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Design and implementation of a mobile device for access control and tracking of a container using GSM technology

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ABSTRACT

This article shows the development of a mechatronic system, which was designed to provide land transport of containers a security structure through a technological, able to control access to the goods transported lock, which in turn owns tracking a module containing the position information of the merchandise, all information collected will be transmitted via a GSM module to the end user (central security office). This seeks to provide a technological solution to social problems in Colombia of carjacking.

KEYWORDS: mobile, device, tracking, security, access control

1. Introduction

Since ancient man in his effort to expand commercial coffers times has designed various transportation to get their products can be brought to faraway places, but with the passage of time this activity has suffered the social problem of theft, so they warrant that the goods are always monitored and safe so they can reach their destination without any mishap.

Although goods transport systems have improved in recent decades, they are not yet sufficiently integrated to meet today's requirements in terms of quality and safety, due to the lack of well-structured and organized intermodal transport chains. Information technology (IT), incorporating communications technology, could become a primary tool in ensuring the safe and efficient operation of freight transport systems [1].

At present the land or automobile transportation of goods is one of the most used, so for this type of transport are designed various security methods such as selection of drivers, owners, carriers, stevedores, security companies and guards, roadside checkpoints, vehicle location system, suppliers of security seals, parking and insurance company. All these methods have been designed in order to organize a logistics planning security that help fight this social problem, as well as innovative and modern ideas such as creating device that protects goods from potential threats when they are transported from one place another, thus reducing the chances of future theft of the goods.

Almost 90% of the world trade is accomplished with the help of containers using different means of transportation including ships and trains. The container trade faces a lot of challenges comprising of container tracking, real time monitoring and intrusion detection, real time theft reporting mechanism, and status reporting of shipment items [2].

The growth in trade, changes in business practices, and safety concerns, have also underscored the need for government-industry partnerships to standardize information exchange and to implement best practices across the global supply chain network. Recently, safety issues have become a major concern. Major goals are therefore to provide support for risk and vulnerability assessments for all interested parties, and to determine ways of monitoring the movement of goods and containers [3,4].

Improving transport efficiency is possible through the development, deployment and use of intelligent transport systems based on advanced information and communications technologies [5].

Traceability facilitates the following of goods and provides all operators of the supply chain with accurate information concerning the products involved. Tracking is defined as the gathering and management of information related to the current location of products or delivery items, whereas tracing refers to the retention of the manufacturing and distribution history of products and components. Monitoring refers to the ongoing assessment of the progress of transport by means of continuous or repeated measurement and evaluation [6].

Unless specific provisions for further traceability exist, the requirement for traceability is limited to ensuring that businesses are able to identify the immediate supplier of a product along with the immediate subsequent recipient (with the exemption of retailers to final consumers) [7,8]. Information technology provides tools for helping transport companies track and trace from the origin to the end of the supply chain; this is particularly important in the area of food transport.

Today in Colombia, the called carjacking not currently displayed data as chaotic in the early nineties, but remains a serious social problem. Because of carjacking, causes disruption of the supply chain of goods in the country and a large percentage of claims of Freight derived from criminal activities such as theft. For some companies, whose work is to ensure the minimization of risk in the supply chain, with activities aimed at detecting and preventing situations that need improvement and optimization of security processes, points to a solution to this problem to be able to provide security and tranquility to its clients, for which it is this article show the development a mechatronic device to counter this scourge that happens every day on the main roads of the country.

2. Developing of the system

The proposed solution lies in a security system comprising a lock, adapted to the geometry of the container doors, which can be tracked via global positioning systems (GPS) and remotely manipulated using Global System for Mobile communication technology (GSM) network control opening and closing thereof when required, and the operator via the mobile device can send text message codes to unlock or lock the security system (electronic lock).

