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Night Vision Patrolling Rover Navigation System for Women's Safety Using Machine Learning

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Abstract--- *Women safety is the biggest threat to India. There are many areas in which women are not feeling safe. This should be changed as much soon as possible. Technology changes and improves day by day to change the way human are living. So this paper focuses on updating technology framework to make stronger women safety mechanism. In this paper, we introduce a new security mechanism to safeguard women during abnormal activities. New security mechanism has been proposed based on the patrolling robot using the Raspberry Pi. Here night vision camera can be used for securing any premises. To improve the accuracy of the classifier, various machine learning models are used. Algorithms like Boosting, Bagging, Stacking and Enhanced reweight mechanism in Ensemble are used. Confusion matrix with individual classifier accuracy is considered for evaluating results. The results show that the proposed method performs well compared to existing algorithms.*

Keywords--- *Night Vision, Patrolling Rover Navigation System, Women's Safety, Machine Learning, Class Imbalance, Ensemble.*

I. INTRODUCTION

The idea behind this is to provide the security to women. Any abnormal activity and small interaction of sound results in the alert to concern authority. Then robot automatically goes to the particular area and capture the image of that area and send it to the user. Raspberry Pi (small powerful CPU) connected with the camera plays an important role in making an automatic robotic system [1], [2], [11].

The system uses cameras and mic mounted on the rover vehicle for securing[19], [20] any premises. The rover vehicle moves at a particular path and is equipped with a camera and sound sensors. It uses a predefined and dynamic line and dynamically generated lines to follow its path while patrolling. Rover stops at particular points and moves to next points if the sound is detected or else the dynamic routing takes place. The system uses Infrared (IR) based path following system for patrolling assigned area. It monitors and sensors each area to detect any problem using a combination of two HD cameras. It can monitor and sensors sound on the premises.

Robot hears and analysis any sound after the area is quiet and it starts moving towards the sound on its predefined and dynamic path. Then it scans the area using its camera to detect any human faces detected. It will capture and starts transmitting the images of the situation immediately to the IoT website. Here the IoT takes for

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receiving transmitted images and displaying them to the user with alert sounds. Hence we put forward a fully autonomous security robot that operates tirelessly and patrols large areas on its own to secure the facility. IoT is important today to get the best outcome for the real-time problem [9], [10].

Subsist Scenario

Asian region is one of the worst countries in crime. It has an offensive record in all types of sexual exploitation in residence, on streets, publically transports and even offices. Indian ladies are in a very constant state of vigilance, sort of a country on terrorist alert. There are grotesque cases of rapes of toddlers, gang rape of eight years kids and girls trafficking. We have created a nation wherever ladies are learning to deal with existential anxiety and that we seek to be mortified.

In the current system, rover's has been controlled remotely. Where the person uses the controller to monitor the area using remote, but manually controlling more humans are required to implement this system.

II. LITERATURE REVIEW

Today technology is everywhere and everything. So the generation of digital data is too big. If we perfectly use this data, we can get valuable insights in many way. Many existing systems do not have a perfect automated mechanism to provide safety to women from unwanted activities. Authors used the Apriori Algorithm [8] in this system. They implemented Prediction technique with Rule Technique to predict the criminal's future planning crimes and individual criminal likely to perform in the future. Results provided 80% accuracy.

Sexual and Violence based on Gender is increasing day by day due to various factors. Both these are collectively called as Violence against Women. These activities are mainly committed against women community. Authors in [7] analyses this type of crimes based on the age groups of the criminals. Their analysis includes processing steps such as data preparation, cleaning, transformation, reduction and analysis [2].

Authors in [3] used crime patterns and evidence-based methods. Crime dataset for crime analysis by polices in England and Wales from 1990 – 2011 is taken to measure the performance of the new method. Techniques like Outlier detection using distance operator (k-NN), Genetic Algorithm used for optimizing of outlier detection operator parameters are used. The classification was done using Decision Tree using the GINI index and the testing and training done using Sample Stratified. The results for the optimized and non-optimized parameters were compared to show the difference in quality and effectiveness.

