

**RAPE DETECTION AND PREVENTION SYSTEM USING IOT AND MACHINE LEARNING**

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An information system project proposal submitted to the faculty of information technology in partial fulfilment of the requirements of the award of a degree in Information and Computer science.

Date of submission: 16 June 2020

# Declaration

I declare that this project has not been submitted to any other university for the award of Bachelor of Science informatics degree

Admission Number: 102008

Signature …………… Date……………………

I certify that this work is being submitted for examination with my approval.

Supervisor name: James Gikera

Signature …………… Date…………………..

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# Abstract

***Keywords: IOT, Machine Learning, Gender Based Violence.***

*Gender based violence is a recurrent predominant disorder in the society. There are actions that have been taken to suppress the situation but most of the incline to be unsuccessful.*

*Women tend to be easily targeted when they are alone or highly intoxicated. Thereafter, the victim may try to reach out to people or report the incident to the police, but the response time tends to be long and the reported case may not be treated with the seriousness it deserves due to factors like lack of evidence or unclear reports by the victim.*

*The aim of this project is to reduce response time by reaching out to a number of people at once, provide evidence of physical struggle and possibly prevent the abuse from occurring. The proposed system is in two segments IOT and Machine Learning. The IOT will include sensors to check the pulse rate, GSM and GPS modules that will facilitate communication with the selected contacts and the Machine Learning segment: creating a model that will be used to detect any signs of physical struggle and later a report will be generated with regards to the data collected. The report may be used for evidence.*

# Chapter 1: Introduction

## Background

Gender based violence (GBV) is violence against women based on women’s inferior status in society which is considered to be a human rights violation. According to United Nations General Assembly in 1993, it takes forms such as Physical, psychological violence within the family, Trafficking in women and sexual abuse (Centre, 2014). It can be enacted by members of an army, terrorist organization or just a civilian.

The data availed at the Centre’s Website indicates that since 2001 to date, the Centre has supported over 21,341 survivors of GBV, of whom 56% were women and 36% girls. In Kenya, 45% of women aged between 15 and 49 years have experienced either physical or sexual violence; One in five Kenyan women (21%) has experienced sexual violence. Most violence is perpetrated in familial relationships where the perpetrator is known to the victim, strangers account for only 6% of GBV in Kenya and most violence towards women is committed by an intimate partner, (Centre, 2014)

There are sites for GVB;

Community/Society- This is a group sharing common social, cultural, religious or ethnic belonging, it perpetuates existing family structure and power inequalities in the society.

Family- This is the arena where physical abuses (spousal battering, sexual assault, sexual abuse) and/or psychological abuses occur. Domestic violence can also take such forms as confinement, forced marriage of woman arranged by her family without her consent, threats, insults and neglect. Given that violence within the family and household takes place in the home, it is often seen as a ‘private’ issue and information about it is lacking. ( Minnesota Advocates for Human Rights, 2003).

In 2007, Kenya experienced post-election violence which brought a lot of disorder amongst its citizens. There were extremist groups or malicious individuals that would go from house to house, to torture the inhabitants; destroy their belongings and even to an extreme of sexual violence women. This was to impose punishment due to the ethnical classes and some would take advantage of the fact that measures were not being and also people lived in and hence the women couldn’t defend themselves.

Alcohol and drug abuse such as cocaine influence an individual’s tendency towards violence. The respondents of the 1991 National Criminal Victimization Survey perceived more than one fourth of violent criminal assailants to be under the influence of alcohol, less than 10% of these assailants were reported by victims to be under the influence of illicit drugs. Of these, more than half were reported to be under the influence of both alcohol and drugs (Parker & Auerhahn, 1998).

The numbers of unemployed youth are increasing to a point they would opt to commit crime in order to gain money for sustainability purposes. In the midst of all this, they commit sexual violence depending on the victim in this case being the women.

