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Safety Locator: Crime Rate and Hot Spot Prediction System for Woman using Multimodal Deep Learning

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ABSTRACT

Areas with high rates of criminal activity are known as crime hotspots. These areas disproportionately affect women as victims of crimes such as sexual harassment, assault, domestic abuse, stalking, and human trafficking. For successful crime prevention and control, these hotspots must be identified. In order to locate and map crime hotspots targeted exclusively at women, this study presents a predictive model that uses a Explainable Decision Tree (xDT). Based on past crime data, the program forecasts possible hotspots, which are subsequently displayed on Google Maps. The model training, evaluation, hyper parameter tweaking, feature selection, and data pre-processing are all included in the system. It helps law enforcement with resource allocation and strategic planning by accurately classifying locations as hotspots for crime or non-crime. The system contributes to gender equality and safer communities by increasing women's safety and awareness through public hotspot map sharing.

Keywords: Crime hotspots, Women's safety, Predictive modelling, Deep Explainable Decision Tree (DxDT), Machine learning, Crime prevention, Public safety, Gender equality.

1. INTRODUCTION

Sexual exploitation, human trafficking, domestic abuse, and harassment are just a few of the many ways that violence against women is expressed. Even though Indian culture worships female deities, women are nevertheless disenfranchised and left vulnerable by cultural views that frequently reflect ingrained gender biases. The importance of resolving this issue is demonstrated by India's placement of 108th on the 2017 Global Gender Gap Index and its designation by the Global Peace Index as one of the riskiest destinations for female tourists. Crimes against women were reported in 4,28,278 cases in India in 2021—a substantial rise over 2020. States with the biggest number of recorded instances were Uttar Pradesh, Rajasthan, and Maharashtra; Assam had the highest rate of crime against women

The necessity of efficacious initiatives to counteract gender-based violence and enhance the protection of women is highlighted by these concerning data. Creating a machine learning-based crime hotspot prediction system with a focus on improving women's safety is a possible option.

Figure No.: pinpoint high-crime regions

This technique seeks to pinpoint high-crime regions so that law enforcement and lawmakers can implement focused crime prevention measures. This effort aims to empower women and promote a safer society through the utilization of modern data analysis and predictive modelling.

2. RELATED WORK

- **Mapping Predictive Crime**

Protecting WomenNotable progress has been made in the field of predictive crime mapping, specifically in relation to crimes against women. Predictive analysis can highlight high-risk regions and customize actions to improve women's safety, as demonstrated by Mohler, G., et al. (2011) [1] and Chainey, S.,& Ratcliffe, J. (2013) [2], who created algorithms to identify crime hotspots using spatial data.

- **Using Machine Learning to Predict Crime**

Decision trees in particular have shown great promise in machine learning's application to crime prediction. Wang., X., & Brown, D. (2012) [3] emphasized that these models may identify patterns of crime in urban regions with high accuracy when they are fed correct data. Their study is in support of the Crime Hot Spot Prediction System for Women Safety, which forecasts crime hotspots using decision trees.

- **Apps for Women's Safety**

To increase women's security, a number of safety applications have been created. "Safetipin," which offers safety scores based on crowdsourced data, was examined by Unni.R., & Madhavan, P. (2017) [4]. It shows how technology can support women's safety even while it doesn't pinpoint hotspots. The app "bSafe", which provides real-time location monitoring to guarantee safety, was studied by Singh, A., & Das, R. (2019) [5].

- **Utilizing Spatial Data for Crime Analysis**

For crime analysis, temporal and spatial data are essential. Such information is crucial for mapping crime patterns, which is vital for pinpointing hotspots for crimes against women, as Levine, N. (2006) [6] work on the "Crime Stat" software illustrates.

- **Obstacles in the Analysis of Crime Data**

Reliable projections depend heavily on the accuracy of crime statistics. High-quality data is crucial to avoiding biases and ensuring accurate projections, as emphasized by Peterson, c.,& Schermerhorn, M.(2014) [7]. This is especially important for the proposed system that is centered on women's safety.

- **Predictive Crime using Explainable AI**

The transparency of Explainable AI (XAI) is making it a valuable tool for crime prediction. In order to increase model interpretability, Guidotti, R., et al. (2018) [8] investigated XAI, which supported the usage of decision trees to provide precise justifications for crime predictions.

