee and that's how we can increase the range (in terms of distance covered) of data travelling to multiple hops and then reaching to gateway which is attached to internet.

VII. Results and Analysis

This system will predict whether a women is in danger or not on the basis of her pulse rate and temperature. If she is in danger then it will automatically call to the necessary contacts. We came up with idea to reduce human interaction with the mobile phones. For prediction part, the paper used Machine learning algorithm - Logistic Regression. The machine learning algorithm will take parameters like pulse rate and temperature from excel sheet which is directly linked with Arduino. For taking parameters from Arduino to excel, the paper have used TeraTerm software. Then algorithm will perform computation and will plot the graphs of training data set and testing data set.

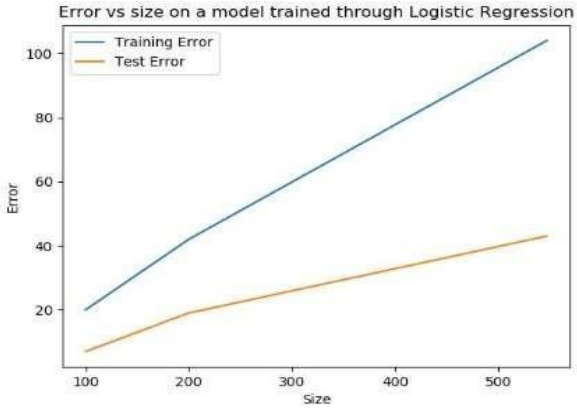

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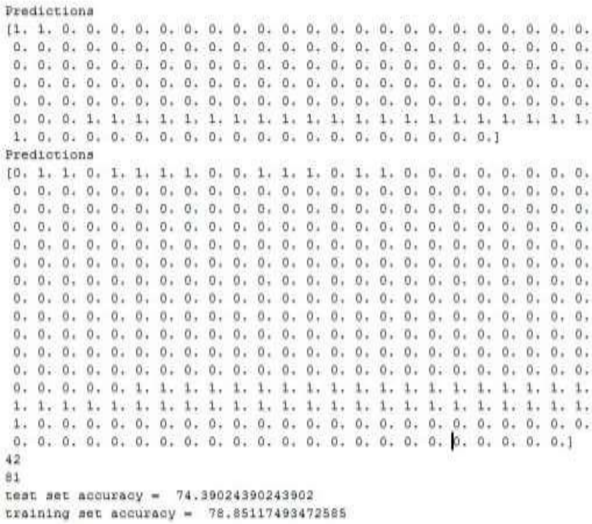
Fig. 5: Graph between the size of the data and the error percentage that is increasing according to increasing dataset.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Predictions
[1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
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Predictions
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 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
42
81
test set accuracy =  74.39024390243902
training set accuracy =  78.85117493472585
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Fig. 6: Prediction of dataset on the basis of training data i.e. danger or not danger. Finds the accuracy of training and testing dataset.

If the accuracy is more, prediction will be more accurate. If prediction results danger then it will automatically send alert to the necessary contacts. In danger, presented system will automatically get activated and dial call to the emergency numbers. If woman is predicted to be in danger, then system will call on 2 given numbers as shown in fig.5.

Fig.7: Shows the final result where after predicting danger emergency calls are being done to two different numbers.

VIII. Conclusion

This paper fulfils the objective of women security and moreover this device can be used by women while travelling alone on roads, in public transport or even at workplaces. It helps us to analyse the severity of crimes against women and also be beneficial for reducing rate of sexual harassment. Secondly, another problem lies with these solutions are that they won't work if at all there is no internet. To provide the solution for that this paper has used zigbee and created mesh network which helped us to transfer the vital information related to women safety to a much larger distance.

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