There have been cases of women being abducted and held hostage or sold to different countries lieu of payment. A different instance though rare in Kenya, the recruitment of women and promise them marriage and wealth, in such the women lured and fall prey to these false proposition. The ones behind this are highly capable of orchestrating sexual violence and sometimes end up killing the victims. (Bigio & Vogelstein, 2017)

## Problem Statement

There are many rape cases that reported to the police but only few of them get a hearing. When victims report these cases, they are mostly in a traumatised state, this makes then unfit to give accurate statements leading to  not recording a report of rape as a crime but noting it as an incident hence investigations not being carried out, raising the possibility that perpetrators could go on to reoffend (Barr, 2019)

The rape few cases that make it to trial they are dealt in a manner contrary to the seriousness it requires. The of the survivors struggle to maintain their composure when confronted with their memories of the violence (Review, 2014). They are expected to show less emotions and give elaborate answers and descriptions when confronted with questions or objectivity to because these cases are normalised to sex. This discourages the victims from reporting the case in addition to it, stigmatisation from the society and sometimes the evidence isn’t considered enough.

There are certain traits that make one a rape-target, the female gender at a high risk of being sexually assaulted and there are few who look for women on their cell phone, searching through their purse or doing other activities while walking because they are off guard and can be easily overpowered. There factors that favour the perpetrators, the use of a weapon to threaten the victim and the attack is most likely bound to happen very early in the morning or late in the night since there would be few people to witness.

Psychological Aggression is an aftermath of sexual violence and it takes exhibits itself in different ways such as, self-esteem, thus leading to anxiety, compliance, and passivity; (Jordan, et al., 2010). Emotional reactions like guilt, shame, Fear, distrust and Sadness. Physical reactions like changes in eating or sleeping patterns, concerns about physical safety.

There are financial costs that incur to the community. These costs include medical services, criminal justice expenses, crisis and mental health services fees, and the lost contributions of individuals affected by sexual violence (© National Sexual Violence Resource Cente, 2010)

## 1.3 Aim

To develop an application that detects physical struggle and prevents women from being sexually assaulted.

### 1.3.1 Specific Objectives

1. To investigate the struggles experienced by victims during assault.
2. To review the existing solutions that prevent sexual violence from occurring.
3. To design and develop using the proposed technologies.
4. To test an application that implements the proposed system.

### 1.3.2 Research questions

1. What are the challenges faced by victims during the attack?
2. What are the existing solutions and the challenges they face?
3. How to develop a machine learning model?
4. How to test the system?

## Justification

The proposed system is meant to detect sexual violence using the Machine Learning model analysis that uses body movements to detect physical struggle, the victim able to use the data acquired and generated inform of a report, can be used as proof. The helps in case the victim decides to report the case to the police.

The IOT side of the system includes communication with enlisted contacts, the fact that more people are aware when the victim feels unsafe, increases the chance her getting help from people and the contingency that the police will be on time will be high.

Real time data analysis with renders the proposed system essential because data being generated automatically, this way persons with malicious motives don’t get to interfere with the data and less time is wasted given that the report can be sent immediately to the right personnel.

## 1.5 Scope and Limitation

Given that GVB is a broad subject, the proposed system aims to focus on Sexual violence.

Nairobi will be the point of focus given that it is a densely populated urban area and there tends to be a high rape cases There has of a record of 24.5 per cent of rape cases according to the Daily Nation. (Anon., 2019). With a population of 4,734,881 (Anon., n.d.), The women understudy will be 15 years and above since as stated before, 45% of women aged between 15 and 49 years have experienced either physical or sexual violence and it would be easier for them to operate the system with ease.

There is a high rate of unemployment and also drug and substance abuse by the youth this also increases the crime rate in the city.

Limitations: The victims are hard to approach given that they may be experiencing stigmatisation, Post S Traumatic disorder, social isolation or depression so they may shy away from being because they feel ashamed or are fearful of what may be said about them. The researchers as well might face some difficulties in obtaining sensitive information hence they need to be trained for such occurrences.

# Chapter 2: Literature Review

## 2.1 Introduction

This chapter discusses the, Technologies used for the proposed systems, existing IOT applications that focus on Women security such as; Athena, safecity, SHE, RPE and React Mobile alongside their shortcomings and conceptual diagram of the proposed system will also be illustrated.

