Generation of Test Cases for Identification of Crime against Women through HLR and VLR

ABSTRACT

In recent years, it is observed that crimes against women are increasing exponentially growth manner and the nature of the crime may be sexual harassment at any place including the workplace, acid attack at any place, rape, domestic violence, and many more which the criminal may leave his location treated as visitor location for performing criminal activities against the women whose mobile is treated as a home location. In the present work, a criminal scene is established through the mathematical technique for matching these two locations for identification of the crime. From the literature, it is observed that mathematical matching techniques are not in use for the identification of crime. The purpose of the present work is to fill this gap by developing a Unified Model by the use of Unified Modeling Language which has been validated through valid test cases after implementing the model in the Python programming language.

Keywords: Crime, Women, Criminal, VLR, HLR and Matching Technique.

1. INTRODUCTION

During the past years, the crime rate against women has been rapidly increasing in an exponential manner around the globe. As per the report of the World Health Organization (WHO), out of three women, one woman is physically or sexually assaulted by a male or female. The crime against women includes kidnapping, raping, demand of dowry, sexually abused or assaulted, abduction, murder, deaths due to dowry demand by the opposite partner, parents or relatives of partner, eve teasing, eavesdropping of women, forced and revenge pornography against women, women trafficking and many more. Many of the crimes against women have already been listed in the Indian Penal Code (IPC). There are further subcategories of the crime. Many of the State and Central agencies in India are continuously failing to establish the crime against women in India as not able to produce the digital evidence as defined in the Indian Evidence Act 1872 and also in the Information Technology Act 2005 amended from time to time by the Government of India (GoI). From the literature it is revealed that limited research work is available to proper establishment of the crime against

the woman, therefore the presented approach shall be very helpful to establish the crime against the women. In this approach, a systematic model is presented by the use of Unified Modeling Language (UML) which can be used to verify the home location of the woman and the visitor location of the criminal as it is possible in the present digital era. Before the description of all these, it is necessary to explain the available research work on crime against women, the evolution of the digital era in terms of HLR (Home Location Registration) and VLR (Visitor Location Register), the role of Unified Modeling Language and generation of the test cases through a case study on woman crime. The human being may use the digital devices when crime takes place and these devices are generally known as the hand-held devices which are well connected through the cloud server via network signal as represented in the following figure 1.

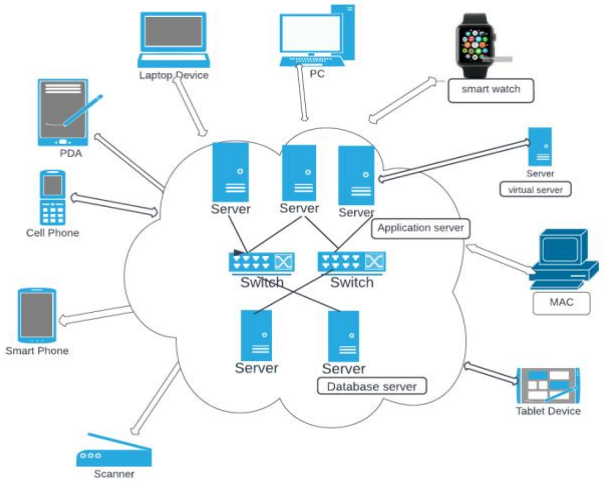

Figure 1. Accessing of Cloud Server by Hand-held Devices

In the above figure, it is clearly shown that the offender may have a hand-held device like a smartwatch, cell phone, or smartphone which are well connected through the cloud server either based on the geo-location or satellite network.

Before 2020, the cases against women were tremendously rising but due to the coronavirus (Covid-19) effect, this has been reduced in the year 2020 [1]. In the old days, crime against women may or may not be reported in the record but the reason for increasing this record is only enhancement in the digital services accessed by the females in the online mode. In the current days, one can also write e-FIR by the use of the online portal controlled by the e-

thana located in the different districts of India. As per the recent report in Times of India, about 90 girls are daily raped by persons in India which leads to 2093 rape cases during the year 2021 only in one state of India [2]. Koenig [3] has elaborated the domestic violence with a case study of North India, which is the worst region of India with tremendous growth in domestic violence among family members. From the Sex Reprod Health Matters, it is observed in India that before marriage, women are innocent but after marriage, women know the experiences of marital rape and sexual violence within marriage [4]. Menon [5] has beautifully explained the rights of women by saying "No" to the person who is going to perform the above-mentioned cases. A report by Times News Network published in the year 2022 says that the Supreme Court of India seeks the direction of the Indian government for the long pending petitions in the various High Courts [6].