Geolocation based and spatial based methods are used by authors of [4]. Datasets such as SNAP Gowalla a dataset, Data SF criminal dataset are considered in this paper. Random Forest (RF), Linear Regression (LR) and Support Vector Machine (SVM) were used as existing algorithms. Random Split method utilized with 80% for training and 20% for testing in classification. Crime Areas plotted using Google Map API and Open Street Map in the San Francisco Bay area and Criminal pattern discovery according to the context of user activity and location-based social networks. Predict crime frequency and find which crime is to be more difficult or easier to be predicted.

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Kamal Taha et al., in [5] proposed communication-based methods. They have taken the flow of communications/information links between two criminals such as phone call records, messages,etc.) Names of criminals/suspects, the type of crime, location and date of the crime and etc., Real-world data sets like Enron email dataset, Nod obo mobile phone records dataset are used in this paper. Authors measured Recall, Precision, and Euclidean Distance.

Authors in [6] used a different approach to crime detection. Their main aim is to identify the crime factors rather than focusing on the causes of crime occurrences. They used data mining to extract previously unknown useful information from unstructured data. Authors predicted criminals based on the crime data. This paper gives different types of criminal analysis using several machine learning.

An imbalanced data set can be balanced either using data level or algorithm level approach.

Data-Level Approaches

At the data level, the objective is to balance the classes using some sampling methods. Altering the class distributions towards a more balanced distribution. Sampling approach can be distinguished into the over-sampling approach and under-sampling approach [12], [14], [16].

Under-Sampling - There are much more samples of one class than the other class in the imbalanced class distribution problem, so the under-sampling approach is used to reduce the number of samples in the majority class. Random Under-Sampling (RUS) and Tomek links come under this category [14] .

Over-Sampling - The over-sampling approach increases the number of minority class examples by replicating the examples of a minority class or synthetic generation of examples to reduce the degree of imbalanced distribution. Random Over-Sampling (ROS*)* and SMOTE come under this sampling [17].

Algorithm Level Approaches

The methods at the algorithm level provide the steps to the classifier to classify the examples [6]. Because of this reason, traditional boosting algorithms do not perform well in the minority class. In recent years, some algorithms are studied to combine the data level approaches with the algorithm level approaches to solve the class imbalance problem [3].

Boosting - It is another technique which is used to improve classification performance. It is a technique which can be used to improve the performance of any weak classifier. The widely used boosting algorithm is AdaBoost, which iteratively builds an ensemble of models [6].

AdaBoost is an algorithm level approach which does not have any pre-processing method. It took more iteration, during each iteration example weights are modified with the goal of correctly classifying examples in the next iteration, which were incorrectly classified during the current iteration. Without balancing the imbalance problem it increases the accuracy [6].

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SMOTEBOOST It combines the Smote algorithm with the Boosting algorithm which is based on AdaBoost. During each iteration of boosting, SMOTE is applied to the training data is to achieve the more balanced training data set [6].

RUSBOOST is used to improve the performance of the trained data which combines the AdaBoost algorithm with the RUS algorithm. RUSBoost is based on Smote Boost which in turn based on AdaBoost by using an over-sampling technique(SMOTE)which helps to balance the class distribution, while AdaBoost improves the classifier performance using these balanced data. RUSBoost also achieves the same result but it uses RUS rather than SMOTE [6]. Various enhancements of ensembles are presented in [15], [18].

III. PROPOSED SYSTEM

Raspberry PI (Small powerful CPU) is installed with the night vision camera which help the system to go for the automation and help to find the human involving in any problem detected using the sound using sound sensor and according to the sound produced it automatically goes to that area and capture the image and send it to nearest police station using IoT technology. Figure 1 shows the detailed architecture of the novel proposed system architecture.

