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A Novel ML-Supported IoT Device for Women Security

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Abstract - *Globally, Women harassment has become a major challenge on a serious note. Many devices and approaches have been proposed towards the women security, but most of them are not completely automated. The present devices need human interaction to perform their task. Considering this limitation, with new approach using the technologies like internet of things and machine learning models to predict women under threat. The Device is built with a raspberry pi-supported device that consists of the heart rate sensor and temperature sensor. These values are fed into a logistic regression model, it takes the sensor values from the device and use them to detect whether a woman is in danger or not. It is also connected to an online portal which initially takes information like age, location, occupation, and emergency contacts, it helps to improve the prediction of user status. The device detects the user who is in danger and instantly forwards the location, heart rate and temperature to the nearby police station and the contacts mentioned in the online portal. In this way, without using any human interference, the device rescues the women.*

Key Words: GPS, Internet of Things, Machine learning, Online portal, Sexual harassment, SMS, Women safety

1.INTRODUCTION

No matter how developed a country is, there are always some situations where women face incidents like acid attacks, harassment, rape, murder, molestation, etc. The cases like Justice Clarence, Disha, Nirbhaya, the murder of Oksana Makar, Houston gang rapes are the topmost cases in women harassment and murder. After research, it was concluded that most of the women face sexual harassment in their work pace and living neighbourhood. Sexual harassment has been a fixture of the workplace since women first began to work outside the home [1].

To solve these problems faced by the women, many students and engineers came up with many solutions such as sending an alert message through one click, smart bands, mobile applications, etc. When these solutions are deeply observed, we realized that none of them is completely automatic, because we cannot expect a victim to perform even a simple operation when she is going to get exposed to sexual harassment. Though there are many devices and methods which were developed to control these criminal acts, still there are some limitations because of which they cannot be used as a real-world application. A pulse detecting device was developed which detects the pulse rate and if it crosses the threshold value it sends an alert message, but in some situations, the device may even send the message if the person using the device might be under some physical exercises.

After A brief study on the limitations of these devices, we came up with the idea of developing a device that combines both internet of Things and a Machine learning algorithm. The device consists of a Pulse detecting sensor along with a temperature sensor. These sensors constantly collect data and forward it to the cloud. The cloud carries a machine learning algorithm. This machine-learning algorithm intakes the sensor values forwarded by the sensor and detects whether the women are secure or not, if the women are detected as she is in danger a message will be forwarded to the family members and the nearby police station along with the GPS location of the victim. In this way, the alert can be passed at the right moment and completely automated without any human interaction.

2. Related Work

Many researches developed multiple devices and below mentioned projects are some of well-known projects.

2.1 Schemes related to women safety

A. **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 [2].

B. **Smart band:** Which is integration of Arduino, temperature sensor, heart beat sensor and the device which is used to send alert message to only connected Smartphone when she is in abnormal situation [3].

C. **SHE:** Garments which has an electrical circuit & generate 3800kV [4]. It will generate 82 electric shocks, which will help women escape from the situation in case of multiple attacks [5].

D. **VithU app:** It is a mobile app, which will be providing security for women while in emergency situation. When pressing only 2 clicks of power button in the smart mobile, this app will get activated & send out alert SMS and location to saved contacts every 2 minutes [6][7].

E. **Mobile Gesture:** The paper [8] proposes an emergency response situation recognizing app called as IPROB to provide women safety even in the situation like terrorist attacks or natural disaster, by just shaking the mobile above the predefined threshold value automatically activate the system [9].

F. AESHS: (Advanced Electronics System for Human Safety) It is a device that helps track the location of the victim when attacked using GPS facility [10].

G. 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 sense 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 [11].

H. I Safe APP: A mobile-based women safety application (I safe Apps). In this paper, mobile-based application (I safe apps) is developed with the Android support to know whether a woman is safe. It gives the location of the woman in danger by giving fake phone calls, video forwarding, location and first-aid information.[12]

2.2 Analysis:

After a brief study on each device mentioned, we could analyze that the main drawback of these devices and applications is that they are not completely automated, which means these devices must have human interaction as their trigger to perform their operation. Considering these limitations, we came up with a device that doesn't need any kind of human interaction whereas it takes the parameters such as age, heart rate and temperature of the user as its trigger and performs its operation according to it.

3. Proposed Model

The device which we are presenting has the capacity to detect the emergency situation of a woman and also sends the information along with GPS to the nearby police station as well as family members. It also contains a small button when a woman feels she is going to be in a danger, although the device is completely automatic it's just an emergency option for the user.

The device is going to be in a form of fist bands just like the other colorful and designed one. This band has an inbuilt sensor which tracks the heart rate just like a fit-bit as well as the temperature of the person using it. These sensors work constantly when the user attach it as a band to their hand. These sensors forward the data to the cloud and there by machine learning algorithm is applied on the sensor data and predicts whether the user is in danger or not. The data of the user from an online portal is also forwarded to the machine learning algorithm to make the prediction more accurate.