Let us describe some of the important references related to the modeling language which is useful to design a model for establishing the crime scene at the incident place. In the year 1997, OMG [7] described all UML specifications. Further, OMG [8] has developed a unified modeling language which is standardization, general prospects modeling language in the field of software engineering. UML was developed by graphics notation technique to create a visual model of software. Booch [9] has described that UML facilitates communication and reduces confusion among project stakeholders. It allows users to model everything from enterprise information systems and distributed web-based applications to real-time embedded systems. OMG [10] has described UML superstructure specification and OMG is an active group released various versions of UML.

In the year 2018, Abdelhedi, et.al. [11] used column-oriented systems an automatic process called Object2NoSQL generated for creating a big data warehouse. A logical model is proposed that exhibits a sufficient degree of independence so as to enable its mapping to one or more column-oriented platforms. Ciccozzi, et.al. [12] have conducted a systematic review in which 63 research studies and 19 tools among 5400 entries by applying a systematic search and selection process. This paper identifies, classifies, and evaluates existing solutions for the execution of UML models. Koc, et.al. [13] have given a systematic review of the UML diagram and conducted a comprehensive review from 2000 to 2019 and among these 128 were selected and examined. The scientist focuses on the utilization of UML diagrams in software engineering research. This identified the research question and keywords for how the UML diagram is utilized. This investigates the SLR process and gives an overview that how the methodology is applied and how the data is collected by exploring the subsection:

Research Questions, Search Strategy, Inclusion and Exclusion Criteria, and Data Extraction and show the result and discussion. Semenova, et.al. [14] have presented a review of the language UML. This will help the scientist that how the UML diagrams with their application are used, the merits and demerits of the UML language, its object-oriented approach, and its hazards. The SWOT matrix is formed by SWOT analysis. Booch [15] has described the important diagram of UML which is widely used for the development of software design. Dennis, et.al. [16] help the scientist and researcher able to learn new techniques and approaches to develop the system more effectively and efficiently. In this book, the phases of the System Development Life Cycle (SDLC) planning, analysis, design, and implementation are described. Further, Booch, et.al. [17] Have illustrated the application of the UML to complex modeling problems across a variety of application domains. Foster, et.al. [18] adopted a methodical approach to solving software engineering problems and has given fundamentals of software engineering, software investigation and analysis, software implementation, design, and software tools.

2. BACKGROUND

Some of the important basics related to Law along with the technological aspects in which there is a crucial role of the HLR and VLR, are described below in brief:

☞ **Kidnapping**

It refers to the kidnapping of a human being either from India or from the legal guardian. Sections 360, 361, and 366 are covered under the Indian Penal Code (IPC).

☞ **Chain Snatching**

It is related to the snatching of a valuable article by a woman by a man at a public place. Due to this crime, old women around the globe are suffering and in India, Section 378 of the IPC covered this type of crime.

☞ **Eve Teasing**

It is related to the sexual harassment of a woman by a man in a public place. Section 509 of the IPC covers this type of crime and many Indian women are suffering from sexual harassment in the workplace or anywhere known as public place.

☞ **Sexual Harassment**

It is defined as a request for sexual favors, verbal comments, and physical touch of a sexual nature. It also includes sexual abuse, assault, showing pornography against her will, and many more.

☞ **Domestic Violence**

It is commonly happening in the Indian country and increasing day by day against the male as well against the female. If one person is earning in the family and another is not then one has full right to do anything against the other. It includes asking for dowry, beating, assault, abuse, forcefully sexual harassment, and many more.

☞ **Rape**

It is the most popular crime in India and the Government of India has failed to reduce this type of crime and it is increasing day by day in a very fast manner. The sections of IPC 376, 376A, and 376B are covered and this type of offense by the offender is categorized according to the age of the woman like the rape of a minor, rape of a woman, rape and murder, rape in families, rape by public servant, gang rape, marital rape, etc.