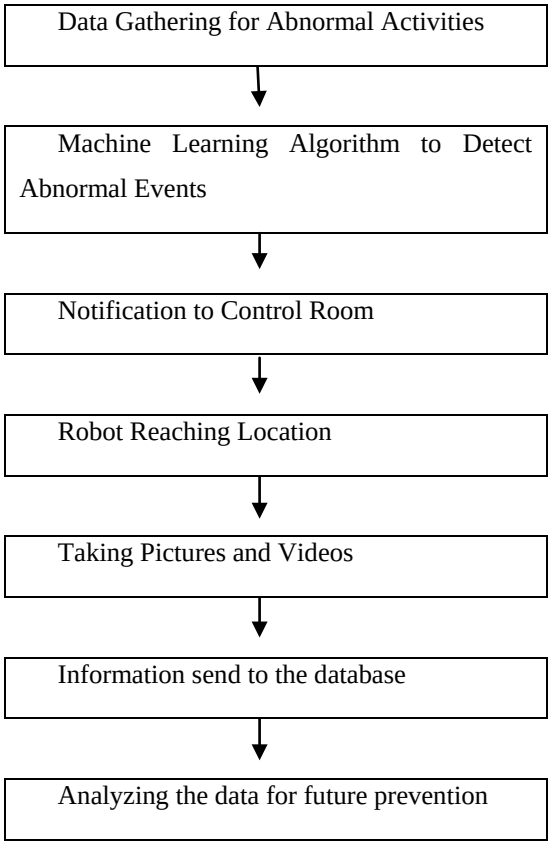

Fig.1: Proposed System Architecture

The robot receives and finds any audio if the area is silent and it gets ready to move towards the audio on its predefined and active way. Any human face is detected and then it scans the place with the help of its camera. Once

the image is captured, then the process is started transferring the images to the IoT website. The user receives the image with an alert sound. Figure 2 shows the rover vehicle.

Fig.2: Rover Vehicle

Monitoring Section

Motions are detected and actions will be performed like recording, taking the photo, sending the notification. User can add stroke to receive photos of the event via email after they occur. Keep track of all actions and alerts generated for every camera. Whenever motion is detected, the appliance records all activities and keeps an event log and history. The event log shows the time of prevalence and outline of the activity. Minimize the number of false alarms by masking motion in concern areas. User can add a mask on the camera read to exclude concern areas from motion detection. This may minimize the number of false alarms and unwanted notifications. Figure 3 shows the tracking the motion and capturing the photo details.

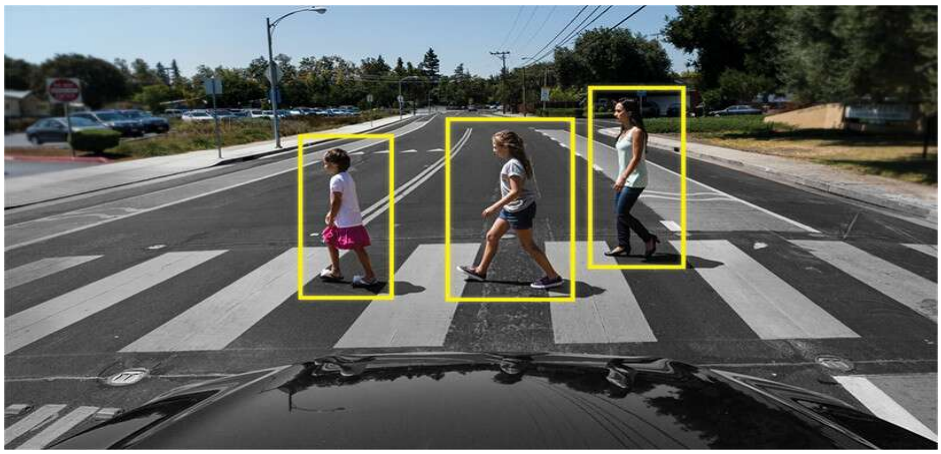

Fig.3: Tracking the motion and capturing the photo

Navigation System

The ultimate goal of this robot is to reduce the time in the periodic checking process. The robot automatically finds the current route with the navigation system. Reflective tape is used to mark the turning points, all corners and edges. The infrared sensor is used in the robot to detect the tape. The robot will travel in a straight line until it finds a reflective tape, representing a checkpoint. Internally stored data tree is having all set of data such as next checkpoint, turning directions and carry on in a straight line.

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Robot Vision

The artificial intelligence is the most used in this security robot for finding and detects the attackers and gives warning alert to the human operator. Neural networks are very highly flexible in processing the data structures which consist of an n number of nodes organized in layers. The relationship of Each node is weighted and the known weights are adjusted robotically by using the neural network's test data.

The captured images taken by the robot by using the camera and detected messages are divided and randomly, any one of the frames are inserted into the neural network. When human pictures are detected, the neural networks should stop the robot and the alert message is given to guards.