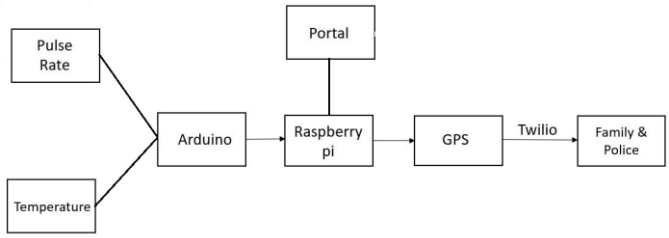

Fig:1 Block diagram of proposed architecture

4. Prototype:

This is the section mentioning all the hardware equipment's and software implementations we used for this paper:

1. **Online Portal:** Every device has a unique IP address and these IP addresses are connected to an online portal. The online portal is available as a website and also a mobile application where the user initially fills in the details like Name, Age, home and work location, previous medical issues etc. This information helps the machine learning algorithm to predict more accurately.
2. **Arduino UNO:** The Arduino Uno is a microcontroller board grounded on the ATmega328 (data sheet). It consists of 14 digital input/output pins (out of which 6 can be utilized as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a facilitation for USB connectivity, a power jack, an ICSP header, and a reset button. The Temperature sensor and the heart rate sensor are connected to this Arduino board [13].
3. **Pulse rate sensor:** The heartbeat sensor gives a digital output of the heartbeat. When the heartbeat detector is working, the LED flashes for every heartbeat. This digital output will be connected to the microcontroller directly to calculate the beats per minute (BPM) rate. It works on the principle of light modulation of networked satellites and is tracked to up links data for synchronization. The system uses four frequencies in the L band, which ranges from 1.2 to 1.6 GHz [14].
4. **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 [15].
5. **Raspberry Pi:** Raspberry pi is one of the strongest single board computers. It does this by providing low-cost, high-performance computers that people use to learn, solve problems, and have fun. The Raspberry Pi is our project is used to intake the sensor values from the

Arduino board, and it is responsible to perform the machine learning algorithm on the sensor data. Raspberry Pi works on python programming; hence the machine learning code is written in python language. Once the algorithm detects a threat, it sends the GPS location as a short message service (SMS) with the help of Twilio (A third-party application used to send messages through IoT devices and other applications).

6. **GPS Module:** The GPS U-Blox 6m module as shown in Figure 3 is a kind of stand-alone GPS receivers that feature high performance as a positioning machine [16]. With optimized architecture, power, and memory. This module is perfect for devices that use the battery as a resource, with limited cost and space, making it very suitable to use on CanSat. By having 50 channels of positioning engines, it can accelerate Time-ToFirst-Fix (TTFF) to less than 1 second [17].

5. Proposed Machine Learning Algorithm

Considering the sensor values all alone may not give the right information of the particular user's scenario, to come up with this limitation we implemented a machine learning algorithm to better understanding and prediction of the user's scenario. The algorithm intakes the sensor values along with the information from the online portal and uses these parameters in the Logistic regression to predict the situation of the user more accurately.

5.2 Logistic Regression

Logistic Regression is a classification algorithm used mostly for the prediction of categorical variables. It helps to predict the binary values as the output, for example, 0 / 1, False / True, Yes / No. This section is provided with brief information about the statistical technique that we used to predict the menacing situation of a woman. The indication of the dangerous situation can be considered as a categorical variable and has the value of 1 (in danger) and 0 (not in danger). The model of the probability of danger is a function of the pulse rate and body temperature. The chart-1 mentioned below reflects a relation between temperature and heart rate. As the heart rate increases, the temperature increases too.

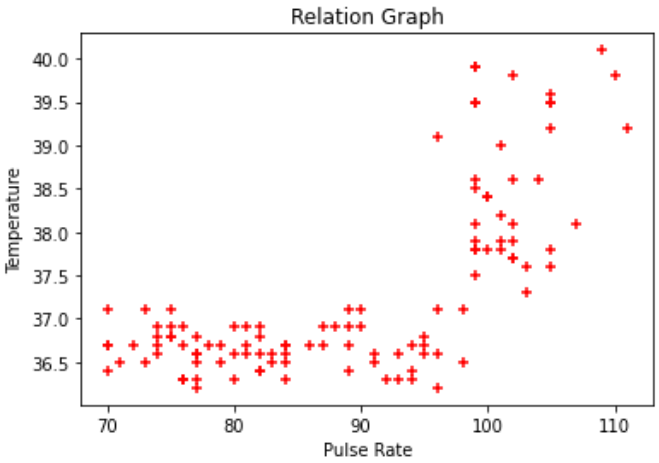

Chart-1 Relation between Pulse rate and Temperature

The Dependent variable can be expressed as a linear function of the independent variable in the following manner:

$$\mathbf{Log}\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \qquad (1)$$

The corresponding probabilities can be retrieved back by the estimated log equation to the following probability form:

$$\mathbf{P} = \frac{e^{\beta_0+\beta_1 x_1+\beta_2 x_2}}{1 + e^{\beta_0+\beta_1 x_1+\beta_2 x_2}} \qquad (2)$$

here x1, x2 can be represented as the heart rate and temperature values.

