Facade Design Pattern for Theft Monitoring System with sms and phone call alert

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Abstract:

Every establishment may experience theft, which can result in the loss of priceless goods and interfere with routine business. We suggest designing and implementing a theft tracking system with SMS and phone call alerts to deter theft and lessen its effects. The system comprises a network of sensors positioned throughout the establishment in key areas. These sensors have motion detectors built in, so they can pick up on any movement in their field of view. The central control unit receives a signal from the sensors when they spot movement, analyses the data, and issues an alert. The central control unit is in charge of keeping an eye on the sensors and launching the necessary alarm when required. The proposed work is designed using facade design pattern and details are provided in the design section.

Keywords: theft monitoring system, SMS alert, phone call alert, sensors with motion detectors, central control unit, alert, theft prevention, security personnel, surveillance equipment, cost-effective solution, customizable, retail stores, warehouses, offices, reliable, efficient, and deterrence, Facade design Pattern.

1. Introduction:

Theft of motorcycles is a serious problem all around the world, and it has increased recently. The high resale value and convenience of motorcycles make them more desirable targets for thieves as they gain in popularity. Owners of motorcycles must therefore take the required safety measures to protect their vehicles. In this essay, we suggest a motorbike theft prevention and recovery security system. For the purpose of preventing and recovering stolen motorcycles, the system combines both hardware and software components[1]. A mobile application and a web-based interface are part of the software component, while a GPS module and a GSM module are part of the hardware. To stop unwanted access, the system also includes an alarm and immobiliser system.To show how well the suggested method works in preventing and retrieving stolen motorcycles, it is tested and assessed in a variety of scenarios.

Statistics show that motorcycle theft has become a serious issue in many nations, with numerous motorcycles being taken every day. It can be challenging and time-consuming to get a stolen motorbike back, costing the owner a lot of money. Effective motorbike theft prevention and recovery methods are therefore becoming increasingly necessary.[3] This problem is addressed by the proposed security system, which offers a complete remedy that not only deters theft but also facilitates the recovery of stolen motorcycles. The system's GPS and GSM components allow for real-time tracking and monitoring of the location of the motorcycle, and its web-based interface and mobile application allow for remote monitoring and control.By warning the owner and sounding an alarm when unlawful access is discovered,

the alarm and immobiliser system can also aid in preventing theft attempts. Overall, the suggested approach is a trustworthy and effective method of preventing and recovering stolen motorcycles, giving motorbike owners piece of mind.

One solution for motorbike naps is the Scorpio Ride "Core" Cellular Motorbike Alarm and GPS Tracking System which is already on the market. It utilises a module that is built within the bike and an iOS or Android app [2]. It will notify the user through a Short Message Service (SMS) warning if the motorcycle has been stolen. It can track a vehicle's location as well.This system doesn't have enough safeguards against attempted theft.These factors led to the proposal in this study to modify motorbike security system options. Also, this study aimed to expand and enhance its features in order to better serve its objectives.

This cutting-edge vehicle security system may shut off the engine and notify the owner of the vehicle in real time. Thus, the theft of the motorbike is avoided. To facilitate the search and recovery of stolen motorcycles, this security system also includes image-capturing technology and the ability to pinpoint the motorcycle. This can be done through the GSM (Global System for Mobile Communication), GPS (Global Positioning System), sensors, system immobilisers, and cameras. The user can have full authority over the system through a mobile application.

2. Literature survey:

Crisgar et.al proposed a system [1] in which the vehicle owner can utilise a Progressive Web App-based User Interface, also built on Firebase, to manage device mode, display the location of the vehicle in real time on Google Maps, and compile historical data on vehicle movements.

Wijaya et.al proposed a system [2] so that the owner of the vehicle can use a Progressive Web App-based User Interface, likewise constructed on Firebase, to control device mode, show the location of the vehicle in real time on Google Maps, and accumulate historical information on vehicle movements.

Sarmah et.al proposed a system [3] which is suggested to be put to the test using a real-time deployment at the KU campus, accounting for 30 rooms for 60 days. It is found to be extremely beneficial in terms of safety from any theft and power savings when compared to existing systems.

Mohanasundaram et.al has proposed a system [4]. This system guards against theft while allowing users to view the specifics of the theft, highlighting those components, and saving the information on a USB drive. Examples of criteria include position, stance, lighting, background, camera quality, and gender.

Desnanjaya et.al proposed a system [5] using telegraph messenger, this is utilised to build a Raspberry Pi-based home security monitoring system. This system may give out temperature alerts, keep an eye on the home's security against burglars or criminals, and detect smoke or gas.