Implementation Process

The components of the robot are made up of pieces using the shelf Vex robotics kit. The pieces are connected together with hex bolts. A laptop is fitted on the top the frame which services all the processing power of the robot. The 4 Vex Omni Directional wheels are attached with robot for effective Movement. A Vex Spin Motor is used to drive each wheel. Phidgets Distance sensors are equipped to the frame with the support of nuts, bolts and 6-32 screws. The forward sensor is mounted on the front frame rail along with the left and right sensors are mounted on their respective side rails. A slotted angle bracket is attached with a reflective sensor which is facing downward and this bracket has a slot which allows changing the height of the sensor for the different floor surface. Equipment like motor, power and other controls are placed on circuit boards using strips of Velcro for the purpose of flexible removal. The USB hub with Velcro and Phidgets Interface, with 6-32 screws place on the front board. The rechargeable battery with Velcro, Phidgets Controller and Phidgets Distance Sensor Interfaces with 6-32 screws are placed in the rear board. Figure 4 represents the Raspberry PI with the system peripherals.

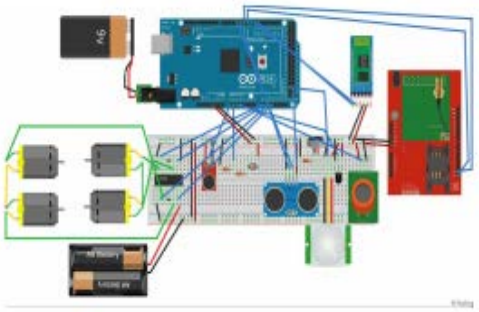

Fig.4: Raspberry PI with the system peripherals

Learning Algorithm

For developing a neural network, training is a key part. The expected and actual output should have a minimal difference for two neutrons based on the connection weights. For this, the neural network should compute the (EW) error derivative of the weight and a backpropagation algorithm was taken due to neurons are linear in the network. The rate of error changes the level of a unit is calculated. The EA is computed with our system to find the hidden

unit in all layers before the output. In the initial state hidden unit and the output units, weights are calculated. After that weights from the EAs of that output, units are multiplied and the products is added. The resultant sum that we find is equal to the EA for the hidden unit. Before the output layer, the system calculates the hidden layer and then computes EA for other layers.

It was decided to try a number of different designs to see which had the best results. Since it takes a substantial time to train each network increasing with the resolution of the input image, the experiment was done using low-resolution pictures. The goal of the experiment was to find the optimal number of hidden layer nodes to produce the most accurate results.

Enhanced Reweight Menanism In Ensemble

Algorithm Steps

1. Apply any base classifiers like decision tree, naïve Bayes in the first iteration
2. Calculate the number of correctly classified instances and misclassified instances in each class after the first iteration
3. Now calculate the PC1 and PC2
4. If PC 1 is greater than PC 2 then follow the below steps in the second iteration
CRC1=1
CRC2=PC2/PC1
5. If PC2 is greater than PC1 then follow the below steps in the second iteration
CR2=1
CR1=PC2/PC1
6. Now calculate the new weights based on previous iteration results
7. Learn the deep networks based on the ensemble in upcoming iterations

NC1=Instances taken for training (model) from class 1 (Not Crime) class in the first iteration

NC2=Instances taken for training (model) from class 2 (Crime) in the first iteration

PC1=% of Instances correctly classified which was taken for training (model) from class 1 (Not Crime) in the first iteration

PC2=% of Instances correctly classified which was taken for training (model) from class 2 (Crime) in the first iteration

CRC1=Class reweight in the class 1 (Not Crime)

CRC2=Class reweight in the class 2 (Crime)

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IV. SYSTEM DESIGN AND RESULTS

A. Requirements For Making The System

Raspberry Pi - Low-cost credit-card-sized machine that connects into a computer display or television, and uses a keyboard and mouse. It is an accomplished little device that enables populace of all ages to walk around computing and to study how to program in Scratch and Python languages.

Night Vision HD Camera - Infrared night vision combines infrared enlightenment of spectral range between 700 to 1,000 nm with HD cameras perceptive to this light. The result, which is apparently dim to a human viewer, appears as a monochrome figure on a usual display tool.

