International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Crime Link: Pattern Recognition and Mapping System

Kiruthiga D[1], Subhiksha K[2], Varshinee S[3], Nisha M[4]

[1]Assistant Professor, Department of AI&DS, CARE college of Engineering, Trichy, Tamil Nadu, India
[2,3,4]Final Year B.Tech, Department of AI&DS, CARE college of Engineering, Trichy, Tamil Nadu, India

Abstract

The increasing rate of criminal activities poses significant challenges to law enforcement agencies in identifying, analyzing, and solving cases efficiently. Traditional investigation methods rely heavily on manual analysis of crime records, which is time-consuming and prone to human error. This paper proposes an intelligent crime detection and case linking system that utilizes historical crime data to identify patterns and relationships between current and past criminal activities.

The system allows users to input detailed information about a newly occurred crime, including location, time, type of crime, and collected evidence. Using data analysis and pattern matching techniques, the system compares the new case with existing crime records stored in a database. If similarities are identified, the system retrieves and displays related past cases, enabling investigators to establish connections and gain insights.

The proposed approach improves investigation efficiency, reduces manual effort, and enhances decision-making by providing data-driven support. The system demonstrates the potential of artificial intelligence and data analytics in modern crime investigation and prevention.

Keywords: Crime Detection, Case Linking, Pattern Matching, Machine Learning, Data Mining, Criminal Analysis, Historical Data, Law Enforcement Systems

1. Introduction

Crime investigation is a critical function of law enforcement agencies, requiring accurate analysis of evidence and efficient identification of suspects. With the rapid increase in crime rates and the growing volume of data, traditional investigation methods are becoming less effective. Manual analysis of crime records is time-consuming and may overlook hidden patterns and connections between cases.

Modern technologies such as artificial intelligence and data analytics offer new opportunities to improve crime detection and investigation processes. By analyzing historical crime data, it is possible to identify patterns and similarities that can help link related cases.

This project proposes a crime detection and case linking system that automates the process of analyzing crime data. When a new crime is reported, its details are entered into the system. The system then compares these details with previously stored crime records to identify similarities. If a match is found, related case files are displayed, assisting investigators in understanding possible connections. If no match is found, the system indicates that the case may be unique.

This approach enhances the speed and accuracy of crime investigations and supports law enforcement agencies in solving cases more effectively.

2. Literature Review

Various techniques have been explored in the field of crime analysis and detection:

Early systems relied on **manual record-keeping and rule-based analysis**, which lacked efficiency and scalability. With advancements in technology, **data mining techniques** have been used to analyze crime data and identify patterns.

Machine learning algorithms such as **Decision Trees, K-Nearest Neighbors (KNN), and Support Vector Machines (SVM)** have been applied for crime classification and prediction. These models help in identifying crime-prone areas and predicting future incidents.

Recent research focuses on **pattern recognition and clustering techniques**, which group similar crime cases based on features such as location, time, and crime type. Additionally, **natural language processing (NLP)** has been used to analyze textual crime reports and extract meaningful information.

However, many existing systems focus mainly on prediction rather than **case linking**, and they often lack real-time analysis capabilities. The proposed system addresses these limitations by combining pattern matching with historical data comparison to establish relationships between cases.

3. Proposed System

The proposed system is designed to provide an intelligent and automated solution for crime detection and case linking by utilizing historical crime data and pattern matching techniques. The main objective of the system is to assist law enforcement agencies in identifying relationships between newly reported crimes and previously recorded cases, thereby improving investigation efficiency and accuracy.

3.1 System Overview

The system operates by collecting detailed information about a newly occurred crime and comparing it with an existing database of past crime records. Each crime record contains structured information such as crime type, location, time, method of operation, evidence details, and suspect information. By analyzing these attributes, the system identifies similarities and patterns that may indicate a connection between cases.

The system follows a data-driven approach, where decisions are based on historical data rather than manual assumptions. This reduces human effort and increases the reliability of the investigation process.