Nagamani et.al has proposed a system [6]. The recommended system is an anti-theft system for a smart house that can immediately recognise the burglar even if they cover their entire body with garments, blankets, or other large materials. Using advanced data handling techniques, this software's purpose is to find

and notify family members of human action that has not been authorised by the owner.

Palacean et.al has proposed a project [7]. This project's main objective is to enable people to use GPS tracking and real-time location reporting without being concerned about the tracker's size. There are many different alarm and tracking systems available for motorcycles.

Shammi et.al has proposed a project [8]." The main objective is to aid in and contribute to reducing the number of vehicle thefts from parking lots for a predetermined period of time, particularly at night. The disclosed edge detection approach has been used to have the best performance in preventing auto theft because of its accuracy and affordability.

Fahim et.al has proposed a system [9] such that it will have a network of cameras that, when they notice movement close to the transformer, go on alert and stream live video to the authority over a cloud network.It safeguards them from thieves and vandals by detecting any irregularities close to the distribution transformer and notifying the proper authority via SMS service.

Priya et.al has proposed a system [10]. Without physically altering the motorcycle, an engine immobiliser or kill switch is easy to install. The Global System for Mobile allowed the motorbike and the user to communicate. (GSM). The cellular network's coverage has an impact on the communication medium.

Gautam et.al has proposed a system [11]. In our suggested approach, fog computing is used to reduce propagation delay and raise the level of security for smart homes. The system begins once automatically, and it thereafter sends an email to the owner whenever an intrusion is detected so that the owner can take any necessary action.

Thamaraimanalan et.al has proposed a system [12]. They found a very small performance loss in the detection rate when they compared the plaintext model of power theft to the privacy-preserving model, which is seen to be a fair price to pay for privacy.

Logenthiran et.al has proposed a system [13]. In conclusion, SETS increases the security of the IoT-based smart home. The only legal use is for energy theft prevention systems, which can also be used in the commercial and industrial sectors.

Metlo et.al has proposed a system [14]. Compared to the existing method, the crowdsourcing-based car tracking system may be more efficient and less expensive. It uses smartphones similar to our own. There is no obligation to install extra tracking devices or sensors inside the cars to provide location data.

Khan[15] et.al has proposed a system that has been demonstrated that our proposed system is autonomous for spotting any kind of vehicles or objects, alerting the driver, monitoring the space between them, inspecting their engines and CNG cylinders, spotting accidents, and sending their GPS locations to emergency services and black boxes separately.

Prakash et.al has proposed a system [16]. If any unauthorised individuals attempt to use an illegal ignition key to start our car, a notice will be sent to the owner. After seeing the notice, the owner can shut off the engine by sending a message to the microcontroller. Additionally, we can use the GPS technology to locate the car accurately.

Mucheli et.al has proposed a system [17]. By using this method, customer power theft's severe power and financial losses are reduced. This theory suggests that locating the places where power theft occurs and notifying the authorities can effectively reduce it.

Beniga et.al has proposed a system [18] They ha've proposed a system that abruptly alerts the homeowner to the theft that is occurring. This idea enables the use of wireless sensing and theft detection. Additionally, it does away with the need for a DVR for recording and wasteful memory storage usage.

Jeffin et.al has proposed a system [19]. The smart metres at various nodes form a device layer. The IoT server layer is performed by the cloud server, while the client layer is performed by the android application developed for users and authorities .

Chandramohan et.al has proposed a system [20] using Arduino and Wi-fi." The microweb-server for the smart home can be accessed remotely (through the internet); this requires user identification and the genuine IP address of the server. monitoring and management of the apparatus. Setting up automated smart home environments and task scheduling. a password changing option. allows voice activation for function switching.

Javvaji et.al has proposed a system [21].The proposed system is built by creating code in the Arduino IDE and uploading it to the Node MCU to monitor temperature, lighting, gas, motion, and security. By including a camera, control and monitoring tasks are improved.

Al-Hadhrami et.al has proposed a system [22]. An IoT platform (ThingSpeak) with the Blynk Application has been used in conjunction with a mobile app to remotely monitor household appliances and to communicate with them when particular conditions are met. This study also made use of systems for home security and fire protection.

Karnik et.al has proposed a system [23]. The system has an alarm feature that uses the Blynk mobile app to simultaneously alert the user and their immediate neighbours. If the thief tries to use the automobile in any criminal activity, the owner will be called, and the owner can lock the engine using a password. The engine won't restart unless the owner enters the password.

Gupta et.al has proposed a system [24]. The suggested system is an easy-to-use home monitoring and safety system that makes use of ultrasonic, gas, and temperature/humidity sensors to increase safety. We might further improve the capabilities of this device by integrating sensors like PIR and IR ones and networking them.