Sound Sensor - Used to notice the sound, this sensor is used to notice the intensity of sound. IR Sensor - Specific light sensor to find a light wavelength in the Infra-Red range

DC Motor (Robot module) - Designed to change the electrical present into power that will force the workings to a robot by apply a firm degree of torque to the motor beam. Raspbian Jessie - Operating system and Raspbian is extremely optimized for the Raspberry Pi line's low recital ARM central processing unit. Figure 5 shows the block diagram.

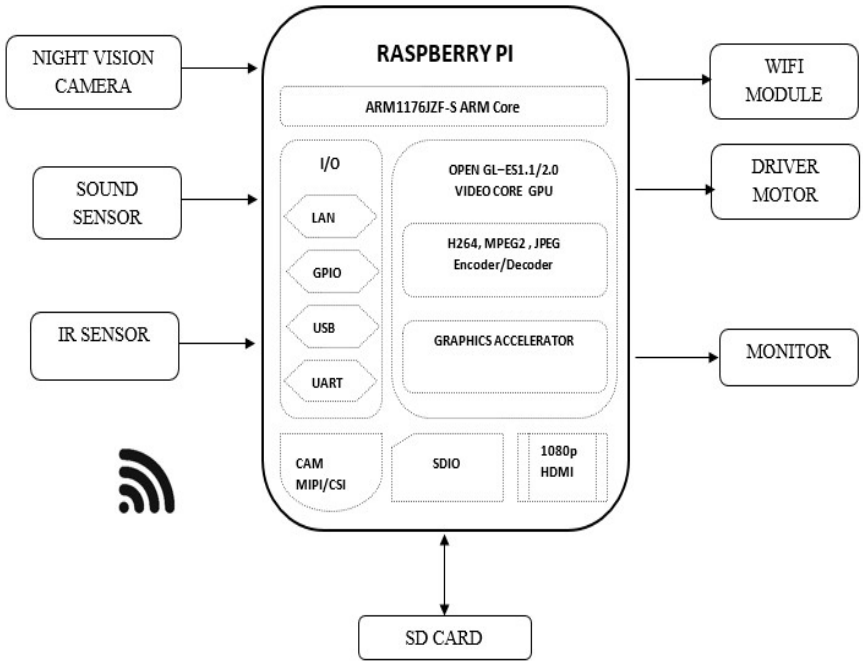

Fig. 5: Block Diagram of the system

In this System, Infrared Sensor is used to make the robot move automatically following a specific path. The sound sensor is used to know the sound in a particular area. IoT is used to send the captured image to the police station. Then Connect USB HD camera with the raspberry pi and also connect Power Bank to Raspberry pi. Plug the HDMI cable to Raspberry pi from the monitor using VGA to HDMI converter cable. Finally, Connect USB Mouse and USB keyboard to the Raspberry pi.

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B. Dataset

It is important that any system has good accuracy. In order to get that accuracy, synthetic dataset is created. To get the best-trained model, all the possible records have been created. Dataset consists of session details like Morning, Afternoon, Evening, Night, Location details city, rural and etc.,

C. Performance Metrics

This paper uses the confusion matrix and two additional metrics which were derived from the confusion matrix as the evaluation method to calculate the performance. True positive represents the positive records that are correctly classified, while True negative represents the positive records that are incorrectly classified. True negative represents negative records that are correctly classified, while false negative represents a negative class that are incorrectly classified. TABLE I gives the confusion matrix details.

Table I: Confusion Matrix

Actual class/ predicted class	**Class1**	**Class2**
Class1	True positive (Not Crime – Not Crime)	False negative (Not Crime – Crime)
Class2	False positive (Crime – Not Crime)	True negative (Crime – Crime)

Table II: Parameters Used For Evaluation

TM1= Total number of instances in class 1 (Not Crime)
TM2= Total number of instances in class 2 (Crime)
TOC= Total number of instances in both the class
CM1=Total number of correctly classified instances in class 1 (Not Crime)
CM2= Total number of correctly classified instances in class 2 (Crime)
COC= Total number of correctly classified instances in class 2 (Crime)
Efficiency can be calculated by using the formula,
Overall Efficiency (OAA) = COC/TOC
Majority Efficiency (MAA) =CM1/TM1
Minority Efficiency (MIA) =CM2/TM2

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Consider a two-class imbalance problem. Class a has very large number of records, so it is considered as majority class (M2). Class b has very low number of records, so it is considered as minority class (M1).TABLE II discusses the various parameters used for evaluation.