## 2.2 Struggles experienced by victims during assault.

At the time of the assault, most victims have an overwhelming experience is fear of being physically injured of being killed. Fear responses associated with the assault (to certain sights, sounds, smells, thoughts, etc.) can persists for weeks, months, or even years. Physical reactions are automatic; when faced with danger or anything we interpret as dangerous our bodies automatically respond. For instance, the hearts begin to beat faster and harder, blood pressure Increases, breathe faster and harder, stress levels increase and muscles get more tense.

However, these reactions, in turn, may lead to behaviours which help avoid the victims avoid the stimuli that triggered the mental and physical reactions. (Anon., n.d.)

## 2.3 Technologies Used

### 2.3.1 IoT

Given that a few sensors and actuators will be used, Arduino fits best with the proposed systems. An Arduino Pulse sensor will be used to check the heartbeat rate. The items included are; Arduino Uno Board and USB Cable, Pulse Sensor Ardui, Jumper Wires, LCD, Potentiometer 10K, 2 LEDs and the Breadboard. The items will be connected using the breadboard having set different parameters, the board is connected to the computer using a USB cable. The Arduino code demo ought to be downloaded and unzipped to the library before uploading the sample source code into your Arduino IDE to allow Arduino to communicate with LCD.

You may download this sample source code and open it on your Arduino IDE. Choose the correct board and port. Then, upload your Code into your Arduino Uno Board. When you open your serial monitor, make sure you change your baud rate to 115200, it has to match to the baud rate stated in the sample source code.

After it’s done uploading, you should see LED1 (red) blink in time with your heartbeat when you place your finger on the sensor. If you grip the sensor too hard, you will squeeze all the blood out of your fingertip and there will be no signal! If you hold it too lightly, you will invite noise from movement and ambient light. So, place your finger on the sensor lightly till you get a read on the LCD or serial monitor that shows signal is already transmitted. You will be able to get the reading on both serial monitor and LCD. (mybotics, 2018)

The blood pressure Sensor goes the same steps of data processing as the Pulse sensor but the requirements may differ; Arduino UNO board w/USB cable, Arduino compatible LCD, Pressure Transducer (We used the Honeywell Differential Transducer 015PDAA5), Voltage-controlled valve, Air pump, Wires, Power Supply (±15V), Resistors (Four 100kΩ, One 1 kΩ), Capacitors (Two 1µF), Breadboard, Three-way splitter, Plastic Tubing, Blood Pressure Cuff and TL072 Op Amp. (LunesCuatro, 2019)

The electromyography (EMG) sensor measures small electrical signals generated by your muscles when you move them. The required item; circuit Chips, Cables and Electrodes, Power, Capacitors and Resistors. The process begins with EMG sensor placement; where it’s placed in the innervation zone of both tendons for better detection quality (Picture 1). Electrodes begin to detect electrical activity generated by muscle movement/contraction. Electrical activity detected is then displayed via the form of waves on a monitor (also known as an oscilloscope). When unusual data is collected, the sensor is triggered.

The stress sensor. The components include; Arduino, Op-amps, Various resistors and capacitors, Wire ,9V batteries, PPG clips, [thermistor (1)](http://www.vernier.com/products/sensors/temperature-sensors/sts-bta/), LTC1043 Switched Capacitor Building Blocks (1), LT1167 Instrumentation Amplifiers, LTC1064-2 8th order Butterworth filter, 2N3904 BJT, or other transistor, LM7805, or other 5V regulator and [GSR finger clips (2)](http://www.mindpeak.com/Neurofeedback-Device-GSR-clips.aspx). The process is still the same, however, To get a reading, we use the thermistor in a voltage divider circuit. As the resistance of the thermistor changes, so does the output voltage of the divider. This signal is low-pass filtered in order to get rid of noise. This filter can have a very low cutoff-frequency, since a person's breathing rate will be in the order of single-digit Hz. The respiration circuit also included a feedback amplifier and high pass filter. The temperature voltage signal was amplified with a gain of 100 and then a high pass filter was used to remove the DC component of the signal. This signal was then put into one of the Arduino's analogue pins. (ajdupree, 2014)

The data is stored on a cloud-platform like AWS.