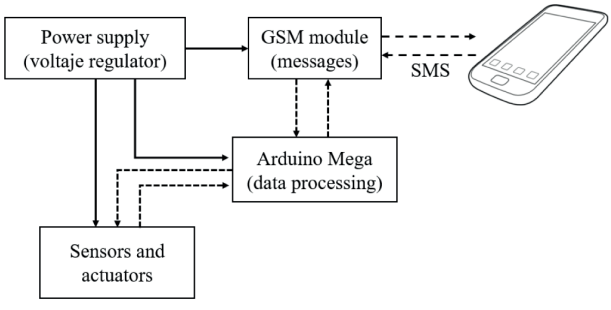

Fig. 1. System of the mobile device for access control and tracking of a container [own study]

The device has the following characteristics:

- Opening and closing controlled by wireless network.
- Manual opening if an unforeseen occurs in the manipulation of the device.
- System adaptable to close the gates of the containers.
- Low operator intervention to manipulate.
- Resistant to any kind of weather, light conditions and coupled with SLM Radio Secure® equipment.
- Tracking of the container.

The device developed has important two points, the first point is to have a safe, tough, durable equipment, it can be easy to handle for operators and the second fundamental point is that it becomes an automated device in which operator intervention to mount and remove the containers can be most efficiently, as well as controlling the opening and closing can be controlled remotely from the main office.

The electronic device is made up of three stages of electronics that works in conjunction with the Atmel Arduino Mega 2650 processor for processing information. These stages are:

- Power: The power module of the device is constituted by LD1085 voltage regulator which supplies a voltage to the device of 3.7 Volt. This regulator provides the necessary power to the VIN pin of the Arduino board. The power supply must supply power to the device must be able to maintain a constant voltage to the Arduino Mega and cellular module m95 module for this power source must deliver a volteje 8V with peak current of 1.5 A temporary due the data transmission to the cell module M95. Turn the feed module must circuiros sensor, control panel, LCD and finally powering the servomotor SG-5010, so chose a rechargeable battery with lithium ion polymer technology, 2200mAh, Output Voltage 7 , 4V able to meet these energetic needs.
- Information processing: The Mega Arduino module processes the information contained in the SMS text from cell module M95 with the ultimate aim of power control the servomotor SG-5010, plus the Arduino servo module must process the information from the infrared optical sensors S525 and QRD1114 the latter responsible for the maximum or minimum opening of the mobile arm of the LS-T13 device, all these changes will ultimately be forwarded to the operator in charge of the device via text message.
- Receiving and sending information: For the step of receiving and sending SMS Arduino Shield the card was purchased with an M95 cell module with embedded antenna (for GSM / GPRS frequency signal 900-1800Mhz) Quectel® company.

2.1. Mechanical system

The device 14 comprises mechanical parts. The overall dimensions of the device are:

- Height: 190 mm
- Length: 487 mm (This measure includes its maximum aperture that can reach the device horizontally).
- Depth: 85 mm.

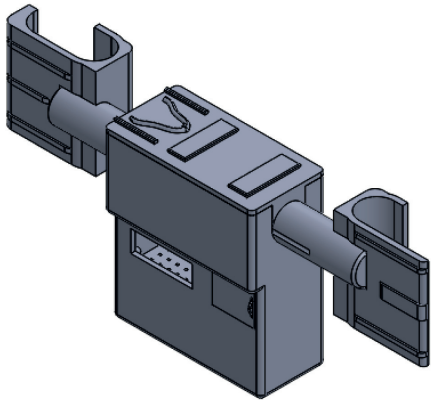

Fig. 2. Assembled device with all its parts [own study]

Below the pieces that make up the mechanical system are named:

- Base 1: The element that contains all mechanical and electronic device parts.
- Base 2: This piece allows axial movement of the shaft 2 by the same shaft does not rotate in the same direction of torque shaft 1 is also the resting bench of axial bearings that owns the device.
- Base: 3 Piece left claw fixed base 1.
- Base 4: Part setting device motor with the base 1, giving support to the engine so that it can rotate the axis 1.
- Base 5: This piece is the bench where it will be placed bearing which allows axial displacement axis 2, the bearing will work to avoid high concentrations of friction at the time of the axis 2 and thus this avoids the wear axis 2.
- Base 6: Strengthening the axis 2, this helps to minimize the loads from the tip of his right arm at the time of displacement.
- Axis 1: Is an endless screw where the tip of its base is connected to the engine of the device while the threaded end of the screw by action of torque produced by the engine pushed axially to the shaft 2.
- Axis 2: Axis 2 is screwed onto the shaft 1, this is the one to make moving the movable arm to secure no or device on the gate of the container.
- Claws Left and right: are the ends of the device, its function is to secure the device in the container gates.
- Cover 1: Is the top cover that adjusts the mechanical part, preventing the parts of the device is removed.
- Cover 2: Is the front cover of the electronic device emergency cabin.
- Cover 3: The back cover which covers the electronics of the device.