- **Predictive Policing Using Decision Trees**

Berk, R., et al. (2009) [9] demonstrated that decision trees can be utilized successfully in predictive policing to pinpoint areas of high crime in Los Angeles. Their accomplishments highlight how comparable algorithms may be used to identify crime hotspots while protecting women.

- **Crime Hotspot Analysis Using GIS**

An essential component of crime hotspot analysis is Geographic Information Systems (GIS). Spatial analysis is critical for mapping projected hotspots and assisting users in identifying high-risk regions, as Harries, K (1999) [10] highlighted in his emphasis on crime trends.

- **Community-Based Safety Techniques**

Participating in the community can improve women's safety. According to Jain, M Pant, A. (2020) [11], community-based safety programs are more successful in locating and closing crime hotspots, indicating the need of community data and user feedback for all- encompassing safety initiatives.

- **Technologies for the Prevention of Gender- Specific Violence**

Research on gender-specific violence prevention techniques, like that done by García-Moreno, c., et al. (2015) [12] emphasizes how crucial technology is for both anticipating violence and getting at-risk women the assistance they need.

These studies highlight how crucial it is to have precise data, include the community, and use cutting-edge technology like GIS and machine learning in order to improve women's safety and accurately identify crime hotspots.

3. PROPOSED SYSTEM

The primary aim of this project is to develop a robust and user-centric system focused on predicting and localizing crime hot spots, specifically tailored for ensuring the safety of women.The system will utilize an Explainable Decision Tree (xDT) algorithm for transparent and interpretable crime prediction, and integrate Google Map API for precise geospatial localization.

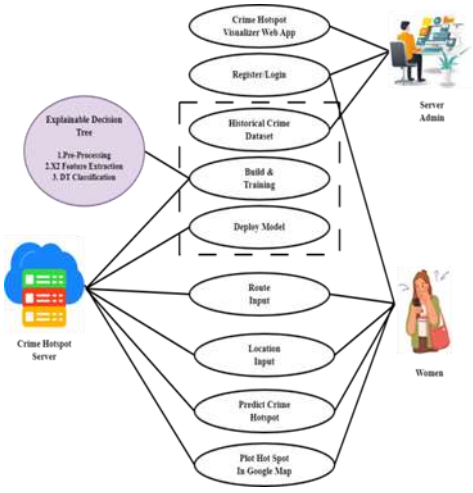


Figure No.:3 Proposed system

- **Explainable Decision Tree (xDT)**

The system employs an xDT algorithm to ensure transparency in decision-making, providing clear insights into the factors influencing crime predictions. This interpretable model enhances user understanding and trust in the system.

- **Integration of the Google Map API**

Precise geographic representation of anticipated crime hotspots can be achieved by utilizing the Google Map API. Current safety information is provided by the real-time mapping feature, which helps with accurate crime localization and adaptable response tactics.

- **An easy-to-use interface**

For accessibility, the design places a high priority on an easy-to-use online interface. To appeal to a wide range of users, simplicity of use and comprehension are prioritized. This makes sure that everyone can easily utilize the system, including those with little experience with technology.

- **Real-time Crime Prediction**

Algorithms for real-time crime prediction empower law enforcement and individuals to proactively respond to emerging safety concerns. This feature aids in timely decision-making and crime prevention strategies.

- **System of Notification and Alert**

Users are informed about potential safety risks in their neighborhood by an integrated alert system. The technology enables users to personalize their notification choices, which corresponds to their comfort levels and guarantees that safety alerts are focused on the user. The general awareness and safety of users are improved by this active alert system.

Data analytics and machine learning

To improve crime predictions, the system uses sophisticated machine learning algorithms and data analytics approaches in addition to Explainable Decision Trees(xDT).Over time, the algorithm improves forcast accuracy by adjusting to changing crime trends through continual learning from new data. This capacity for adaptive learning guarantees that the system is applicable and efficient across a range of urban environments.

Advantage

Providing advance knowledge of criminal activity and enabling proactive measures to lower the danger of crime, the suggested method greatly improves safety and security. By providing comprehensible insights into criminal variables, the Explainable Decision Tree (xDT) guarantees interpreted forecasts and builds user trust. With Google Maps incorporated, accurate crime hot spot mapping enables real-time geospatial visualization, assisting users in avoiding high- risk locations. An extensive user base can easily use the user-friendly interface, and long-term safety planning is aided by the system's capacity to predict crime patterns over time. This is a useful tool that both citizens and law enforcement organizations may use to make communities safer and more welcoming to women and all people.