### 2.3.2 Machine Learning

Using the data generated by the IoT device and Sexual Violence Datasets from sources like Safecity, Data Selection

Data Pre Processing

Modeling

Evaluation

Prediction

ML model to perform data analysis. The data that is inform of the result of what the ML model would have concluded can be shared inform of a report.

## 2.4 Existing Systems

The existing systems include;

### 2.4.1 Athena

Athena is a black silicone pendant the size of a half-dollar and can be pinned to a purse, clothing, or even worn as a necklace. With a recessed button at the centre of the device to prevent accidental alerts, users can hold it for three seconds to trigger a loud alarm that will immediately notify friends and family of their current location, or alternatively, press it three times in quick succession to send a silent alert if you’re suspicious of being targeted. (Anon., 2017)

Silent ROAR is mode which sends a distress message without an alarm and Alarm Mode, which sounds an alarm to emergency contacts. Athena also has 911 calling capabilities and via the ROAR Personal Safety app, users also have access to self-defence videos, general safety awareness tips, and the latest news related to gender equality.

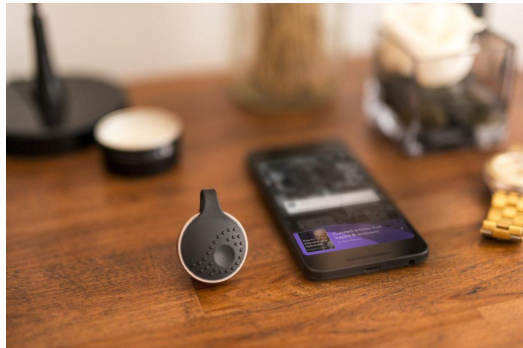


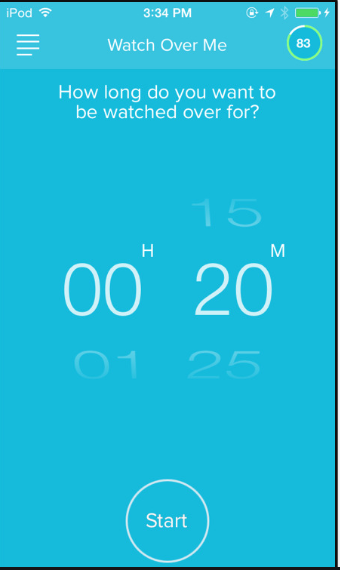
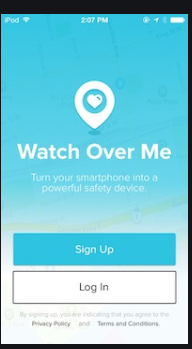
Figure 1: ATHENA

### 2.4.2 Watch Over Me

This an application available that allows the user to set a timer when traveling alone. When you’re in a situation where you don’t have time to make a call for help, just shake your phone and even if it’s locked the app turns on your phone’s alarm, video camera and sends an alert to your pre-set emergency contacts. The application warns you when you’re about to enter a high-[crime](https://www.psychologytoday.com/us/basics/law-and-crime) zone.”

You can choose to add updates in the form of texts, pictures, or video, and if you do not tap the “I’m Safe” button before the timer runs out, friends and family are immediately given your location and any information you've uploaded. Because the app is activated based on inactivity, you’ll be taken care of even if you’re separated from your phone.

Figure 2: Watch Over Me



### 2.4.3 Safecity

This is an application that similarly allows you to report harassment and feelings of threat in and around the city. It also has a tracker function that allows you to “track loved ones to know they are safe”. It basically functions as a crowdsourced platform where individuals can share their personal stories of sexual harassment and abuse in public spaces, categorising them by place, time and type of harassment. This data then gets aggregated into hot spots on a map that indicate trends at a local level. Users of the app users can also upload photos and videos - any resource that can help them to share not only information, but also advice, and more importantly, support. (Bramley, 2015)

This application allows anonymity, the organisation that runs the application (The Red Dot Foundation) has been identifying location-based concentration patterns and trends where sexual violence crimes are committed. This data has been successfully used to engage over 400,000 citizens and official authorities including the police, municipal and transport authorities and community leaders across 15 cities.

