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Dynamic Key Based Smart Lock for Cargo Trucks

Amudha Jeyaprakash
Department of Electrical and Electronics Engineering, Dr. Mahalingam college of Engineering and Technology, Pollachi, Tamil Nadu, India.
Email: a_jeyaprakash@drmcet.ac.in

Rathika P D
Department of Robotics and Automation Engineering, PSG College of Technology, Coimbatore, Tamil Nadu, India
Email: pdr.rae@psgtech.ac.in

Thirumarai Selvi C
Department of Electronics and Communication Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil Nadu, India.
Email: selvichand@gmail.com

Abstract

The concept of a smart lock is to provide more safety and live tracking of a vehicle to reduce cargo thefts. In this project, a dynamic key password is used instead of a static key password, which further enhances the high - security level. This device is much safer than the traditional lock-key-based system and wireless system. This project involves Arduino Uno, GSM, GPS, tilt sensor, and servomotor. The servomotor acts as a lock, where GSM and GPS modules are attached to it. Once the lock is closed, the GPS module in lock tracks the live location of the truck every 15 minutes and sends the location of the truck as a text message to the owner number. A random OTP is sent as a SMS to the owner number via the GSM module once the truck reaches its destination. Then the owner confirms the OTP to generate another random OTP to driver number to unlock the lock. This lock will be opened only to the authenticated person by the use of the key generated. In case of a vehicle under collision or someone tries to open it notifies the owner by sending an alert text message with the current location.

Index Terms—Arduino Uno, GPS, GSM, double dynamic OTP and sensors.

I. INTRODUCTION

Cargo theft is a major problem around the world. These thefts mostly occur in truck stops, warehouses, carrier lots especially during transportation of trucks. Nowadays, it not only affects the high-value business but also the small-scale business leaving their business devastated. There is no suspen- sion of theft that arises until the goods/carrier fails to reach the intended destination. According to the highway studies the truck stops are the most targeted locations for theft. Many drivers feel uncomfortable during rest stops and due to lack of sleep accidents occur. Therefore there is a need for a high- security lock for the vehicles. In the existing system, the key is static or the key entering mechanism is already present.

This old lock system does not have high security. In static- key-passwords are reusable as they may or may not expire. In a traditional lock-key-system, the key may get lost and the electronic wireless-system is not safe as the password may get hacked. In this project, a double dynamic key password is used instead of a static password. The e-key will be generated only at the predefined destination to open the lock where no proxy

can be done. The consignment deliveries may delay due to many reasons so, the owner can monitor their truck by live tracking of its location through a smartphone. A GPS-based smart e-lock is designed to overcome such huge pilferages in consignment trucks. Initially, an OTP is sent as a text message to the owner's mobile number. The GPS module in the lock will track the live location of the truck every 15 minutes and sends the location in a text message to the owner's mobile number. Once the truck reaches the destination the owner confirms by entering OTP. After verifying the OTP, another OTP is sent as a text message to the driver's mobile number to

open the lock. If anyone tries to open the lock/vehicle under collision immediately an alert text message is sent to the owner's mobile number with the current location. This project helps to track the vehicle and also prevents cargo thefts.

II. RELATED WORKS

Jayaraman et al., [1] aimed to prevent the theft of freight that is carried by the load-carrying trucks. The project uses the IoT (Internet of Things) Technology for the E-lock system. The E-lock has the feature of generating the dynamic keys. The proposed system leverage the IoT advancements by overcoming the disadvantages of existing locks. The generated dynamic keys are more secure to open the door or vehiclelock. The lock sends the dynamic key and the location of the vehicle using GPS and GSM modules. The dynamic key is generated automatically every two minutes to the registered mobile number i.e., owner. It uses Cloud MQTT when the network fails and the location of the vehicle is stored in the cloud every two minutes. It is pushed into the server once the network is available. The generated dynamic key lasts only 10 seconds to lock or unlock the solenoid lock. It also uses the android application for receiving messages from the server to the registered mobile number. The lock is opened only when the latitude and longitude match accurately.