3. Methodology:

Three parts make up the suggested methodology: Data Collecting and Acquisition, ML Models, and Actions are taken. The data flow diagram displays the suggested methodology's workflow.

3.1.1. Data collection and acquisition: 8000 images with 5 captions from the Flickr 8k dataset, Kaggle, and Google Images are included in the datasets used. This dataset's fit allows for the preparation of the demonstration. Larger the quantity of images, the more difficult it is to produce the show using the available computer resources.

An IP camera connected to the remote organiser is used to record video. This is frequently accomplished by using the OpenCV library. As soon as the video is recorded, it is managed and converted into picture frames. These image sketches are subsequently fed to ML models to support research.During information pre-processing, the picture is converted into a fixed-size vector, and the vector is then supplied to a convolutional neural network (CNN) based on exchange learning. Based on the ImageNet dataset, this example attempts to conduct picture classification on 1000 different image classes. However, we eliminated the last SoftMax layer from the display and extracted a 2048-length vector (bottleneck highlights) instead since we were required to extract a fixed-length helpful vector for each image.

3.1.2. ML Models: There are several ML models like Classification models, clustering, Regression models etc Several ML models[25] are given processed image frames. To analyse various assessment parameters, each model completes a task in a specific order[26].

A programme that uses a dataset that has never been seen before to detect patterns or make choices is known as a machine learning model[27]. Machine learning algorithms[28], for instance, can analyse and accurately identify the intent underlying previously unheard utterances or word combinations in natural language processing[29].

A machine learning model may be trained to recognise items in images, such as vehicles or dogs[30]. Such tasks can be accomplished by using a machine learning algorithm that has been 'trained' on a sizable dataset [31]. Depending on the job, the algorithm used for machine learning [32] is tuned during training to identify particular patterns or outputs from the dataset. Machine learning models [33] are the results of this process, which can frequently take the form of computer programmes with particular rules and data structures.

3.1.3. Actions: Various measures, like raising alarms, sending alert messages to the owner just, sending alert messages to the police specifically, or sending an alert message to the owner and the police as well, will be taken in line with the findings derived by the ML models.

3.2.Key features:

3.2.1.Motion Detection: Using CNN, we first determined whether or not there were any humans in the frame before detecting motion. Convolution is used for blurring, sharpening, edge detection, and noise reduction that are difficult for other techniques to accomplish.

3.2.2. Mask Detection: When committing a steal, thieves frequently disguise themselves by donning masks. This module produces an output which aids in establishing if the theft is true or untrue. This module's data set comes from Google Images and Kaggle. The Chrome Driver extension and the Selenium package are used to scrape Google pictures.

The information set used to train the model included 1000 photos of two different people, one wearing a mask and the other not.

3.2.3. Facial Expression Detection: The photos are cropped around the faces and the intensity is standardised as part of the pre-processing stage.

Local descriptors are computed and features are extracted. In order to represent this calculation the VLAD term stands for Vector of Locally Aggregated Descriptors. This labelled dataset is trained on the emotion classes using the SVM classifier. Finally, a

haar cascade classifier is implemented to extract the face from the image after it has been cropped into 256 256 dimensions.

3.2.4. Weapon Detection: Another crucial module for identifying real threats from fake ones is weapon detection [8]. Our method for finding weapons is similar to mask detection, with the exception that we first utilise a haar cascade to find a person's hand before looking for a weapon in it. We utilised a data set comprising 4000 photos of each person with a weapon and without a weapon to train the model. The photos included in the dataset have categorical labels. Hence, in order to translate the categorical labels into binary values, we employed a one-hot encoding. We employed augmentation approaches to get decent accuracy because our dataset was tiny.By producing altered versions of the dataset's photos, a technique called data augmentation may be used to artificially increase the dimensions of a training dataset.

3.2.5. Pose detection: The problem of estimating human posture is usually referred to as computer vision techniques that anticipate the possibility of altered human keypoints (joints and points of interest) such as elbows, knees, neck, bear, hips, and chest, among others.
It's an extremely difficult problem because of various factors like little, scarcely audible details, occlusions, and significant enunciation inconsistencies. The graphical structures system is used in the traditional method of enunciated posture estimation. The main idea behind this is to respond to a query with a collection of "pieces" arranged in a very flexible configuration.

3.2.6. Activity Captioning: Using computer vision and natural language processing, activity captioning is a real-time task akin to image captioning. It can take an image and provide a plain English description of what is happening in the image. This module is crucial for figuring out what the individual in view is doing in terms of their course of action. By annotating the camera's captured frames and then notifying the authorities, surveillance systems can be utilised to identify theft. By leveraging the ResNet50 architecture trained on ImageNet weights, we applied the transfer learning method once more.The findings from the aforementioned six modules are aggregated, and after that, they are used as input by an ML model to determine whether to send an alarm message to the owner, the police, or both. The message will include an image that was taken with the camera along with the various attributes that our six modules were able to extract. To cut costs, we might potentially utilise a Raspberry Pi rather than a standard PC.