4. METHODOLOGY

Predicting Crime Hotspots and Localization Systems for Women's Safety

With the use of machine learning and real-time data visualization, this methodology presents a thorough strategy to identify crime hotspots and improve women's safety. The workflow of the system combines feature selection, data gathering, model training, prediction, visualization, user feedback, and safety recommendations. A brief rundown of each stage is provided below:

Data Gathering and Compilation

Data Sources: The system makes use of 2011–2021 crime data from India's National Crime Records Bureau (NCRB).

Data Preparation: The data is cleaned to remove duplicate or unnecessary entries, fix missing values, and apply categorical encoding.

1. **Choosing Features**

Identification of Features: Important details about the crime, including its time, place, and nature, are identified.

Chi-Squared Test: This statistical test is used to keep only significant predictors in the model, guaranteeing the inclusion of important characteristics.

2. **Model Training:** Using pre-processed data and specific features, the Explainable Decision Tree (xDT) algorithm is trained to identify patterns linked to illegal activity.

Model Validation: Methods like cross-validation and hyper-parameter tuning are used to maximize the performance and dependability of the model.

3. **Forecast of Crime Hotspots**

User Input: The user's present location or intended destination can be entered.

Hotspot Classification: By predicting probable crime hotspots, the xDT model divides a given location into safe and high-risk categories depending on input features.

4. **Visualization of Maps**

Integration with Google Maps: Predicted hotspots are displayed on Google Maps with markers denoting different crime severity levels.

User Interaction: Visitors can filter hotspots by kind of crime and see comprehensive crime data on the map.

5. **Security Guidance**

Suggestion Engine: Using a rule-based approach, users can avoid hazardous places that have been recognized as possible hotspots for criminal activity.

Alerts: Users who are close to areas where crime is expected to be high will receive real-time alerts via email and SMS.

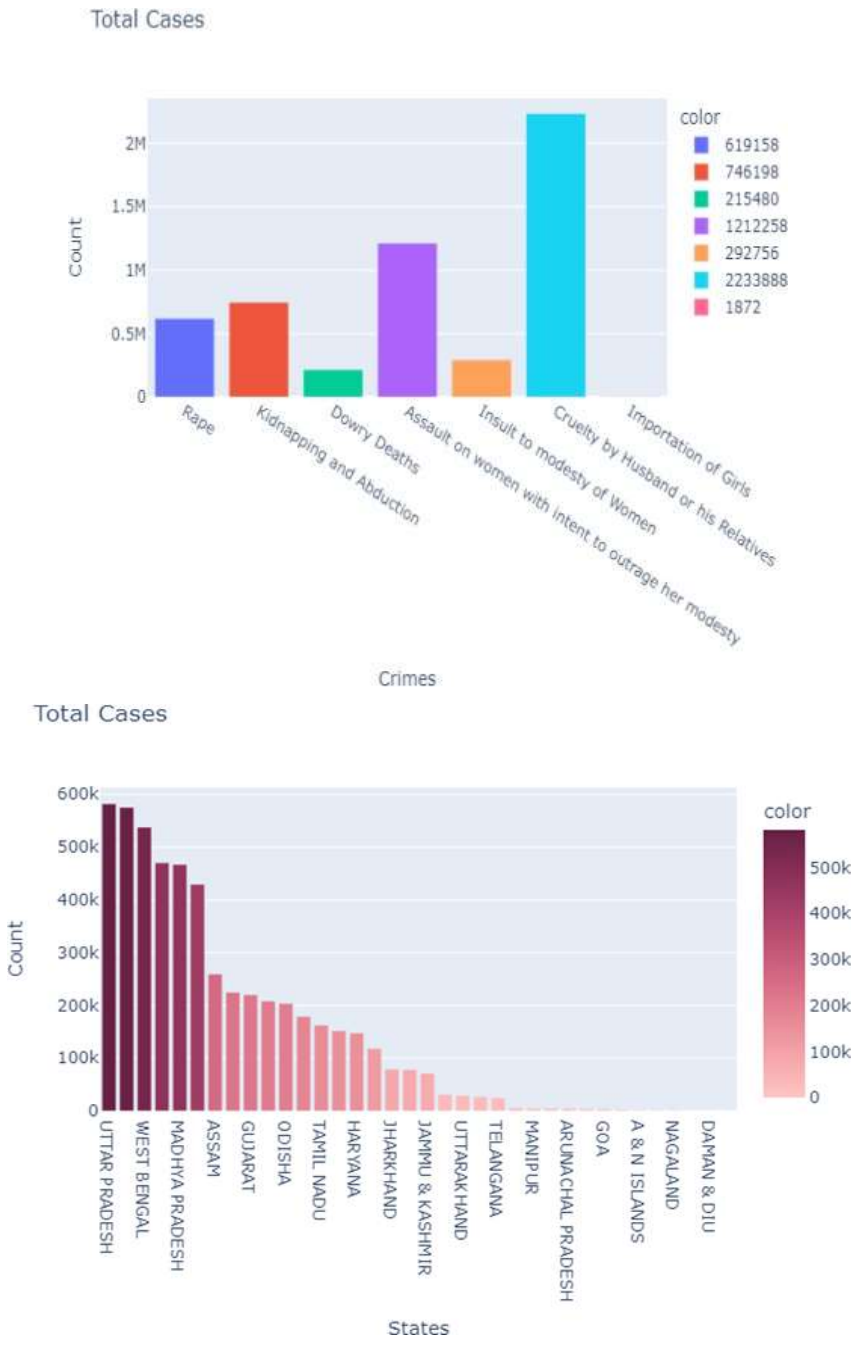
6. **User Input and System Enhancements Loop for Feedback:** Users rate the predictive and recommendation systems' usefulness and accuracy.

