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Evolution of Two Wheeler Security Systems over the Years and its Future Prospects

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ABSTRACT: This paper studies the evolution of anti theft security system for two wheeler vehicles since the start of two wheeler era. To highlight the depth of the situation, it provides some statistics for vehicle theft focussing on Indian Territory. It also throws some light on the functional aspects of few widely accepted security devices that made a mark in the industry. Finally, the paper draws a general conclusion for the future technological trends of two wheeler security based on current global scenario.

KEYWORDS: anti theft security system, evolution, immobilizer, mechanical lock, two wheeler

I. INTRODUCTION

Ever since German inventors Gottlieb Daimler and Wilhelm Maybach invented the first petroleum powered motorcycle in 1885, the two wheeler industry has seen a constant growth and has emerged as one of the most preferred mode of transportation due to its low running cost and ease of operation [1]. The widespread popularity of two wheeler vehicles is also accompanied by high susceptibility towards vehicle theft. The report published by Nation Crimes Record Bureau (NCRB) highlights that in year 2014 152,931 two wheelers were stolen in India valuing a mammoth 4,502,750,000 INR. Out of these only 32,033 could be recovered which translates to loss of 34, 02,020,000 INR [2].

A similar report issued by NCRB in the year 2011 projects a figure of 122,367 stolen vehicles [3]. It can be easily concluded that in this period of three years the number of theft cases of two wheeler vehicles have increased by a considerable amount despite there being continuous development in the field of automotive security system. An inference can be drawn from this data that as the OEMs are becoming more cautious about the security of their vehicles and are providing its customers more advanced security solutions, on the other hand the thieves are also evolving and making them competent enough to find flaws in the security systems currently in use and take advantage of those loopholes.

II. RELATED WORK

This paper is not the first to study the evolution of two wheeler security system. Some researchers in the past have traced back the evolution of security systems designed for two wheelers [4]. But those papers only study the evolution to form a base for their proposed security system. This paper solely concentrates on the evolution, current technologies used and the projected future prospects of two wheeler security system.

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III. BASICS OF MECHANICAL LOCKING SYSTEMS

The mechanical locking systems were initially developed for car industry and later the same concept was also adopted in two wheeler industry. In early 1930s Ford and Chrysler began using pin-tumbler and wafer locks in their cars for security purposes. These types of locks consisted of wafer or tumblers, body, key, and a rotor. The spring loaded tumblers/ wafers would sit inside the slots made in rotor. Spring force would project these tumblers/ wafers outside the rotor accommodating them in the slots made in the body, thus blocking the rotor from rotating. The key is designed in a such a way that it's teeth biting aligns the tumblers/ wafers inside the rotor and allows the key and rotor to rotate freely.

While the basic concept has remained the same over the years, much advancement has been made that has increased both convenience and security of mechanical locks. For instance, the "convenience keys" introduced in the 1960 featured same cuts on both the sides of the key enabling the users to insert key in either direction. Since then many concepts such as two sided wafer, two track wafer, four track wafer etc. have been introduced and used extensively [5].

IV. EVOLUTION

4.1 Early systems

Initially people used mechanical locks and padlocks to securely park their vehicles [4]. The motorcycle had to be secured to a rigid structure like a pole or a railing by means of a chain and then locked by a mechanical lock. Initially this was accepted as a good method to safeguard the two wheeler from being stolen. But as the usage of two wheelers increased, people found it cumbersome to lock the vehicle with a separate lock every time they had to leave the vehicle and perform the equally straining unlocking exercise on their return. This problem called for the need of development of a security system which forms an integrated part of the two wheeler body itself and hence can be easily operated.

4.2 Steering Lock

Steering locks were developed to solve the inconvenient operation of mechanical pad locks. These security systems formed an integral part of the vehicle body and hence did not require separate mounting and dismounting of lock.

The principle behind the steering lock was to lock the position of the steering handlebar in an angular position by a positive locking member to prohibit any unauthorised user from turning it in straight position. The lock is firmly fixed on the two wheeler body and a lock bar projecting from its body fits within a bracket or cavity formed in the moving handlebar. This design proved to be so robust that even in current steering locks the basic design has remained the same. The user has to just rotate the key to lock position which projects the lock bar into the handlebar slot. Similar exercise of turning the key to unlock position retracts back the lock bar, thus releasing the handlebar.

This system proved to be so versatile, robust and economical that it became the most widely used locking mechanism for two wheeler security. But even this popular system had a very serious flaw which made this system highly vulnerable to breakage under adequately applied force. In essence, this system is basically just a positive locking of a rigid member with another member, if excessive force is applied, one of them is bound to break, thus releasing the handlebar and exposing the motorcycle to theft. There have been many cases of thieves using rods and bars to apply high torque to break these locks. Even impact loads pose a threat to these types of systems.

4.2.1 Ignition-Cum-Steering Lock

This system was an improvement over a simple steering lock. In addition to locking the position of handlebar, this lock incorporated the electrical circuit within its reach. Even if the thief was able break away the steering lock by applying force on handle bar, the ignition cum steering lock would prevent the vehicle from starting as the ignition is controlled by the key. Without the right set of keys, ignition would not take place, rendering the bike dead.