3.3.Flow diagram:

Flow diagram for the proposed system is given in the Fig.1

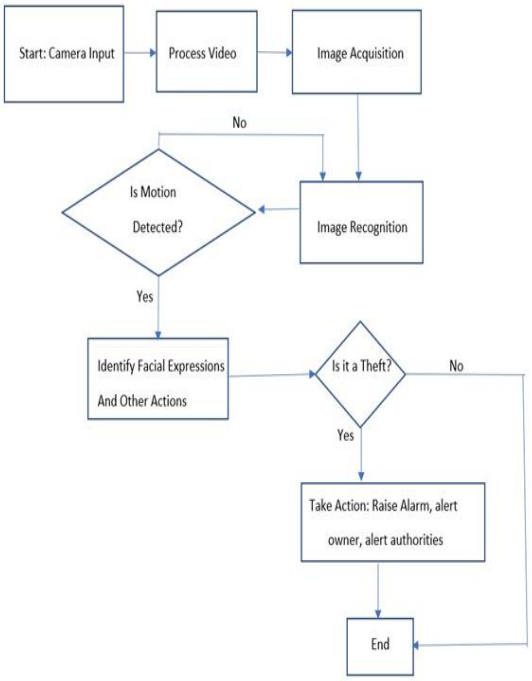

Fig.1: Flow Diagram

4. Design:

4.1. Use case diagram:

Use case diagram for the Theft Monitoring System is shown in the Fig.2

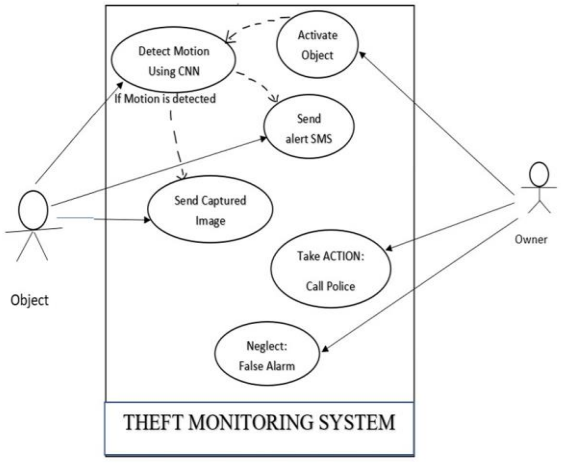

Fig.2: Use case Diagram

4.2. Activity diagram:

Activity Diagram for the Theft Monitoring System is shown in the Fig.3

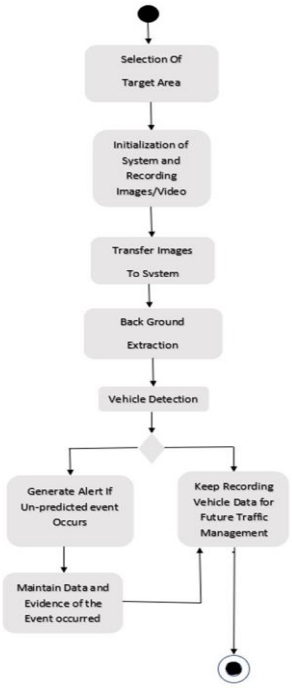

Fig.3:Activity Diagram

4.3. Sequence diagram:

The Sequence Diagram for the Theft Monitoring System is shown in the Fig.4

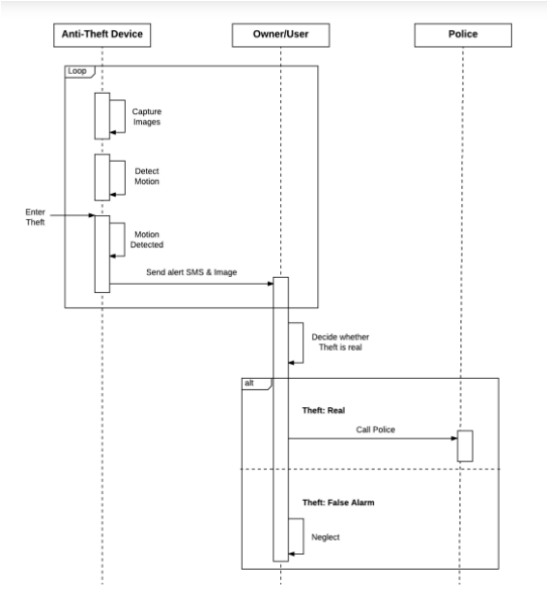

Fig.4:Sequence Diagram

4.4. Class diagram:

Class Diagram for the Theft Monitoring System is shown in the Fig.5

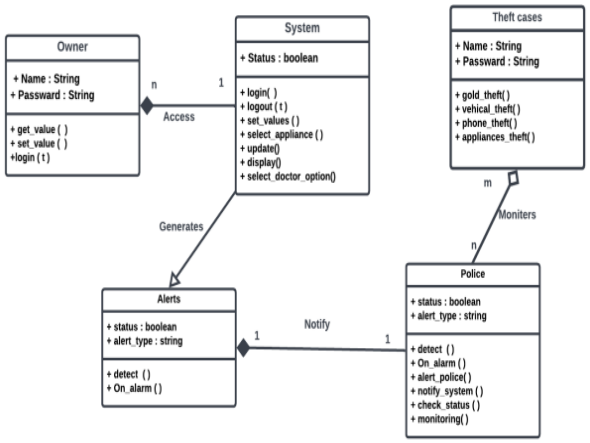

Fig.5:Class Diagram

4.5 Facade design pattern:

Diagram for the Theft Monitoring System is shown in the Fig.6

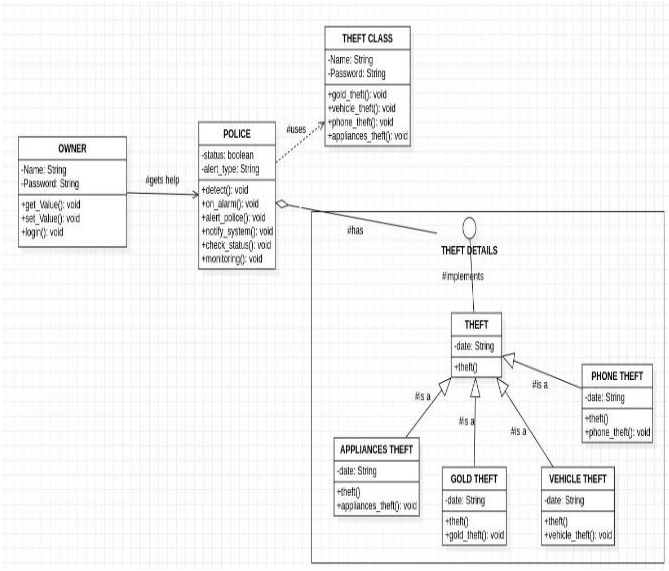

Fig 6: Façade class Diagram