3.2 Architecture of the System

The proposed system consists of several interconnected modules:

1. Data Input Module

This module allows users (e.g., police officers or investigators) to enter crime details into the system. The input includes:

1. Type of crime (robbery, theft, assault, etc.)
2. Location of the crime
3. Date and time of occurrence
4. Description of the incident
5. Evidence details (weapons used, method, clues)
6. Suspect information (if available)

2. Data Preprocessing Module

Once the data is entered, it undergoes preprocessing to ensure consistency and accuracy. This includes:

- Removing duplicate or irrelevant data
- Handling missing values

- Converting text data into structured format
- Normalizing values for comparison

This step is essential to improve the performance of the pattern matching algorithm.

3. Feature Extraction Module

In this stage, important features are extracted from the input data, such as:

- Crime category
- Geographic coordinates
- Time intervals
- Modus operandi (method of crime)

These features are used to represent each crime case in a structured form for comparison.

4. Pattern Matching and Similarity Analysis

This is the core component of the system. The system compares the new crime data with historical records using:

- Similarity measures (e.g., distance-based comparison)
- Machine learning techniques (e.g., clustering or classification)

The system calculates a similarity score between the new case and existing cases. If the score exceeds a predefined threshold, the cases are considered related.

5. Case Linking Module

Based on the similarity analysis:

- If a match is found → The system retrieves and displays related past cases
- If no match is found → The system outputs "No results found"

This helps investigators quickly identify whether the crime is part of a pattern or a standalone case.

6. Database Management System

All crime records are stored in a centralized database. The database:

- Maintains historical crime data
- Enables fast retrieval and updates
- Supports efficient querying and indexing

7. User Interface Module

The system provides an easy-to-use interface where users can:

- Enter crime details
- View matched case results
- Analyze patterns visually

3.3 Working Mechanism

The overall working of the system can be summarized as follows:

1. A new crime is reported
2. Investigator enters all details into the system
3. System preprocesses and extracts features
4. Compares with historical crime data
5. Calculates similarity score
6. Displays:

a. Matching cases (if found)
b. Or no match result

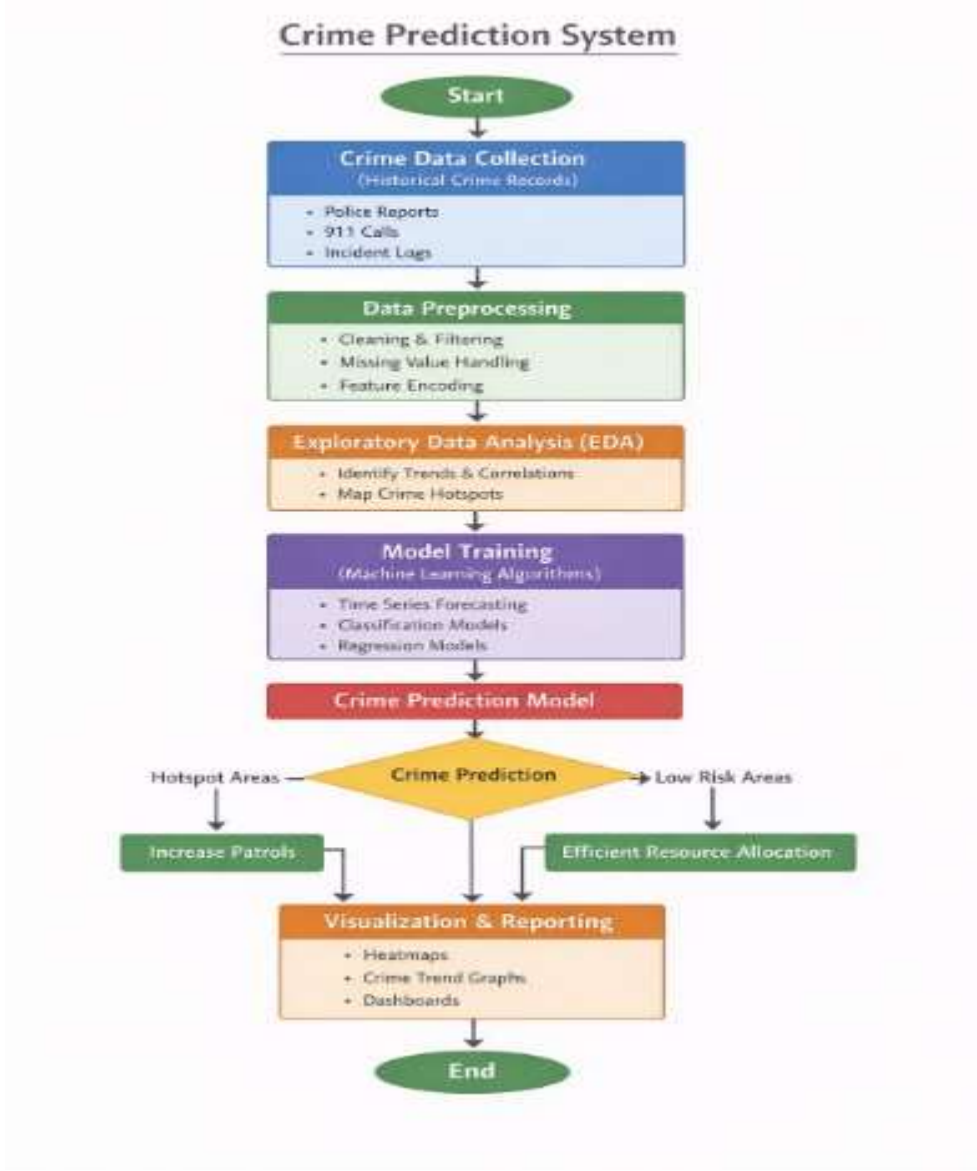


Fig.1 Architecture of the proposed system

3.5 Example Scenario

Consider a robbery case where:

- Crime occurred at night
- Similar method used (e.g., breaking locks)
- Same geographical area

The system compares this case with past records and identifies similar incidents. It then displays those cases, helping investigators identify possible suspects or crime patterns.

4. Results And Discussion

The proposed crime detection and case linking system was evaluated using a structured dataset containing multiple categories of crime records, including robbery, theft, and assault, to analyze its effectiveness in identifying relationships between new and historical cases. The system was tested by entering new crime details such as type of crime, location, time, and evidence information, and then comparing these inputs with previously stored records using pattern matching and similarity analysis te-

chniques.

The results indicate that the system successfully identified and retrieved relevant past cases when similarities existed, thereby demonstrating its capability in detecting patterns based on key attributes such as geographical proximity, time intervals, and modus operandi.

The use of feature extraction and preprocessing techniques improved the quality of input data, enabling more accurate comparisons and reducing noise in the dataset.

Additionally, the system showed a high level of efficiency in processing queries, with minimal response time, making it suitable for real-time applications in law enforcement environments. One of the significant observations was that the system effectively reduced the manual effort required for investigating crime records by automatically linking related cases, which traditionally would require extensive human analysis.

In scenarios where crimes followed similar patterns—such as repeated incidents occurring in the same area or involving similar methods—the system accurately grouped these cases and presented them to the user, thereby aiding in identifying potential suspects or recurring criminal activities.