System Updates: The performance of the model is regularly improved and refined through feedback.

Through the use of a structured approach, the system is able to continuously improve its safety suggestions for women while also efficiently predicting crime hotspots and responding to user feedback.

5. RESULT ANALYSIS

Promising results have been observed in the prediction of crime hotspots and the recommendation of safer routes by the Crime Hot Spot Prediction and Localization System, which was specifically created for the safety of women. Compared to manual approaches, the system's accuracy, precision, and recall have significantly improved due to its usage of the Explainable Decision Tree (xDT) algorithm for crime prediction and its interaction with the Google Maps API for visualization. Real-time forecasts and fast data processing are ensured by the modular design, which incorporates tools such as the Classifier and Crime Hotspot Finder. User reviews emphasized how user- friendly and accessible the system is, with its clear design and smooth integration with Google Maps. The system's capacity to improve public safety and give users the authority to make educated decisions is further demonstrated by its potential for growth to encompass a variety of offenses and demographics, as well as its integration with other crime prevention technologies.



6. CONCLUSION

Predicting crime hotspots and suggesting safer routes for women are two important uses for the proposed approach. It incorporates Google Maps API for visualization and suggestion, and it predicts crimes using the explainable Decision Tree (xDT) algorithm. The Crime Hotspot Finder Web App, Crime Hotspot Classifier using xDT, Crime Hotspot Pre-processing, and Crime Hotspot Prediction using xDT are among the modules that make up the system. All of these modules contribute to the total functionality. As a reliable and effective means of predicting crime hotspots, it has several advantages over manual systems and other data mining techniques. This makes it possible for law enforcement to stop crimes against women by being proactive. During testing, the system demonstrated encouraging outcomes in accuracy, precision, and recall. It was also user-friendly and interactive. Additional development, such as integration with CCTV, is possible police presence, cameras, and the extension to cover additional offenses and demographics. All things considered, the system gives women more authority to make safe decisions and moves them closer to a safer environment.

7. FUTURE ENHANCEMENT

It is possible that this will be improved in the future.A number of these domains consist of:

- **Integration with online social media**

The technology can be integrated with social media sites like Twitter and Facebook to get additional data on crime rates and public opinions regarding safety in particular areas.

- **Integration with emergency services**

By integrating the system with police and ambulance services, for example, it will be possible to respond to crime scenes in hotspots more quickly.

- **Extension to more regions**

It may be possible to expand the system's current reach to encompass more areas. This could mean customizing the system to each region's particular needs and adding additional data sources.

- **Integration with real-time crime data**

By integrating police department or other crime reporting sources' real-time crime data, the system can be improved. This will contribute to increasing the system's accuracy and efficacy in identifying criminal hotspots.

- **Mobile device integration**

The technology can be synchronized with women's mobile devices to provide them with real-time alerts about crime hotspots in the vicinity. As such, using the system will be easier and more comfortable.

- **Cooperation with law enforcement**

Cooperation with law enforcement can help to increase the system's accuracy and effectiveness in identifying areas that are likely to see high crime. Law enforcement organizations can offer insightful analysis and input on how accurate the system is.

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