According to Gang of Four, “The intent of Facade Pattern is to provide a unified interface to a set of interfaces in a sub-system” [34].

By using Facade pattern, the Theft Monitoring System can present a simple, unified interface to the user, hiding the complexity of underlying sub-systems.

4.6. State diagram:

State Diagram for the Theft Monitoring System is shown in the Fig.7.

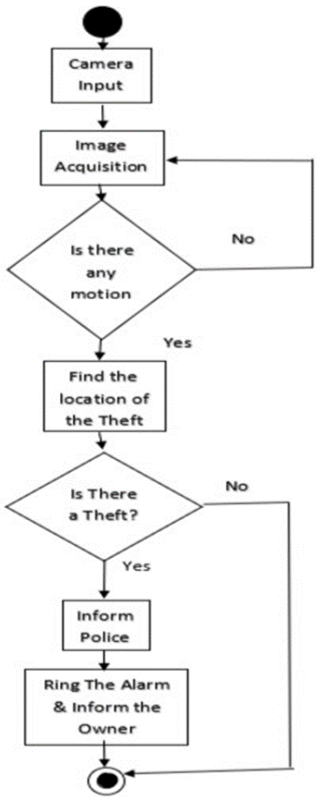

Fig 7:State Diagram

5. Results:

Our product was built using Flutter, which allowed us to create a highly responsive and visually appealing mobile app that works flawlessly on both Android and iOS platforms.

Application contains:

- Login page as shown in Fig.7
- Signup page as shown in Fig.8
- Calling nearest Police Station when theft has been detected which is shown in Fig.9 .
- Different views and the photos captured by the camera which are shown in Fig.10 and Fig.11
- Neighbour is shown in FIg.12