Maurya et al., [2] proposed to design the embedded system in a vehicle that is used for tracking and locating any vehicle by using the Global Positioning System (GPS) and Global system for mobile communication (GSM). Firstly it uses the AT89C51 microcontroller for interfacing the hardware peripherals. It uses the embedded design for monitoring the moving vehicle location and provides information about the location of that vehicle. So, the AT89C51 microcontroller is interfaced with the GSM modem and GPS receiver serially. GSM modem sends the longitude and latitude of the vehicle even in the remote area. GPS modem gives the data about vehicle latitude and longitude continuously while the vehicle is moving to the mobile number of the user. When the user demand s for the location information through the number the system provides the information about vehicle location automatically. The data is sent to the user only when the user requests the message indicating the position of the vehicle.

Patil et al., [3] explained the automatic door lock system which is made to work through an android phone application. This project uses Arduino Uno which is a microcontroller board based on the ATmega328, Bluetooth, and software card emulation in NFC (Near Field Communication) enabled mobile phones. A random 4-digit pin code is generated in the mobile application of the user. The pin is sent to an Arduino microcontroller that is installed in the door of the vehicle or home via Bluetooth. If the generated pin matches with the input pin of the lock then the solenoid lock is unlocked. If the wrong pin is entered then the alert/warning message is sent to the mobile application. This project is not cost-effective.

Lakshmi et al., [4] describes how to identify the theft of vehicles using sensor nodes in vehicles. This paper uses the embedded system and GPS/GSM for locating the vehicle. The controller embedded in the vehicle will send the exact location of the vehicle to the owner and also it prevents the thief from escaping by generating the alarm. The lock can be locked or unlocked only when the owner gives the password to the controller.

Sandeep Singh et al., [5], in this paper, proposed a method of tracking cargo trucks using a GPS module that is cost-effective. In this system, the current location of the vehicle is tracked so that it gives accuracy whenever needed. It also has an electronic lock that works in the principle of electromagnetism. This lock is embedded with GSM and GPS Technology and the location of the vehicle can be tracked on Google / Local maps.

Naidu et al., [6], demonstrated how to send an alert message to the owner of the vehicle when the vehicle is stolen. It includes the GSM module, GPS module, microcontroller solenoid valve for cutting off fuel, a buzzer for alerting, and a sensor to detect the theft of the vehicle. If anyone tries to steal the vehicle then the microcontroller installed in the vehicle interrupts and it gives the order to the GSM module to send the alert message to the owner number. Thus the owner receives the latitude and longitude of the vehicle through a GPS module. When the owner sends the message to the controller the ignition system and fuel supply of the vehicle is cutoff.

Poushya et al., [7] used IoT technology for identifying vehicle theft. This proposed system provides security by sending a message to the user of the vehicle as soon as the vehicle is stolen or moved without the knowledge of the owner. It also provides the location information in a regular interval of time to the registered user through IoT technology. Thus the location for theft vehicle is tracked by GPS technology by sending a location message by GSM technology informing the user about the vehicle condition.

Ayush K Sahai et al., [8], explained the detection of automobile theft and locks the engine using Arduino, GPD, GSM, and RFID. This system is installed in the vehicle so that it can be useful for tracking it. If the sensor identifies any sort of theft, then the user will get a notification through an SMS as soon as the vehicle is stolen. Then the owner can send back the passkey, which locks the engine. Once the engine is locked it send back the location where the engine is locked. This system is designed by using Arduino which is embedded with GSM, GPS, RFID modules. The use of RFID modules makes the project more expensive.

Sathiyanarayanan et al., [9], described that the vehicle's capability of distinguishing the RFID tag based on ASCII data saved in order to turn on the vehicle and to share the location attributes of the vehicle. The security system is equipped with an emergency safety feature by utilizing GSM communication to turn off the machine of the vehicle when it is stolen. It does not provide accurate information when the system is affected by environmental conditions as well as the time delay.

Balbin et al., [10], proposed to integrate GPS and IoT technology into the existing door latches. In this design, they integrated Google maps for getting the location using GPS technology. The lock system has a condition in which the device would alarm when a breach is detected while the lock

is closed. It relies on the data from the ultrasonic sensor and connection to the Internet to notify the user. Time is recorded in seconds is the time when the breach condition is satisfied until the user is notified of the breach. If the network fails the data is not notified for the user.