D. Results

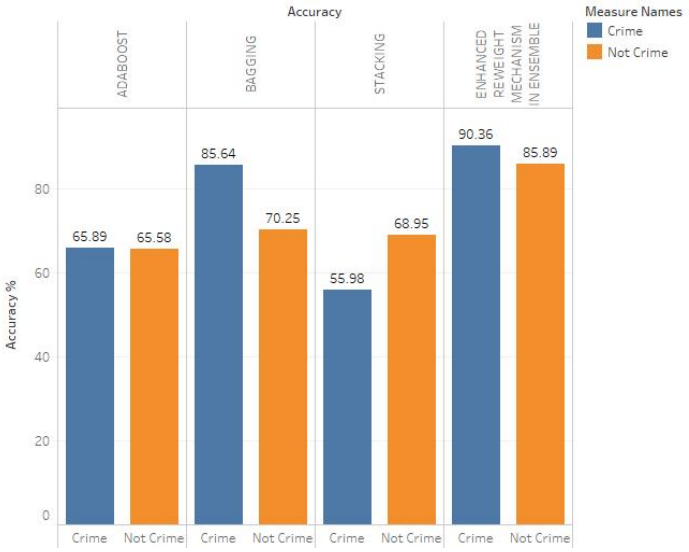

Fig.6: Accuracy – Class Imbalanced Data

The collected dataset consists of class imbalance in the ratio of 99:1. So the results are calculated based on 2 scenarios. The first scenario takes class imbalance data as input. The second scenario takes class balanced dataset using SMOTE.

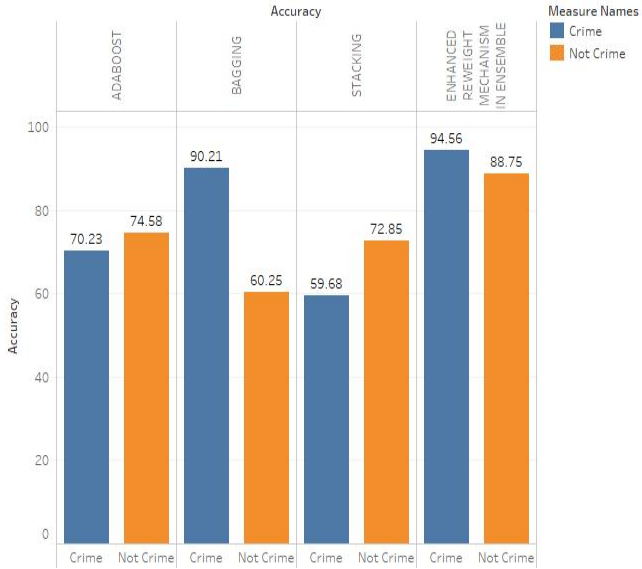

Fig.7: Accuracy – Class Balanced Data

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Adaboost, Bagging, Stacking, Enhanced Reweight mechanism in the ensemble are applied to both the datasets. Results show that the new algorithm gives better accuracy in most cases. Also, the importance of balancing classes is justified based on the results. In most cases, class balanced data and new algorithm provide good accuracy. Crime prediction with 95% accuracy is the highest accuracy. This accuracy is given by new ensemble algorithm.

E. Applications

The system could applicable in most popular areas like buses, trains, movement less locations, outer areas.

V. CONCLUSION

Wide range of area surveillance is done using the night vision camera fitted on the rover and also automatic system when the sound is detected robot will follow the particular path and go to that spotted area and capture the area and send to police station server using IoT. This concept is an automatic smart way to patrolling overnight to safe women.

Four algorithms namely Adaboost, Bagging, Stacking, Enhanced Reweight mechanism in the ensemble were considered in this paper. Results show that the new ensemble algorithm gives better accuracy in most cases. 95% accuracy is given by the new ensemble algorithm to correctly predict the crimes.

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