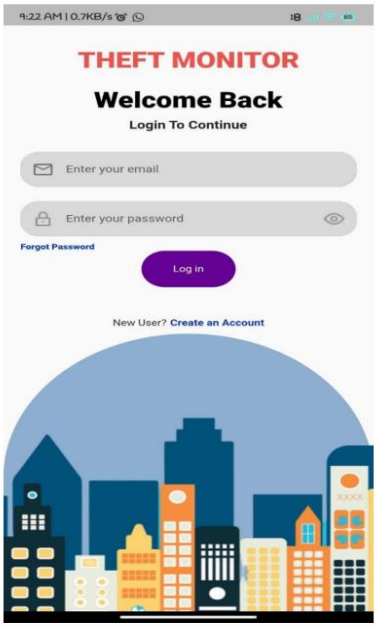

Fig.8:Login page

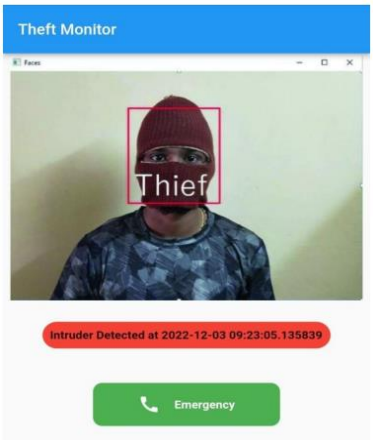

Fig.10:Call

Fig.11:Camera View

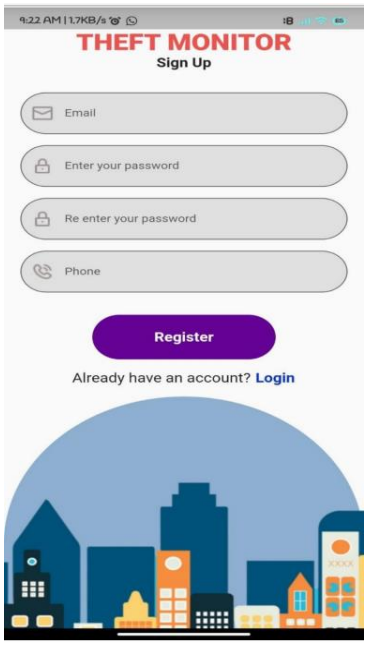

Fig.9:Sign up page

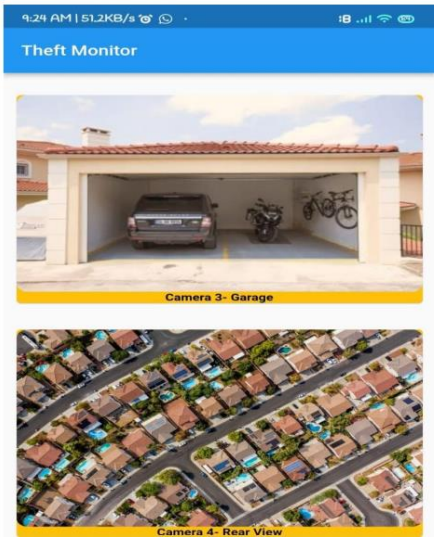

Fig.12:Camera View

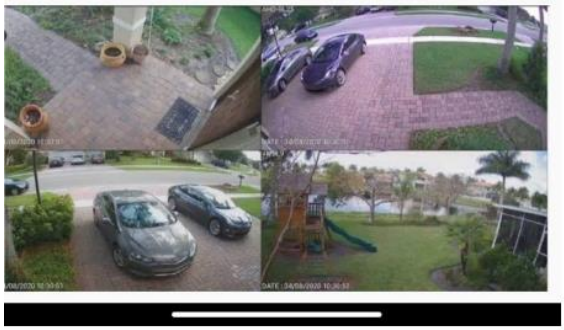

Fig.13:Neighbour

6. Conclusion:

A realistic approach for businesses wishing to prevent theft and lessen its effects is the design and implementation of a theft monitoring system with SMS and phone call alerts. A central control unit and sensors with motion detectors enable the system to instantly identify and notify the appropriate employees of any suspicious activity. This affordable option can be tailored to meet the requirements of diverse enterprises, including offices, warehouses, and retail outlets. A short response time and the ability to take prompt action are made possible by the ability to get SMS and phone call warnings with detailed information about the place and time of the suspected theft.

For businesses that would otherwise need to invest in costly security personnel and surveillance equipment, the deployment of this theft tracking system can save them a lot of money. Due to the greatly increased danger of getting caught and the potential repercussions of theft, this system can also serve as a deterrence to future thieves. Also, the system's adaptability makes it simple to integrate with current security measures and may be modified to meet the particular requirements of each organisation. This system's dependability and effectiveness make it a useful asset in preventing and lessening the effects of theft, giving business owners and managers peace of mind.

Overall, this theft tracking system with SMS and phone call alarm is a dependable and effective solution to stop theft, giving business owners and managers an extra layer of security.The proposed work has been improved by using facade design pattern.