Rahman et al., [11] designed a password-protected electronic lock. This lock uses RFID technology and the PIC18F452 microcontroller. When the password is entered the PIC monitors the password and unlocks the door when the correct password is entered. Though this lock is cost-efficient it does not guarantee the security of the home/vehicle. The password can get hacked easily. This is the major disadvantage of the project.

Hadis et al., [12], proposed the system of Smart Lock System for Doors with Special Features using Bluetooth Technology. This system comprises Bluetooth technology integrated with IoT. It works by using a device like a mobile phone for activation of Bluetooth to identify the user located near the Bluetooth signal area. Then it matches the identity of the user and connects the communication between the lock control system and the user of access. The system will then open if the user of access is located near the validation area. This system requires the activation of Bluetooth each and every time it opens the door.

From the above literature survey, we can find that mostly the electronic passwords are hacked easily or the lock does not provide accurate information about location data. Based on the limitations from the literature review, we propose a system which overcomes the following objectives:

- To generate a random password only at the destination.
- To increase security by double dynamic key generation also to reduce the cost.
- To track the live location of vehicle during door tampers or vehicle under collision.
- To reduce the usage of smart cards, finger or face detection as it may slow down sometimes.
- To reduce the usage of battery in lock.

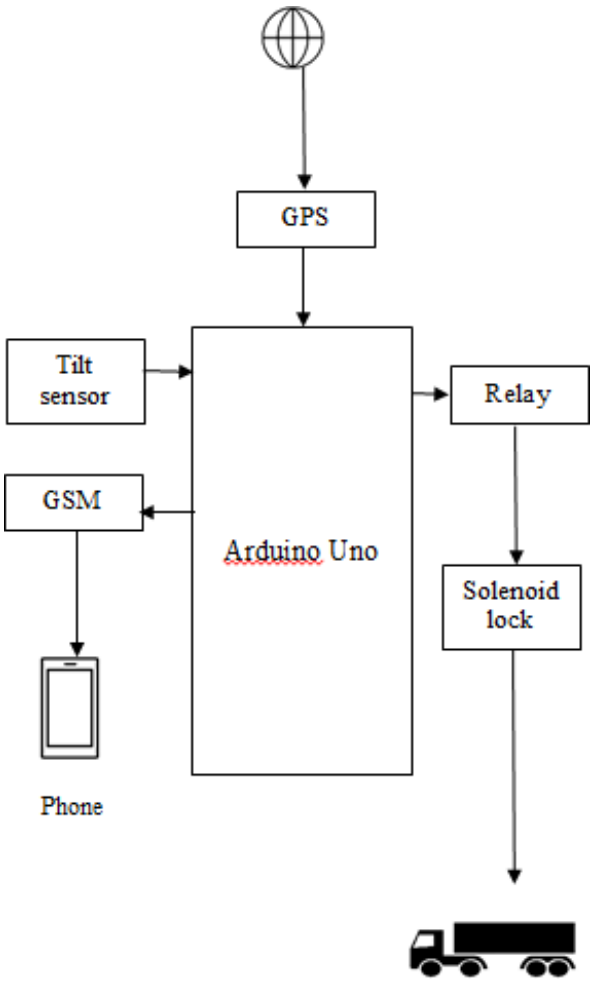

Fig. 1. Block Diagram of the Proposed System

III. PROPOSED SYSTEM

In this proposed system, the entire process is controlled by Arduino Uno. The solenoid lock is integrated with GPS and GSM modules. Tilt sensor, GSM, and GPS require an input voltage of 3.3v. Thus the buck converter is used to reduce the external 12v dc to 3.3v dc and it also reduces the usage of an external battery. To maintain high security two random

OTP are generated to open the lock. The existing wireless lock system and lock-key-system have no real-time visibility and the capital expenditure is more. The smart card is not required to open the lock as the card may get lost or stolen easily. When the lock is closed an OTP is generated randomly is sent to the owner's mobile number as a text message through the GSM