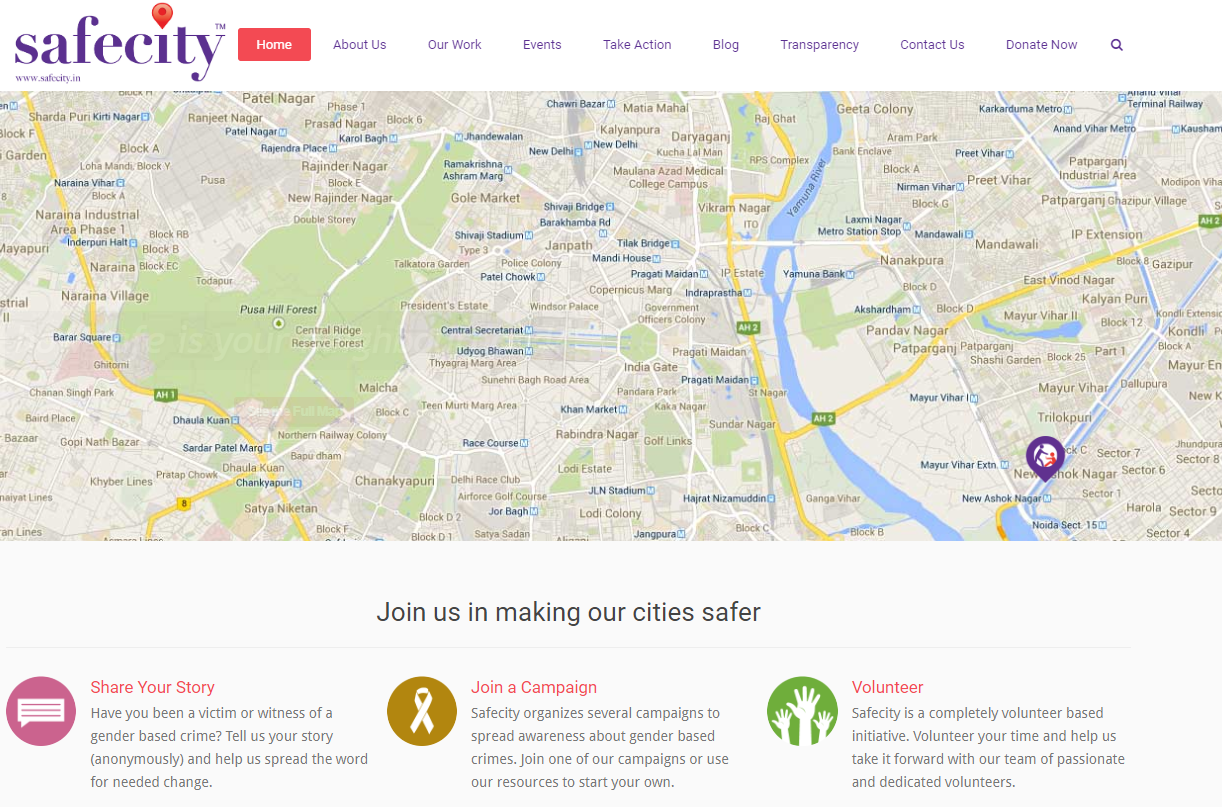


Figure 3: Safecity

### 2.4.4 React Mobile app

React Mobile offers both a free safety app and a panic button device that can be attached to clothing, car keys, wallets, or carried in hand. Once activated, a React Mobile dispatcher immediately provides emergency contacts with your profile information and GPS location. React Mobile also offers group packages, perfect for organizations and community groups looking to stay protected together.

The application allows the user to save contacts that would be contacted in case of an emergency. There are three options: ‘I’m fine’ when the feels safe. ‘Follow me’ is selected when the user feels the need share their location, the location is live until a different option is selected. The location is shared through text and email. The last option being ‘Help Me’, 911 would be automatically contacted but, the user has ten seconds to cancel the call in addition to, the selected contacts would have received a message stating that you are in danger.

