Abstract—Automobile, automobile traffic control and validation of its documents are necessary and vital part of law enforcement in a country. The Police, Motor Vehicle Department or the concerned authority needs to do a hectic task for the proper and legal validation of all automobiles on road. The task is time consuming and takes a lot of human efforts for proper law enforcement. As per the new rule imposed by the government of India all modern vehicles on road must have a RFID tag stuck on their windshield which can store any values and the values can be read from a distance using a RFID reader. X-PATROL is implemented on the basis of this feature. The RFID tag is encoded with unique number like registration number or chassis number of each vehicle and is stuck on a part of the vehicle which is readable for the RFID readers mounted on the road. X-PATROL not only validates vehicle documents it can also be used as a replacement for speed cameras and can be used to check vehicle traffic and real-time surveillance. X-PATROL validates the documents by reading the RFID tag value and cross checking it with the expiry dates of documents on the database. If the documents are found to be invalid it informs the concerned contact and deducts penalty from their linked bank account. Speed checking is done using two RFID readers on road and calculating the speed taken to cover the distance. In the end, practical application of X-PATROL was found to be advanced, feasible and efficient than existing systems.

Keywords – RFID, Arduino, Website

I. INTRODUCTION

Radio Frequency Identification (RFID) is the next generation wireless communication technology applicable to various areas such as distribution, circulation, transportation, tracing and tracking, etc. RFID is a non-contact technology that identifies objects attached with tags. RFID readers obtain the information of objects and surroundings through communication with tag antennas. Reader and tags can communicate in a wireless way. RFID can also identify mobile objects of high speed. And it can identify a certain amount of Tags simultaneously by its anti-collision mechanism. RFID is thought to be highly automatic.

Nowadays, low-cost RFID has been attracting more and more interests from both industry and academic institutes. [1] It has gained wide range adaptation for low-cost and ubiquitous computing applications, such as location tracking, access control and environmental conditions monitoring. A RFID system consists of three parts: radio frequency (RF) tags, RF tag readers and the back-end database that associates records with tag data collected by readers. RF tags consist of a microcontroller, an antenna (either wire or printed using conductive carbon ink), and polymer-encapsulating material that wraps around the antenna and the chip. Readers interrogate tags for their contents through RF antenna and interface to back-end databases for more functionalities.

RFID, as an attractive and relatively effective technology, is widely and successfully used in manufacturing process. So we want to apply RFID technology to solve this special problem. Our problem solution consists of vehicles fitted with RFID tags and RFID readers on road to monitor and survey the vehicles.

RFID when compared to other near field communication mechanisms has a main advantage of less set up time which is required in implementing our system. Less setup time is the cause which makes RFID tags useful in such a system which needs dynamic response.

![Comparison with other technologies.](image)

This paper is organized as follows. The architecture of the X-PATROL is firstly proposed in section II. Then detailed design and implementations are introduced in section III. In this section, detailed module wise description of RFID reader,
Arduino and website are given. Then, how to integrate the RFID reader, website and database is detailed.

II. ARCHITECTURE

The architectural framework of X-PATROL is simple and mean. The system works with two computers, three arduinos, two LED’s and two RFID readers. Each component has its own functional operations and roles in the system.

![Diagram of X-PATROL Architecture](image)

Figure: Architecture of X-PATROL

In X-PATROL the admin has the full privilege of changing operations of the components, functions of each component, predefined traffic rules such as speed limit and has the privilege to update delete and add documents entries into the database. The admin has an online login portal to change data and operations and he can do it remotely from any place as the server and websites are online. Admin also has the privilege to change the speed settings of the system. The system follows a hierarchical distribution of privileges as from admin to IR sensor. In order to change the settings of a component its predecessor component has to be reprogrammed accordingly.

In X-PATROL the admin resides in a remote system and access the system components through connected website. The website contains the database and the login modules for different assigned authorities. The admin can change the settings of the system from the website as it is directly connected to the Arduino via the processing module. The website also contains database which holds all the records of the vehicles like chassis number, registration number, owner name, owners contact phone number and email id and legal records of the vehicle like pollution certificate, insurance forms, tax papers etc. Every time a vehicle passes the RFID reader, it reads the unique ID value and cross checks the value with the value in the database and examines the validity of the documents the vehicle has. If the documents are expired and invalid the system immediately sends messages to the registered owner and notifies the owner about the same through SMS and emails. The system also catches vehicles with over speed by monitoring them continuously by checking their time taken to cover the two RFID readers and if the vehicle has covered it within the permissible time then the vehicle owner is notified about the event and will be penalized. The architecture of the above mentioned operations are simple and only involves working of the processing modules, Arduinos and the RFID readers. The RFID readers read the RFID tag values and sends values to processing modules via Arduinos. The Arduinos are coded in such a way as to get the corresponding values from RFID readers and pass the values instantly to the processing modules. From the processing modules the values are transferred to the server and crosschecked for validation.

It is impossible to fake X-PATROL as the system nullifies every possibility for error. If a vehicle without RFID tag is passing through the road the system immediately responds by signalling LED lights (on future developments this light signalling can be converted to cameras for capturing the images of the vehicle). This operation is done with the help of the IR lights at both ends of the system along with the RFID readers. If a vehicle passes through the IR it detects the vehicle and if the RFID reader is not able to obtain tag values, then the system assumes for a faking attempt and the LED blinks immediately. Thus the chances to fake the system without using RFID tags are nullified.