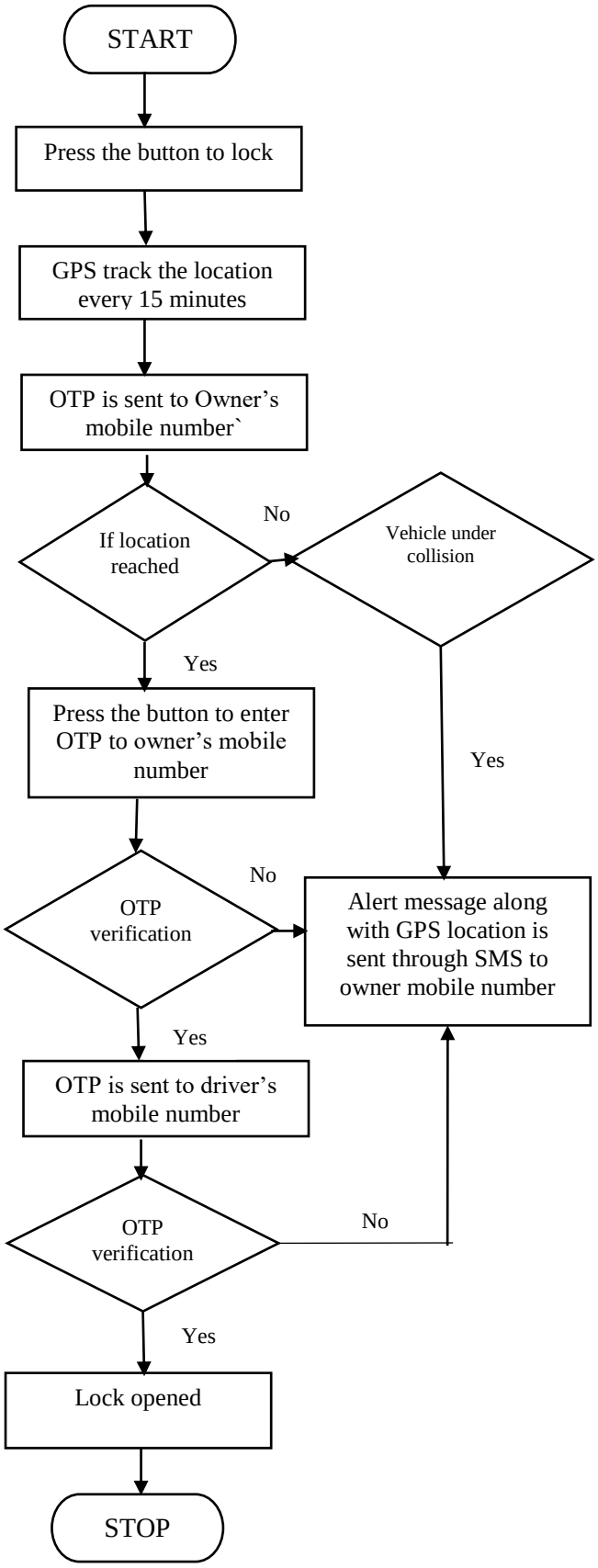

Fig. 2. Flow Chart of the Proposed System

module. The GPS module will constantly track the live location of a truck every 15 minutes and sends the text message to the owner's mobile number. After reaching the destination the driver has to confirm the location by clicking the button in the lock. Then the owner's OTP entered. If the wrong OTP is entered another OTP will not be generated at the delivery point. This confirms the current location and delivery point. After owner OTP is entered another random OTP is sent to the driver's mobile number to unlock the lock.. We can easily track the location even if the truck loses the chain custody or deviates from the regular path. It also reduces the risk when unplanned routes are taken. The smart e-lock also consists of a tilt sensor that will detect the door tampers or vehicle collision and sends an alert message along with the current location. This reduces theft and provides more security.

IV. WORKING PRINCIPLE

When the lock gets closed an OTP is sent to the owner's mobile number. After reaching the destination the driver has to confirm the location by pressing the button in the lock. The owner's OTP is verified and another OTP is sent to the driver's mobile number to unlock the lock. The truck will be tracked every 15 minutes and the location will be sent to the owner's mobile number. If door tampers or collision occurred an alert message is sent to the owner's mobile number.