However, the application has available concerns there are times when it can’t load this would be very risky when you the user does not feel safe.

Figure 4: React Mobile

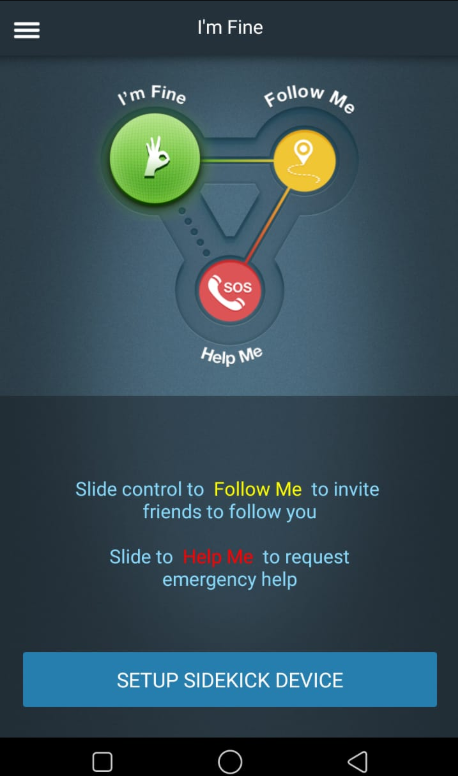
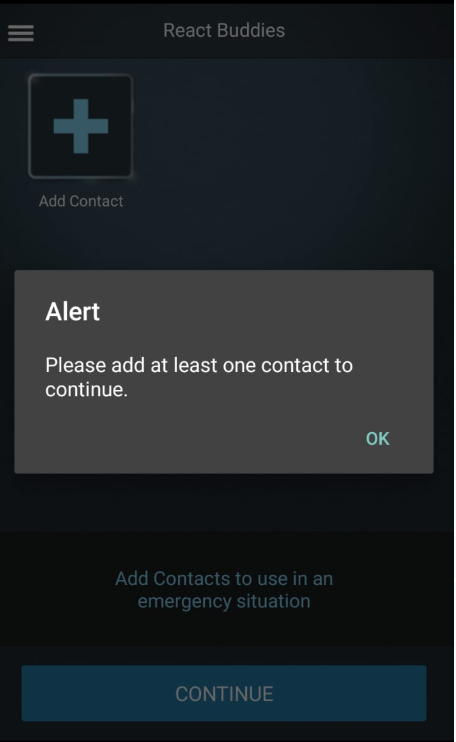


Figure 2. 5

### 2.4.5 Prevention Education

There are programs that have been that different adapted by different institutions to different types of audiences. Adolescents, educators stress the importance of eliciting student participation rather than presenting an entirely didactic program. Programs for older students may include: Setting clear personal boundaries. Confronting sex role stereotypes. Developing healthy attitudes toward emotional and sexual intimacy. Distinguishing between non-assertiveness, assertiveness, and aggressiveness.

The University of Michigan has a nationally known, full-fledged Sexual Assault Prevention and Awareness Centre that offers a wealth of services to the campus community. Their campus rape crisis centre provides peer education on rape prevention, organizes rape awareness weeks, and provides programs for men through the Men's Outreach Committee. (Joel Epstein & Langenbahn, 1994)

(Anon., 2019)

Figure 5: RPE

### 2.4.6 SHE‐ Society Harnessing Equipment (IoT)

It is an IOT garment embedded with an electronic device. This garment has an electric circuit that can generate 3800kV which can help the victim to escape. The garment delivers an electric shock to attackers strong enough to cause severe burns, protecting the victim from any of the electricity. The garment is fitted with a pressure sensor connected to an electric circuit with the capabilities of providing the electric shock when it is squeezed forcefully, and the system is placed in a bi-layer fabric, which ensures insulation to the victim (ZIKRIYA, et al., 2017)

The pressure values for squeeze, pinch and grab have been calibrated. The force applied on hugging does not satisfy the conditions for actuation of the device, and there is also a self-actuation switch where a woman can actuate it by herself when in unsafe environment." (Graham, 2013)

Embedded in the fabric are four flexible sensors which can detect the position of your fingers, an accelerometer which tracks the movement of your arm, a joystick and four push buttons. The sensors and buttons can be configured anyway the wearer wants. It is linked to an interface app either on their computer or mobile device.