☞ **Acid Attacks**

This generally happens against the woman by the man for hurting or threatening purposes. Therefore, a man throws the acid over the face of a woman or any body part of the woman.

☞ **Stalking**

When someone is breaching the privacy of another, then this crime happens. It is done either through the internet or a digital device.

☞ **Cyber Crime**

Due to the rapid change in technology, this type of crime is increasing exponentially manner to the use of internet technologies, and in India, it has increased due to an increment in internet users. It includes abuse, pornography, bullying, stealing digital money, hacking of identification of human beings, and many more.

The rapid change of technology has several advantages and disadvantages since aforesaid crime may occur and the offender may use any kind of hand-held device.

3. PROPOSED MODEL

For identification of the above types of crime, a model based on the modeling language is proposed in which different classes are interacting and it is shown below in the following figure 2.

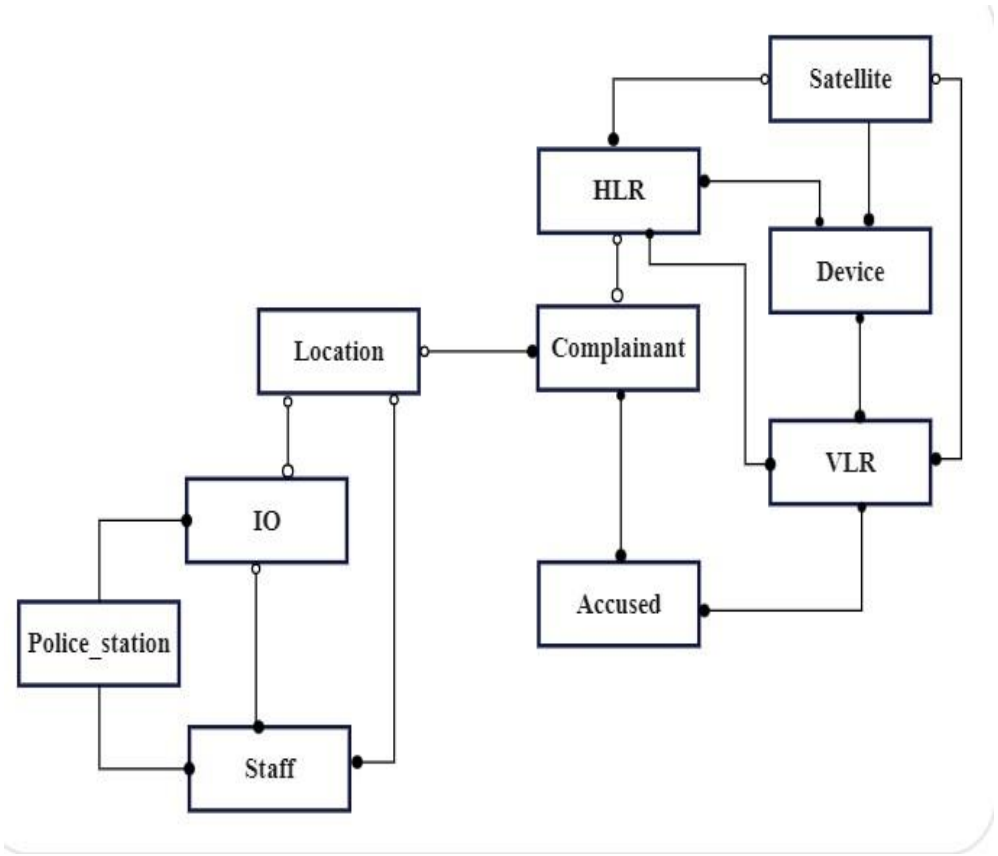

Figure 2. UML Model for Matching HLR with VLR

In the above diagram, some of the abbreviations are used which are IO as investigation officer, HLR as Home Location Register, and VLR as Visitor Location Register. The investigation officer has a staff who is attached to the police station represented as Police_Station class and both are posted at a particular location of the police station. The class represented as Complainant is treated as the first party having the home location and represented as an HLR while the offender is represented as accused having VLR. HLR and VLR work through a digital device that is well connected through the satellite network. The above classes may have the following attributes which shall be used for matching the HLR and VLR for the identification of criminal science happened between the complainant and the accused. The purpose of the above model is to collect the HLR of the complainant and VLR of the accused from the crime scene by the investigation officer which shall be used as evidence to establish the crime by the offender. The attributes are represented in the following table 1.