2.2. Tracking and monitoring

The use of standards in the digital communications between container electronic monitoring systems and the different intermodal platforms would allow the use of fewer wires and connections, improving system features and fault tolerance. Information provided by a variety of sensors could be used to improve overall monitoring [9].

Electronic monitoring of the location of vehicles during transport can be achieved by two methods: automatic vehicle identification and the (GPS). The former involves the detection of the conveyance at various critical waypoints along its normal route. This is rather inexpensive and involves a relatively small number of active systems reporting to a central data processing site. The time elapsed between waypoints can be monitored for compliance with regard to expected travel times, though problems can arise if a vehicle has to change its normal route [10].

2.3. Wireless communication

Wireless network technology is an essential tool for today's professionals every day more mobile productivity. With a wireless network, enterprise employees can stay connected to productivity applications and information resources virtually anytime, anywhere.

There are several ways of achieving wireless communications for intermodal transport (see Fig. 3) – wireless wide area network (WWAN), wireless local area networks (WLAN), and wireless sensor network (WSN) systems. Table 1 summarizes the most important standards for wireless networks.

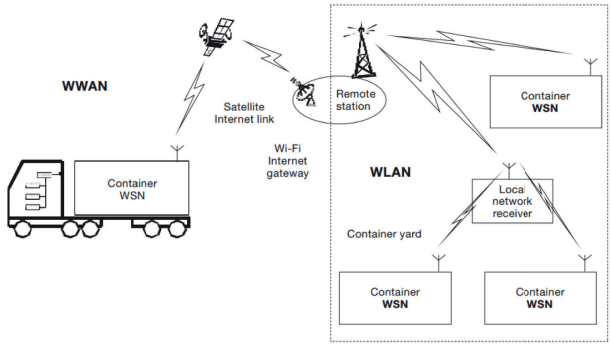

Fig. 3. WWANs, WLANs and WSNs in intermodal transport [11]

Wide area networks enable long-range communication between containers and central servers, and are facilitated by satellite and cellular systems. Satellite systems are quite expensive compared to cellular systems, but they provide virtually ubiquitous coverage, so they can relay status messages and GPS data from nearly anywhere in the world [12].

Table 1. The most important wireless networks solutions [11]

Name	Implementations
WWAN (Wireless Wide Area Network)	GSM (Global System for Mobile-Communication) CDMA (Code Division Multiple Access) GPRS (General Packet Radio Service) UMTS (3G) (Universal Mobile Telecommunications System)
WLAN (Wireless Local Area Network)	IEEE 802.11.x HyperLAN Home RF
WSN (Wireless Sensor Networks)	Bluetooth Zigbee

Global System for Mobile-Communication (GSM) and General Packet Radio Service (GPRS) modems are widely used in commercial vehicle tracking and fleet management. Recently 3G technologies have emerged. 3G is a wireless industry term for a collection of international standards and technologies aimed at improving the performance of mobile wireless networks. 3G wireless services offer data packaging enhancements such increased speeds and the capacity for combined voice and data services with high quality service facilities. The two main 3G technologies are UMTS (Universal Mobile Telecommunications System) and CDMA2000 (Code Division Multiple Access 2000) [13].

A WSN is a system comprised of radio frequency (RF) transceivers, sensors, microcontrollers and power sources [14]. Recent advances in wireless sensor networking technology have led to the development of low cost, low power, multifunctional sensor nodes [11]. Sensor nodes enable environment sensing together with data processing. They are able to network with other sensors systems and exchange data with external users. Sensor networks are used for a variety of applications, including wireless data acquisition, machine/ building monitoring and maintenance, in smart buildings and on highways, environmental monitoring, site security, automated on-site tracking of expensive materials, safety management, and in many other areas [15].