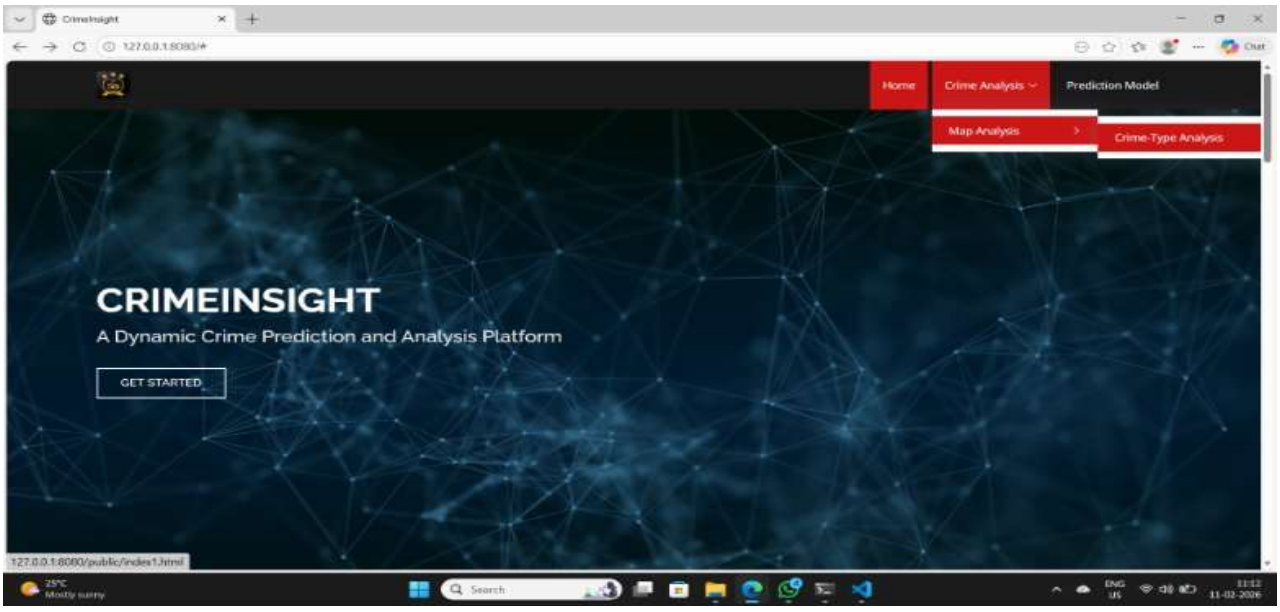
Furthermore, the system demonstrated scalability by handling multiple records without performance degradation, indicating its applicability in large-scale databases.

However, the system's performance is highly dependent on the availability and quality of historical data; incomplete or inconsistent data may lead to reduced matching accuracy or fewer relevant results.

In cases where a new crime did not share sufficient similarities with existing records, the system appropriately returned a "no results found" output, indicating that the case may be unique or previously unrecorded.

Despite these limitations, the overall performance of the system highlights its effectiveness as a decision-support tool for crime investigation, as it enhances the speed, accuracy, and reliability of case analysis.

By leveraging data-driven techniques and automated pattern recognition, the system provides valuable insights that assist investigators in understanding crime trends, linking related incidents, and improving the overall efficiency of law enforcement operations.