7. References:

[1] Crisgar, P. V., Wijaya, P. R., Pakpahan, M. D., Syamsuddin, E. Y., & Hasanuddin, M. O. (2021, June). Gps-based vehicle tracking and theft detection systems using google cloud iot core & firebase. In 2021 International Symposium on Electronics and Smart Devices (ISESD) (pp. 1-6). IEEE.

[2] Shalini, S., Rachel, A. S., & Roshinee, A. R. (2020, March). Tracking Real Time Vehicle and Locking System Using Labview Applications. In 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS) (pp. 55- 57). IEEE.

[3] Sarmah, R., Bhuyan, M., & Bhuyan, M. H. (2019, April). SURE-H: A Secure IoT Enabled Smart Home System. In 2019 IEEE 5th World Forum on Internet of Things (WF-IoT) (pp. 59-63). IEEE.

[4] Mohanasundaram, S., Krishnan, V., & Madhubala, V. (2019, March). Vehicle theft tracking, detecting and locking system using open CV. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp. 1075- 1078). IEEE.

[5] Desnanjaya, I. G. M. N., & Arsana, I. N. A. (2021). Home security monitoring system with IoT-based Raspberry Pi. Indones. J. Electr. Eng. Comput. Sci, 22(3), 1295.

[6] Nagamani, T., Beniga, W. H., Dhanish, K. S., & Benitta, A. S. (2022, January). Anti- Theft Monitoring for a Smart Home. In 2022 4th International Conference on Smart Systems and Inventive Technology (ICSSIT) (pp. 76-82) IEEE.

[7] Palacean, A. V., Trancă, D. C., Contaşel, C., Tătăroiu, R., & Duţescu, C. (2021, November). IoT Enabled Optimized Architectures for GPS Anti-Theft Tracking Devices. In 2021 20th RoEduNet Conference: Networking in Education and Research (RoEduNet) (pp. 1-6). IEEE.

[8] Shammi, S., Islam, S., Rahman, H. A., & Zaman, H. U. (2018, February). An automated way of vehicle theft detection in parking facilities by identifying moving vehicles in CCTV video stream. In 2018 International Conference on Communication, Computing and Internet of Things (IC3IoT) (pp. 36-41). IEEE.

[9] Fahim, A., Chowdhury, M. A., Alam, M. F., Elahi, F., Shourov, E. C., & Hasan, M. (2021, January). Smart transformer theft protection and maintenance monitoring system. In 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST) (pp. 607-612). IEEE.

[10] Priya, B. J., Kunda, P., & Kumar, S. (2021). Design and Implementation of Smart RealTime Billing, GSM, and GPS-Based Theft Monitoring and Accident Notification Systems. In Proceedings of International Conference on Recent Trends in Machine Learning, IoT, Smart Cities and Applications: ICMISC 2020 (pp. 647-661). Springer Singapore.

[11] Gautam, R., Shrestha, R.,he existing work has been increased by using facade design pattern Mishra, S., & Singh, J. K. (2022). Blockchain Enabled Vehicle Anti-theft System. In Security and Privacy in Cyberspace (pp. 209-226). Singapore: Springer Nature Singapore.

[12] Thamarai Manalan, T., Mohankumar, M., Dhanasekaran, S., & Anandakumar, H. (2021). Experimental analysis of intelligent vehicle monitoring systems using Internet of Things (IoT). EAI Endorsed Transactions on Energy Web, 8(36).

[13] Li, W., Logenthiran, T., Phan, V. T., & Woo, W. L. (2019). A novel smart energy theft system (SETS) for IoT-based smart homes. IEEE Internet of Things Journal, 6(3), 5531- 5539.

[14] Metlo, S., Memon, M. G., Shaikh, F. K., Teevno, M. A., & Talpur, A. (2019). Crowdsource based vehicle tracking system. Wireless Personal Communications, 106(4), 2387-2405.

[15] Khan, M. H. U., & Howlader, M. M. (2019). Design of an intelligent autonomous accident prevention, detection and vehicle monitoring system. In 2019 IEEE International Conference on Robotics, Automation, Artificial-intelligence and Internet Of-Things (RAAICON) (pp. 40-42). IEEE.

[16] Prakash, K. J., Reddy, K. P. K., Goud, K. S. K., & Reddy, S. T. (2021, July). Vehicle theft intimation over sms and remote control of its engine. In 2021 6th International Conference on Communication and Electronics Systems (ICCES) (pp. 1496-1501). IEEE.

[17] Mucheli, N. K., Nanda, U., Nayak, D., Rout, P. K., Swain, S. K., Das, S. K., & Biswal, S. M. (2019, March). Smart power theft detection system. In 2019 Devices for Integrated Circuit (DevIC) (pp. 302-305). IEEE.