A. Hardware setup

The supply voltage of 12v dc is fed to the dc-dc buck converter. The buck converters will reduce the 12v DC to

3.3 V DC. The output of the buck converter is given as input supply to the Arduino board, LCD, Tilt Sensor, SIM 800 module, and GPS module as these devices operate in

3.3 DC voltage. The relay is connected as the input of the solenoid lock as this lock needs a 12 volt DC supply for its operation whereas the output of the Arduino Uno is 5v. When the button which is connected to the Arduino is pressed the OTP is sent to the owner's registered number. Once the owner gives authentication another OTP is sent to the driver's mobile number to unlock the lock at the intended location. With that OTP the lock can be opened. The GPS and GSM modules are used to track the vehicle location and sent the data continuously as SMS to the owner. The tilt sensor is used when the lock/vehicle gets crashed and the message is sent along with the location of the vehicle.

B. Software setup

The software setup for the smart e-lock consists of Arduino language code. The Arduino language code is written in the Arduino Integrated Development Environment application to upload programs in Arduino compatible boards. The IDE translates and compiles the sketches into code that Arduino can understand. The advantage of the Arduino technology is it can directly upload the program into a device without any hardware programmer to burn the program. The random OTP is generated and it is stored in a variable in the lock. The entered OTP is verified with keypad value and OTP stored in the variable to unlock it. The vehicle tracking is done by a GPS module where it is integrated with Arduino Uno. It checks the condition and passes the message to Arduino and the Arduino sends the text message through the GSM module. The tilt sensor is used to capture door tampering or collision. If the tilt sensor reads the value 1 it checks the condition with Arduino and sends the alert text message.

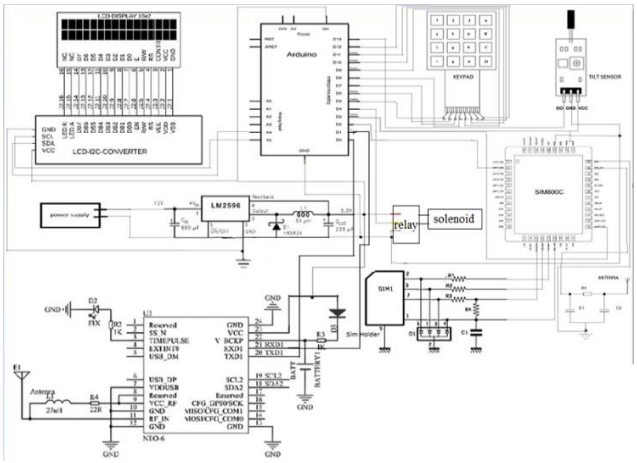

Fig. 3. Circuit Diagram of the Proposed System

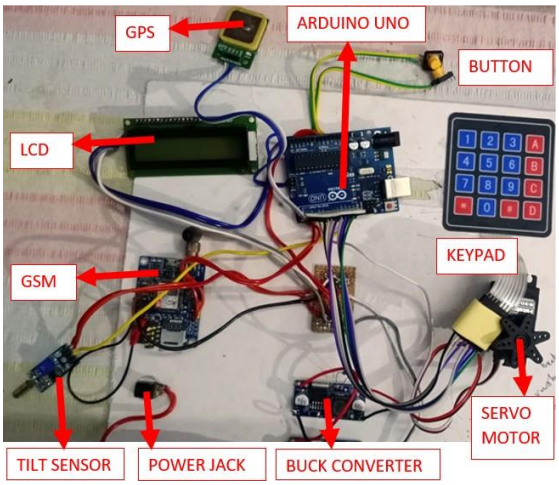

Fig. 4. Hardware Setup

V. RESULTS

The system has been thoroughly checked and to make sure it operates properly. All features have been integrated into a single lock system which ensures more security, safety, and ease accessible everywhere.

STEP 1: After closing the lock an OTP is sent to owner's mobile number.

STEP 2: The GPS module in lock tracks the live location of the truck every 15 minutes and sends the location of the truck as a text message to the owner number.

STEP 3: In case of a vehicle under collision or someone tries to open it notifies the owner by sending an alert text message with the current location.