Name of Class	Name of Attributes

Satellite	Satellite_Id, Satellite_Address, No_ Active_User
HLR	HLR_Id, HLR_Subscriber_Name, Subscriber_Address, Subscriber_Mob_No, Port_No
Staff	Staff_Name, Staff_Id, Staff_Device_Id, Staff_Address
Device	Device_Id, Device_Subscriber, Biometric_Storage, IMSI_No
Complainant	Complainant _Id, Complainant _Name, Complainant _Address, Complainant _Mob_No
Accused	Accused_Name, Accused_Id, Accused_Address, Accused_Mob_No
IO	IO_Name, IO_Id ,IO_Device_Id, IO_Address
Location	Location_Id, Location_Name, Location _Address
Police_station	Station_Name, Station_Id, Station _Location
VLR	VLR_Id, VLR_Subscriber_Name,, Subscriber_Address, Subscriber_Mob_Number, Port_No

Table 1. Representation of Attributes of the Class

For matching the HLR and VLR, web or online mapping is done by the use of geolocation which is computed in terms of decimal degree. The individual human being having a hand-held device has geolocation in the general format of 0° 00′ 0.0036″. It is represented as latitude, and longitude with geographical coordinates. The decimal degree representation of the above is computed by following the formula

$$D_{dec} = D + M/60 + S/3600 \quad (1)$$

where $D=0^0$, $M=00'$ and $S=0.0036''$

therefore, decimal degree representation of 25°60′36″ is computed by (1) which is 26.01°. In this representation degree symbol is optional, hence it can be represented as 26.01.

The International Mobile Subscriber Identity (IMSI) number is a unique number containing fifteen digits which is to be allocated to the user by the operator at the time of purchasing the Subscriber Identity Module (SIM) card. In the hand-held device, it takes 64 bits as represented in the following figure 3.

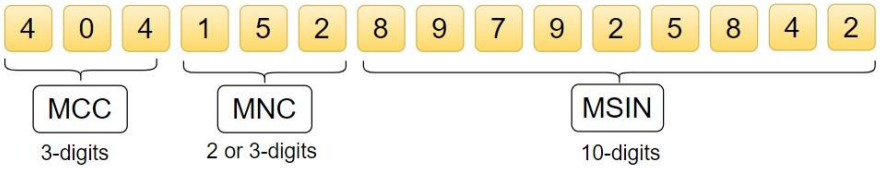

Figure 3. Format of International Mobile Subscriber Identity (IMSI) Number

In the above diagram, IMSI consists of three major components i.e. Mobile Country Code (MCC) is a code that indicates the service provider and region, using the Mobile Network Code (MNC), one cell may be identified or base station, and finally, the Mobile Subscriber Identification Number (MSIN) provides a unique identification to the individual user.

The algorithm for matching the geo location of the complainant and the accused is given by

```
Match_HLR_VLR()
{
fetch_imsi_complainant()
geo_loc1=fetch_geo_loc_complainant()
fetch_imsi_accused()
geo_loc2=fetch_geo_loc_accused()
if(geo_loc1==geo_loc2) then
print("Suspected Crime is Established")
else
print("Suspected Crime is not Established")
}
```

The above algorithm for matching the location of the complainant and accused is implemented by the use of object-oriented programming language which is also compatible with the UML as the model is represented in the above-mentioned figure 2.

4. RESULTS AND DISCUSSION

The proposed algorithm has been implemented through the Python object-oriented programming language through a case study given below:

Case Study

In domestic violence, a woman X was beaten by her husband Y at the location of 456, Park Street, Kolkata India on 25 October 2023 at 10:25 A.M. The mobile numbers of both are given below:

Mobile Number of X: 0987654[redacted]

Mobile Number of Y: 0987654[redacted]