As we mentioned we used a data set which consists of variables like Name of the user, age, pulse rate, temperature and condition as mentioned in the Table-1.

TABLE I
SAMPLE DATA SET

Name	Age	Pulse Rate	Temperature	Condition
Eden	26	86	36.4	0
Mariam	24	85	37.1	0
Taniyah	27	109	40.0	1
Niharika	29	87	36.9	0
Naga Priya	23	114	38.4	1

6. Result and Analysis

We successfully developed a device that has the capacity to detect the heart rate and temperature of a woman, analyze the readings given by these sensors and the online portal, it performs a machine-learning algorithm to predict whether a woman is in danger or not. If the device detects that the user is in danger, then it forwards the location of the user to the nearby police station as well as family members. As we

mentioned, for the prediction part we choose logistic regression, which takes the parameters like age, pulse rate and temperature. Finally, by analyzing all these parameters, the algorithm predicts the condition of the women.

6.1 Online Portal

The online portal is a beneficial feature to the device. It initially takes the values like age, emergency contact numbers and other past medical complications from the user when they start using the device. The portal is developed using HTML, CSS, JavaScript and PHP. It uses Google Firebase as a platform to send the details of the user to the machine learning algorithm in a CSV format. These details from the portal help the machine learning algorithm to predict the complexity of the women situation more accurately. The portal is responsive for both web and android application. The user interface of the online portal is mentioned in figure [2] which consists of details like Name, Occupation, Age, Contact, Emergency contact, Home and Work location, Previous Health issues.

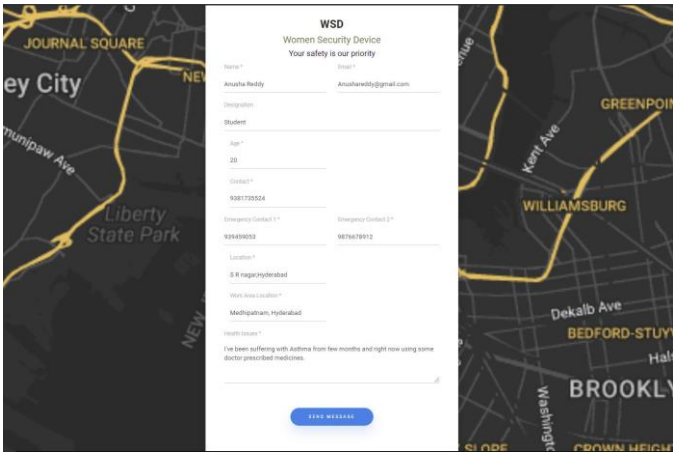

Fig:2 Online portal User Interface

6.2 Prediction Results

As we mentioned we used the concept of logistic regression for this paper, we used multiple libraries like pandas, NumPy, Matplotlib, seaborn, SKlearn for the data analysis, mathematical calculations, data visualization, data splitting, and data re-presentation. We used the fit function to fit our train data set into the regression model and then compared the test data set with the predicted data set. In the conclusion, the model achieved 89.28% of accuracy as mentioned in the figure [3].

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Prediction based on trained dataset:
[0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0
 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0
 0]
The accuracy score between test set and predicted test 89.28571428571429
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Fig:3 Prediction and accuracy output

6.3 GPS and Message

Once when the system detects that the women is in danger, it sends the location as a message to nearby police station as well as family members. Now this is done by using the NEO 6-M GPS module which is connected to the Raspberry Pi as mentioned in the prototype. Once after the detection the GPS module gets activated and by using the Twilio library in python a short message service (SMS) is forwarded which includes location, heart rate and temperature of the user as mentioned in the figure [4].

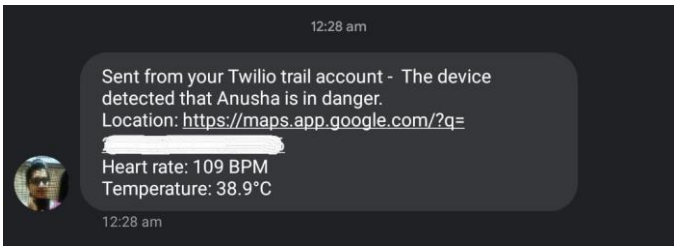

Fig:4 Message sent by Twilio

7. Conclusion

Compared to any other women safety devices, we developed this device which is completely automated without any human interaction. The online portal gave adequate information and had some impact on the ML algorithm, it achieved 89% of accuracy in the prediction test. The working of the device was quick, and it forwarded the data to the Raspberry Pi within a very short time with more accuracy. Finally, we developed a device which can be carried by a woman while working, travelling, exercises and other day-to-day activities and eventually keep herself safe and secure all the time.

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