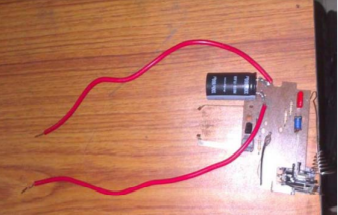


Figure 6: SHE

### 2.4.7 **Automatic Classification of Sexual Harassment Cases**

There are no existing Machine Learning similar to the one being proposed, however, a model was created so that it is able to learn the patterns in the descriptions of the cases, and lastly, predict the categories of each of the cases. Using a dataset with 2,122 sexual harassment cases within a chart with 9 columns that as a pandas Data Frame. The data goes through data preparation. The only features that our model needs are the description and the category label, being the input and output respectively.

Every unique category was extracted and extended the category column into its Boolean representation. Multilabel classification assigns to each sample a set of target labels. The resulting categories being; Touching /Groping, Catcalls/Whistles, Sexual Invites, Stalking, Others, Commenting, Rape / Sexual Assault, North East India Report, Indecent exposure, Chain Snatching, Ogling/Facial Expressions/Staring, Taking pictures, Poor / No Street Lighting and Online Harassment.

The dataset is iterated over to transform each case category feature into 14 new non-exclusive Boolean features where a 1 means that a specific category was present in the sexual harassment case. It then vectored, the description column (input) and to perform some EDA (Exploratory Data Analysis).

A text file is built for each sexual harassment category where I collected all the description cases for that particular category. Initially, I added to the pipeline Tokenization, Lemmatization and stemming. Some of the case descriptions contain words that are not in English. In order to normalize the data, we defined a regex pattern and filter the data with it. Notwithstanding, I kept non-English words for the EDA to avoid missing information. On the other hand, the dataset to be fed to the ML model does need to be normalized. One direct way to achieve this is by the means of The Natural Language Toolkit.

The data goes through hyperparameter tuning and logistical regression then after a test was done on a social media platform and the data bellow was the output.

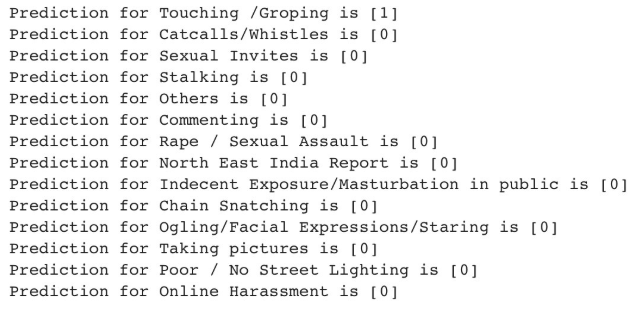


Figure 7: Output

(Manzatto, 2019)

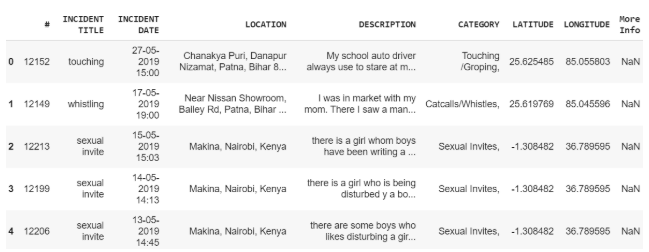


Figure 8: Safecity Dataset

## 2.5 Gaps in Existing Systems

The measures that most of the stated applications take, may only deter perpetrators from harming one person, not necessarily from harming others, or attacking the target at another time. They also do not inform the users on area that have had previous cases of sexual violence, very expensive so only a few can access the device and if the perpetrator happens to get hold of the device the victim becomes hopeless.

## 2.6 Conceptual Diagram

The conceptual diagram gives visual representation of how the proposed system is going to work.

Figure 9 Conceptual diagram

Database

IoT Integration

ML model

Report

Results

Sensors

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