For the sake of security, the complete details of the mobile numbers are not given. After that, the geo location of each mobile number is fetched by the use of the Python programming language after implementing the following algorithm:

```
# importing geopy library
from geopy.geocoders import Nominatim

# Calling the Nominatim tool
loc = Nominatim(user_agent="GetLoc")

# Entering the location name
getLoc = loc.geocode(input("enter location1="))

# printing address
print(getLoc.address)

# printing latitude and longitude
print("\nLatitude1 = ", getLoc.latitude)
hash_lat1=hash(getLoc.latitude)
print("Longitude1 = ", getLoc.longitude)
hash_lng1=hash(getLoc.latitude)
print("\n")
```

After getting the geolocation of the mobile numbers of the complainant and accused, the following code is written for matching the mobile numbers controlled through integer data type. It establishes whether the crime is occurred or not.

```
def match_location(Complainant_Mob_No, Accused_Mob_No):
    Complainant_data = None
    Accused_data = None
    for id, data in Complainant.items():
        if data.get("Mobile_No") == Complainant_Mob_No:
            Complainant_data = data
            break
    for id, data in Accused.items():
        if data.get("Mobile_No") == Accused_Mob_No:
            Accused_data = data
            break
    if Complainant_data is not None and Accused_data is not None:
        if Complainant_data["Address"] == Accused_data["Address"]:
            return True, Complainant_data["Address"]
        else:
            return False, None
    else:
        return False, None
```

For the verification of the above code, the following parameters/attributes are considered as test cases on the basis of the data represented in table 1. The various combinations of test cases are given below:

Table 2. Generation of the Test Cases based on Attributes

Test_Case_ID	Test Case Input	Expected Output	Actual Output	Result
Test_Case_1	Complainant_Mob_No= "9876543210", Accused_Mob_No = "8876541324"	Suspected Crime is Established, Location: 456, Park Street, Kolkata	Suspected Crime is Established, Location: 456, Park Street, Kolkata	Pass
Test_Case_2	Complainant_Mob_No= "1234567890", Accused_Mob_No= "9876543210"	Suspected Crime is not Established.	Suspected Crime is not Established.	Pass

In the above table, Test_Case_1 represents the selected case study which shows that a woman was beaten by her husband, and through programming it is observed that "Suspected Crime is Established". The other Test_Case_2 was executed over the two mobile numbers used for the complainant and accused after getting the geolocation of each one. The above code is verified which represents that "Suspected Crime is not Established". The results generated through Python programming are represented in the following figure 4. It is also observed that the entire communication is obtained through programming within a fraction of a second.

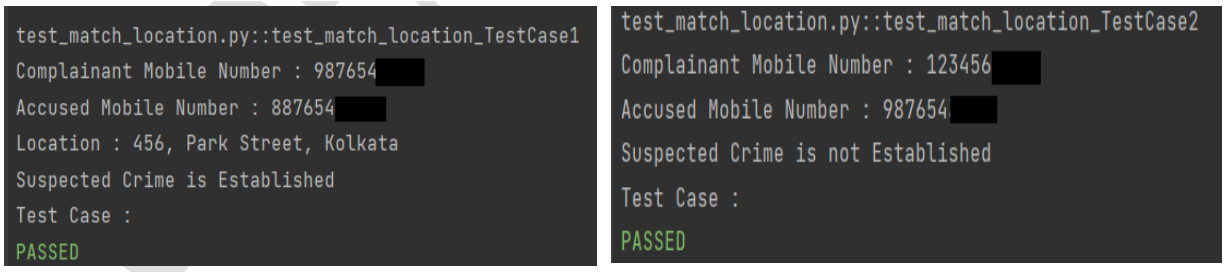

Figure 4. Representation of Results through Python Programming

4. CONCLUSIONS

From the above work, it is concluded that the presented approach is a novel approach not available in the literature till today which may be used for establishing the crime and may be

used as evidence against the accused in the criminal cases as listed in the paper. The above approach may also be extended over the Internet Protocol (IP) addresses used in the IP-based Wi-Fi camera located on the streets of the city for establishing the crime that may occur at the roads of the city. The presented approach shall definitely secure the entire city but the limitation is that the entire city should be covered with the Wi-Fi cameras. Similarly, the said approach may be useful for matching the locations of the videos covered during the crime by the Wi-Fi camera installed at the location of the complainant and accused. The entire crime scene can be established within a fraction of a second which may lead to quick generation of evidence against the accused.

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