Though the thief can still drag the bike and take it along with him after breaking the steering lock, ignition locks provides an additional security and hence reduces the chances of theft.

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4.2.2 Magnetic Lock

The international guidelines for two wheeler security require a vehicle lock to have at least 1000 combinations or equal to the number of vehicles produced annually if it is less than 1000 [6]. This is done to ensure that chances of unlocking of one vehicle from the key of another vehicle are minimised. To increase the security, engineers would have to make the system bigger by incorporating more lock plates/ tumblers which increases its combinations.

Another way of increasing the combinations is to overlap the present ignition cum steering lock with another lock. A magnetic lock possesses a very simple construction. A number of magnets are present in slots made in the body of a magnetic lock; these magnets obstruct the movement of shutter which covers the keyhole opening. When a key embedded with magnets having same polarity as that of magnets installed in the lock are placed next to each other, the magnets in the lock assembly push back, thereby releasing the shutter, hence granting access to the user to insert the key in the ignition switch.

Mathematically, total number of combinations now becomes the product of the combinations of ignition lock and the combinations of magnetic lock. Taking a standard case of an ignition lock with 1000 combinations and a magnetic lock with 24 combinations, the effective total combinations turns out to be 24000.

Apart from this, installing a separate magnetic lock above the ignition provides a two tier security solution making it a time consuming activity for the thieves to break one lock and then to proceed to another.

4.3 Immobiliser

The additional security provided by the ignition cum steering lock was short lived as thieves mastered the art of “hot wiring” which is bypassing the vehicle ignition circuit and starting the ignition [7]. Furthermore, key duplicity posed a major threat to vehicles as duplicating a key is a matter of minutes and can be done very easily. Having a duplicate key is as good as having the authentic key and vehicle theft is inevitable in such conditions.

Engineers found a solution to this problem by incorporating the intelligence of electronic systems with the strength of a mechanical system. Immobilizer is an electronic device which helps in differentiating between authentic and duplicate key. It is basically a transponder receiver combination, with the key having a transponder and the ignition lock mounted on the motorcycle having the receiver and logic circuit. Generally, the ignition control of the vehicle is under the control of this logic circuit. In some vehicles equipped with fuel injection system, the same logic circuit can be configured to block the fuel injection system as well.

On rotating the key to on position, the lock communicates with the transponder of the key and exchange of coded data takes place. If the code sent by the transponder matches the code stored in the logic circuit of the lock, the ignition system is allowed to function, in case the code does not match, the ignition system is left inoperable.

A typical 32 bit transponder can have any of the $2^{32} = 4, 294, 967, 296$ possible values [5]. Copying the transponder code is not as easy as copying the teeth biting of a key, hence even if the thieves are successful in copying the mechanical aspect of the key i.e. the biting pattern, the electronic component will reduce the chances of theft.

Honda was the first motorcycle manufacturer to commercially include immobilizers on its product range in 1990, since then many other manufacturers have also included immobilizers in their products.

4.4 Hands free systems

The world is now shifting to an era where keys will become obsolete. Developed in 1995 by Siemens and commercially launched by Mercedes in 1998, a hands free system or a keyless go systems eliminates the need of physically taking out the key from your pocket to perform the necessary functions like unlocking, locking and starting the vehicle [8]. Initially this technology was confined to car industry but in the past few years it has trickled down to two wheeler segment as well.

A hands free system is basically an electronic extension to the mechanical locking system. While the mechanical part takes care of securely locking the handlebar, the electronic part is responsible for performing the authentication procedure. In a hands free system, locking/ unlocking and ignition switches are provided on the vehicle. When the user having a keyless fob with him/her presses the unlock button, the hands free system searches for the key in the vicinity. If the system finds a key within the specified range, it allows the user to perform the desired function and otherwise blocks the access.

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Hands free system is a current generation technology which is still in its early phase in many markets. Due to its convenient use and added electronic security, hands free systems will dominate the world automotive security systems for the next few years.

V. FUTURE TRENDS

In today's scenario, user comfort and convenience have become the paramount factors for any product design. This thought will serve as the driving force for all the products developed in the future. Currently as hands free system has eliminated the need to physically operate the key, development has already began to eliminate the need to even carry a key fob.

The most promising contender in this field emerges out to be biometric authentication system. Many researchers are now working towards developing a security system which allows the user to unlock their vehicle by either scanning their fingerprints or retina [9]. Freedom from carrying a key would be a great leap forward in this area. While the technology itself is very simple and is used in many industries to perform authentication procedures, making this technology fit for use in external environment where the vehicles operate will be quite an arduous task.

VI. CONCLUSION

With the pace our world is progressing, the electronic industry is going to revolutionize every process in the future making it extremely convenient for the user. Two wheeler security systems are surely going to benefit from the development of the future technology, giving a tough competition to vehicle theft. But we should remember that while the future will focus more on electronic aspect of security, the mechanical component cannot be forgotten.

This study highlights one important aspect which can otherwise be easily neglected, i.e. regardless of how much electronic systems advance in the future; we cannot solely rely upon them for providing anti theft capabilities. An electronic system will always work in conjugation with a mechanical locking mechanism which performs the actual locking function and prevents theft.

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