[18] Nagamani, T., Beniga, W. H., Dhanish, K. S., & Benitta, A. S. (2022, January). AntiTheft Monitoring for a Smart Home. In 2022 4th International Conference on Smart Systems and Inventive Technology (ICCSIT) (pp. 76-82). IEEE.

[19] Jeffin, M. J., Madhu, G. M., Rao, A., Singh, G., & Vyjayanthi, C. (2020, July). The Internet of things enabled

power theft detection and smart metre monitoring systems. In 2020 International Conference on Communication and Signal Processing (ICCSP) (pp. 0262-0267). IEEE.

[20] Chandramohan, J., Nagarajan, R., Satheeshkumar, K., Ajithkumar, N., Gopinath, P. A., & Ranjithkumar, S. (2017). Intelligent smart home automation and security system using Arduino and Wi-fi. International Journal of Engineering And Computer Science (IJECS), 6(3), 20694-20698.

[21] Javvaji, K. S. S., Nelakuditi, U. R., & Dadi, B. P. (2020, July). IoT based cost effective home automation and security system. In 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT) (pp. 1-5). IEEE.

[22] Alsuhaym, F., Al-Hadhrami, T., Saeed, F., & Awuson-David, K. (2021, July). Toward home automation: an IoT based home automation system control and security. In 2021 International Congress of Advanced Technology and Engineering (ICOTEN) (pp. 1- 11). IEEE.

[23] Karnik, A., Adke, D., & Sathe, P. (2020, December). Low-cost compact theft-detection system using MPU-6050 and blynk IoT platform. In 2020 IEEE Bombay Section Signature Conference (IBSSC) (pp. 113-118). IEEE.

[24] Gupta, M., Dhanush, J., Vikas, R., Krishna, S. B., Naik, A. R., & Gowda, C. (2022, January). A Safe and Reliable System for Monitoring the Home Remotely. In 2022 International Conference on Computer Communication and Informatics (ICCCI) (pp. 1-4). IEEE. [25]Ashwitha, A., & Latha, C. A. (2022). GSA-based support vector neural network: a machine learning approach for crop prediction to provision sustainable farming. International Journal of Intelligent Computing and Cybernetics.

[25] Ashwitha, A., & Latha, C. A. (2022). GSA-based support vector neural network: a machine learning approach for crop prediction to provision sustainable farming. International Journal of Intelligent Computing and Cybernetics.

[26] SALMA, S., & ASHWITHA, A. (2022). HYBRID CNN-LSTM MODEL: RAINFALL ANALYSIS AND PREDICTION FOR KARNATAKA REGION. Journal of Theoretical and Applied Information Technology, 100(22).

[27] Ashwitha, A., & Latha, C. A. (2022). Fuzzy Ranking Algorithm with Seagull Optimization-Based Decision Tree for Short-Term/Long-Term Rainfall Prediction. International Journal of Fuzzy System Applications (IJFSA), 11(3), 1-17.

[28] Deshmukh, Anusha Ashok, Anushka Srivatsa, A. Ashwitha, Arpith Monteiro, and Chaitanya Gajakosh. "Crop Yield Prediction to Achieve Precision Agriculture using Machine Learning." In 2022 IEEE 2nd International Conference on Mobile Networks and Wireless Communications (ICMNWC), pp. 1-6. IEEE, 2022.

[29] Ashwitha, A., Tonse, A. S., Kumar, M. B., & Hegde, A. K. (2022, November). Language Translation for Impaired People. In Proceedings of the International Conference on Cognitive and Intelligent Computing: ICCIC 2021, Volume 1 (pp. 231-240). Singapore: Springer Nature Singapore.

[30] Ashwitha, A., Latha, C. A., Sireesha, V., & Varshini, S. (2022, November). Comparative Analysis of Machine Learning Approaches for Crop and Yield Prediction: A Survey.

In Proceedings of the International Conference on Cognitive and Intelligent Computing: ICCIC 2021, Volume 1 (pp. 53-61). Singapore: Springer Nature Singapore.

[31] Ashwitha, A., & Latha, C. A. (2022). Crop recommendation and yield estimation using machine learning. Journal of Mobile Multimedia, 861-884.

[32] Kambli, P., Ashwitha, A., & Shruthi, G. (2021). e-Reside: A Case Study on Blockchain for IoT in Home Automation Using Raspberry Pi. In Convergence of Internet of Things and Blockchain Technologies (pp. 57-75). Cham: Springer International Publishing.

[33] Ashwitha, A., Shruthi, G., Shruthi, H. R., Upadhyaya, M., Ray, A. P., & Manjunath, T. C. (2021). Sarcasm detection in natural language processing. Materials Today: Proceedings, 37, 3324-3331.

[34] https://www.pearsonhighered.com/assets/samplechapter/0/3/2/1/0321247140.pdf