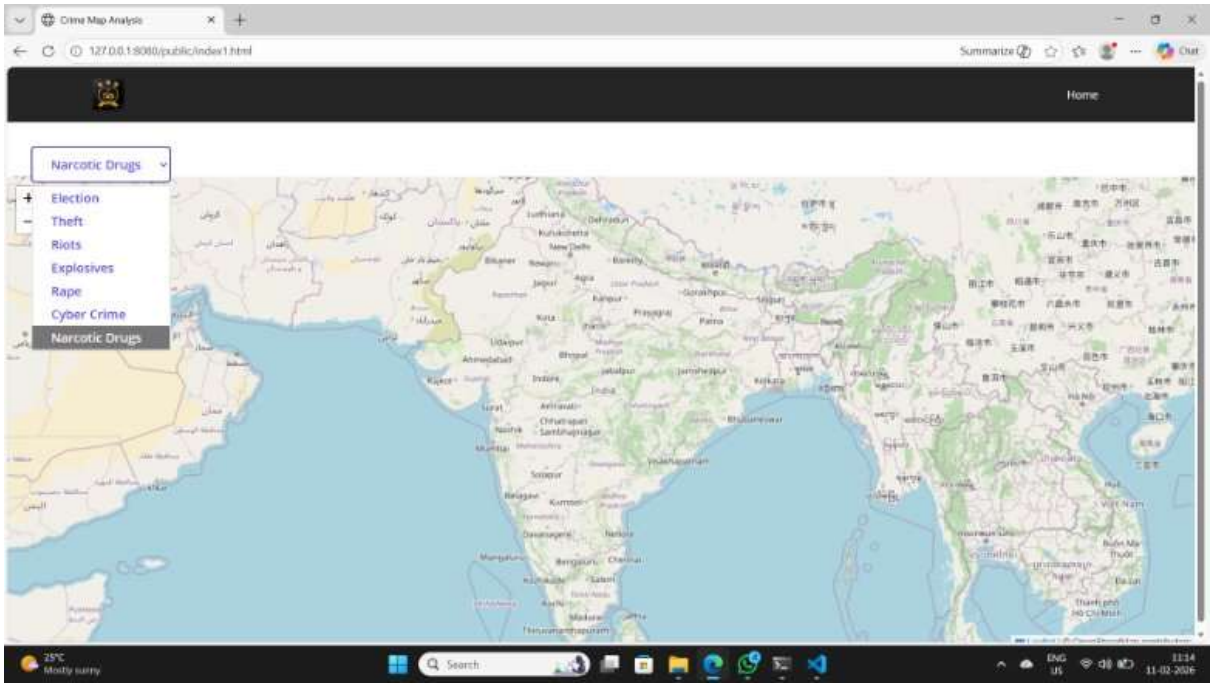


Fig 2 : User's Dashboard for Real-Time Crime

5. Conclusion

This paper presents a crime detection and case linking system that utilizes historical data analysis to support law enforcement investigations. By comparing new crime data with past records, the system helps identify patterns and relationships between cases. The proposed approach reduces manual effort, improves investigation speed, and enhances accuracy. The system demonstrates the effectiveness of integrating data analysis techniques in crime investigation and provides a foundation for further advancements in intelligent crime detection systems.

6. Future Enhancement

The system can be enhanced by integrating advanced machine learning and deep learning techniques for improved pattern recognition. The inclusion of natural language processing can enable analysis of textual crime reports. Real-time data integration and mobile application support can improve accessibility. Additionally, incorporating facial recognition and image analysis can further strengthen crime detection capabilities.

References

1. Chen, H., Chung, W., Xu, J. J., Wang, G., Qin, Y., & Chau, M. (2004). *Crime data mining: A general framework and some examples*. IEEE Computer.
2. Nath, S. V. (2006). *Crime pattern detection using data mining*. IEEE International Conference.
3. Wang, T., Rudin, C., Wagner, D., & Sevieri, R. (2013). *Learning to detect patterns of crime*. Machine Learning Journal.
4. Phillips, P., & Lee, I. (2019). *Predictive analytics for crime detection and prevention*. Springer.
5. Aggarwal, C. C. (2015). *Data Mining: The Textbook*. Springer.
6. Han, J., Kamber, M., & Pei, J. (2011). *Data Mining: Concepts and Techniques*. Morgan Kaufmann.
7. Kantardzic, M. (2011). *Data Mining: Concepts, Models, Methods, and Algorithms*. Wiley.

8. Ngai, E. W. T., Hu, Y., Wong, Y. H., Chen, Y., & Sun, X. (2011). *Application of data mining techniques in financial fraud detection*. Decision Support Systems.
9. Bolton, R. J., & Hand, D. J. (2002). *Statistical fraud detection: A review*. Statistical Science.
10. Jurgovsky, J., et al. (2018). *Sequence classification for fraud detection*. Expert Systems with Applications.
11. Carcillo, F., et al. (2019). *Scalable framework for fraud detection*. Information Fusion.
12. The above data is pictured in the next graph.Improper use of i.e.” and “e.g.”. (Proper usage: Andrew S. Effect of Non-visible Electromagnetic Particles on Photosynthesis”. https://www.example.com/volume-14/issue-5/effect-of-non-visible-electromagnetic-particles-on-photosynthesis