Overall the system maintains a hierarchical distribution of privileges and power to manipulate system settings. This architecture provides simplicity for the admin to manipulate settings of the system, and provides easiness in modifying and debugging the system for the developers concerned. The processing modules can be considered as the backbone of the system as it provides data transfer to the database and it controls the Arduinos and provide power supply [2]. The third Arduino in the middle provides power to the RFID readers [3]. It also controls the on/off states of the RFID and LED units. All the power connections for the Arduinos are taken from processing modules and the power supply for other sub units are taken directly from the Arduino’s power output port. The minimalistic and simple architecture provides easy implementation and increases portability of the system. The overall utility and easiness to handle the system is much better when compared to other existing systems which use common subsystems.

The main advantage of this architecture is that it is cost effective and affordable for public use. The architecture provides rigidity and robustness when implemented for rough use like traffic monitoring. The system provides good results and guarantee against architectural mistakes and malfunctions. The followed architecture is safe and provides less chances for attacks and threats as the hardware components like Arduino and RFID readers are hard to hack and manipulate without direct access. The implemented architecture provides maximum network and internet security as the system uses closed connection between components without external links and use of internet is needed only for the website related operations. Internet security in this architecture is pretty good as the website designs are secure and robust. Chances for cyber-attacks are nullified by using advanced and secure implementations for website and related portals.
Scripts and programming languages used in the making of the system are efficient and advanced. The website uses an Apache 2.4.27 server [4] which provides utmost security and stability. The graphics and animations in the site are done using Raphael 2.1.0 [5] which is the most advanced web based graphics script till date. The server is programmed using PHP version 5.6.31 which is conventional and secure and can be modified easily when needed and the version used in making X-PATROL is the latest available one. The JavaScript frameworks are done using Modernizr version 2.8.3 [6], jQuery 3.1.1 and Hammer.js [7] version 2.0.4. The web framework is done using Bootstrap [8] and real-time website updation is done using AJAX. The Arduino is interfaced with Database using NetBeans [9].

Thus X-PATROL is built over a simple and advanced platform which is best for the use of the system in all scenarios.

III. DESIGN AND IMPLEMENTATION

Design and implementation of X-PATROL is simple and follows a minimalistic design pattern and easy implementation techniques using commonly used computer languages and methods which are safe and secure. The simple design provides easy way for the administrator and other authorities to make updates and modifications easily. The website is designed using basic and commonly used methodology which is understandable for all. The login portal and database entries are designed in simple and mean manner, which makes it easy to understand and work with.

The unique RFID tag values read from the vehicles are passed onto the database via the Arduino by interfacing the Arduino with the database using NetBeans. The unique ID values read by the RFID reader are passed onto the Arduino via closed circuit cable connection. This design makes the system compact and quick responsive. Similarly, the speed checking system is also designed to produce quick responses to activities. The speed checking system is designed in a way that, while the RFID readers reads values and passes it to database, a script is made to run continuously which holds the RFID Number, tag value, time difference and other required values, and then the time the same tag is read at next RFID reader is checked and if the time difference is found less than permissible time, then the ID value is moved to penalty table in database and the responsible contact number is notified about the details via SMS and email.

The documents validity checking operation is also designed compactly such that the read ID values from the RFID are passed onto database via the Arduino and are crosschecked with the already entered values by the assigned authorities, if the documents are found expired or invalid, then the ID value is moved to penalty table in database and the same is notified to the concerned contact number.

It is nearly impossible to fake X-PATROL as it is equipped with alternate capabilities to catch culprits who drive their vehicle without the RFID tag. If a vehicle passes through the RFID readers and the IR sensor, the IR sensor detects it and checks whether any value has been recorded in the RFID reader, if yes, then that vehicle possess a RFID tag. Else if the IR sensor sense the vehicle and the RFID is not able to read values then the system assumes for a vehicle without RFID tag and the connected LED is blinked. On future development and advancement, the led can be changed to a camera which captures the culprit’s vehicles number plate and penalize him.

The above figure shows the working methodology of detecting vehicles without RFID tag. In first case the vehicle has a RFID tag, but in second case the vehicle does not possess a RFID tag and so the LED is triggered.

The overall design of the system is compact, safe and efficient. It is easy to understand things even for a common man who has lack of technical knowledge. The implementation is also efficient and uses advanced methods which has less error possibilities and provide higher scope of modifications in later stages. The implementation techniques used are flexible and portable and can be extended with ease if required. Addition of new methods and operations can be done easily and effectively. The hardware components used for implementing the system also provides greater extendibility and flexibility of use.

IV. CONCLUSION

X-PATROL performs an essential law enforcement activity replacing difficult human work. X-PATROL was theoretically found to be efficient and much more economic than existing systems in real world applications of document validation, speed checking and real-time surveillance. It provides instant results by informing the vehicle owner by sending SMS and mail to the given mobile number and mail id. It deducts penalties instantly from the victim’s bank account and thus eliminating possibilities for corruption. It provides better, efficient and accurate results in speed checking and traffic monitoring when compared to conventional methods like speed cameras, traffic policing, speed checkers etc.

![Figure: Method of detecting vehicle without RFID tag.](image_url)
X-PATROL has less chances of errors and malfunctioning which makes it dependable, believable and trustworthy. It provides correct data and dependable data at all situations.

The system provided correct results in tests conducted at different scenarios under different circumstances. The data and results were accurate and the system performance was as expected, provided instant summaries and required feedbacks.

Finally, the use of X-PTROL as a road surveillance turned out to be very beneficial and efficient as the total cost of system implementation was less and the system was found feasible as no much changes were needed to be applied on current system to implement X-PATROL.

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REFERENCES

[6] https://github.com/Modernizr/Modernizr