2.3.1 Module configuration M95 with Arduino

The M95 GSM module is a quad band edge products listed as one of the smallest in the world. LCC welcomes technology package offers the highest reliability and robustness. Your 19.9x23.6x2.65mm size and easier welding process can be incorporated into almost any application to users. Featuring an industry-standard interface, M95 delivers performance GSM / GPRS for SMS, data and voice with very low power consumption and extended temperature. It has built-in protocols to ensure easily meet all the requirements of M2M applications, including VTS, Industrial PDA, Personal Track-ing, wireless POS, smart metering and many other M2M applications. Info SMS text message is processed by the module M95 which receives, reads and translates the information that is given in ASCII language to a language compatible with the microprocessor Atmel. The communication between the GSM module M95 and Arduino Mega is performed through the serial ports Rx (pin 0) and Tx (pin 1).

To be able to make proper communication between the LS-T13 device manager and the operator of the device is M95 configuration module if necessary for this is to use a serial communication between the computer and the module M95 Quectel this communication is done via the Serial Monitor Arduino, whose fundamental goal of making this communication is to verify the proper operation of the M95 module. For this configuration AT commands are used acording to the manufacturer specifications. AT commands are coded instructions that form a language of communication between a terminal modem and man. AT commands are well appointed for the synthesis of Attention. Although the main purpose of the AT command is communication with modems in the field of mobile telephony it has also affiliated GSM standard this language to communicate with their terminals. In this way, GSM mobile phones have a set of specific AT commands that interfaces to configure and provide instructions to the terminals, allowing actions such as data calls or voice, reading and writing in the address book and send SMS, plus many other options configuration terminal.

2.4. Control Panel

The control panel is an emergency resource that is designed in order to prevent damage to the device when it is this failure in preventing the cellular signal reception of message sent to and from the operator in charge.

The control panel consists of three switches and a knob that allows the operator to change options on the menu that is designed, the operation of the elements of the control panel can be summarized as follows, two switches allow the opening and closing the movable arm while the third switch changes the status bar automatic control (remote opening), and manual (Using the control Panel), the knob as previously mentioned is responsible for changing the menu when you are in the "Manual" option.

3. Operation of the system

It has to send a text message to the device for the action that is required to perform code, in this case you have the possibility to send a message to open, close, namely the GSM signal and observe the battery level of the device . When sending SMS text message that is received by the GSM module, once received is stored in buffer and then are stored in a String chain, once this is done we proceed to compare the message with the algorithm and depending on the content Message proceed to execute the corresponding action, such as whether the message is written the message "Open" this makes a comparison with a string that has the same message, if the message is the same as it is stored in the memory of the Arduino module this shall send a pulse activating the servomotor.

In order to have a final limit movement of each servo action this sensor will aimed to stop the movement of the servomotor, said sensor further stop or actuate the actuator to send an electronic pulse module port module indicated Arduino Mega that action has already executed and then send a response to the operator via a text message.

Every action that the user wants to perform on the device will automatically generate a reply message as the device for lack of coverage cannot do always have the option of using the control panel. As for driving the servomotor you can also check the status of the device either to know the signal level at the time or to know the level of battery charge.

4. Conclusion

In recent years, much international research has focused on the development of an intelligent transport system. Most of these systems have involved human or freight transport. For the latter, a number of supply chain monitor and tracking tools have been developed, although none has been implemented in Colombia before in a low cost.

The combination of available information technologies such as GPS and wireless data communications can provide complete

monitoring information about good transported in containers. The number of recent IT applications published shows that research into intelligent transport systems is an emerging field fuelled by advances in technologies and worldwide concerns about security and safety. The technologies now available make the development of a standard monitoring system for containers feasible.

A remotely controllable device for containers was developed, as a shipping container body having associated therewith at least one door and at least one door latch having a latch, the locking element would be arranged for locking engagement with a door mounted, with one wireless communicator mounted in a secure location within the shipping container and being operative to wirelessly transmit information to a remote monitor regarding the status of an electronic seal mounted onto the locking element for confirming locking of the at least one door, and at least one wireless antenna mounted within a protected enclosure on the outside of the shipping container for transmitting the information from the at least one wireless communicator.

Acknowledgments

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