STEP 4: After owner OTP is verified another OTP is sent to driver's mobile number to unlock the smart lock.

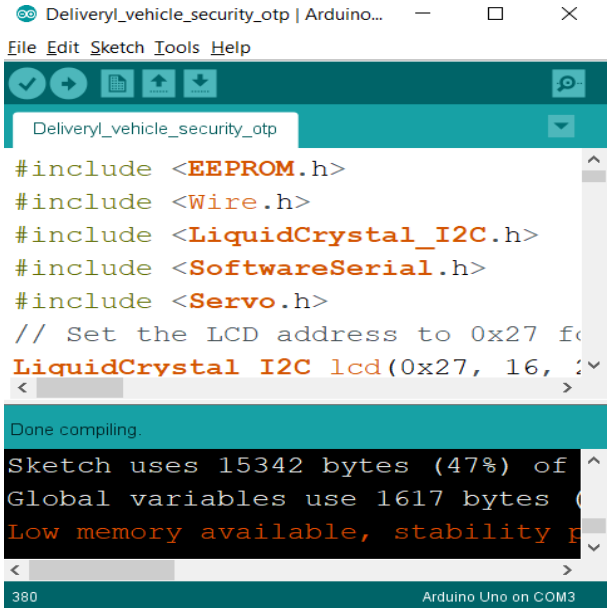

Fig. 5. Arduino IDE

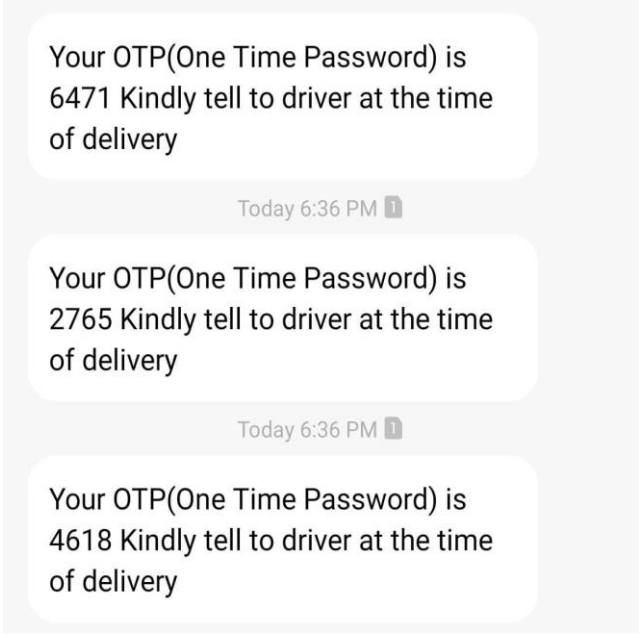

Fig. 6. Delivery confirmation message

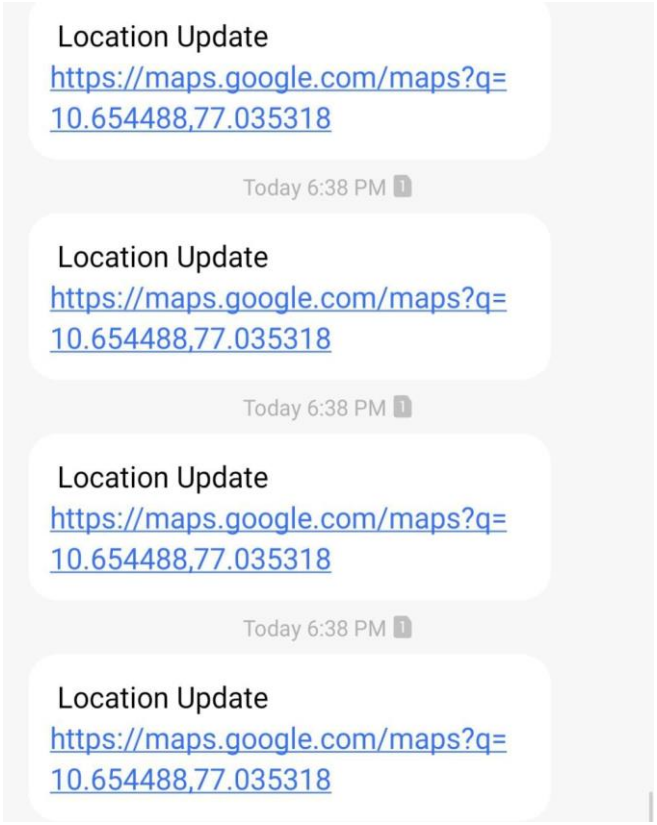

Fig. 7. Location update message

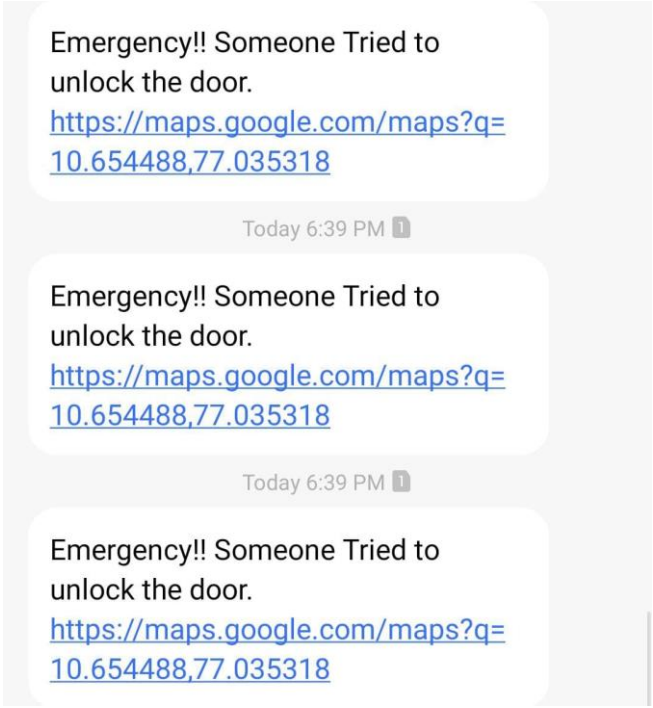

Fig. 8. Alert message

VI. CONCLUSION

A smart e-lock system has been designed and developed catering to the issue of pilferage and thefts in goods and fuel-

carrying vehicles. It utilizes a lock control system that uses Arduino UNO integrated with GSM and GPS modules. These modules are used to generate the location of the vehicle continuously and that data is sent to the mobile number of the authorized person.

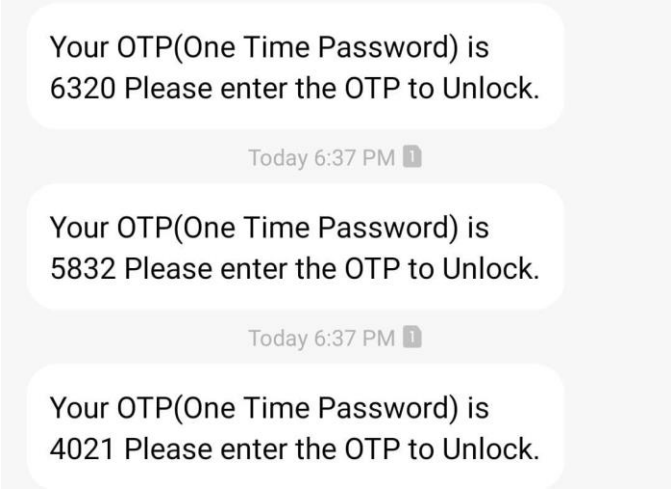

Fig. 8. OTP to unlock the lock

The location information helps us to track the vehicle as well as helps to prevent the theft of goods. Dynamic keys are generated from the lock and are used for user authentication which helps to prevent unauthorized access to the lock system and sends an alert message. It also informs when and where the vehicle is crashed. This method helps to prevent unexpected situations and also to prevent the theft of goods. This prototype is more cost-effective and production- friendly so that it is affordable to all the sections of users.

In the future in addition to this system, an application can be created using google API to lock the destination and the key to be generated only at the predefined location. Instead of using a manual keypad, a cloud server can be introduced to store OTP and also to verify it. Additional security patches can also be installed to reduce theft.

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