



Object Management and Tracking System Using RFID and GPS

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Abstract

The paper deals with object tracking and management, in side warehouses and processing plants. It is proposed to track individual items using Radio Frequency Identification (RFID) tags and different types of RFID readers. The vehicular movement is monitored using Global Positioning System (GPS). RFID and GPS technologies are key enablers for logistics supply chain visibility and tracking. RFID is useful for inventory and material handling processes in warehouses, preprocessing plants, cold storage plants and processing units. As soon as the RFID-tagged goods leave the warehouses, one often loses track of them until the next receiving point. During the transportation if there is no tracking of vehicle it might result in missing of the vehicle, illegal off-loading and avoidable delay. GPS is used to track vehicle and reduce such risks.

Key words: RFID, GPS, GPRS, GSM

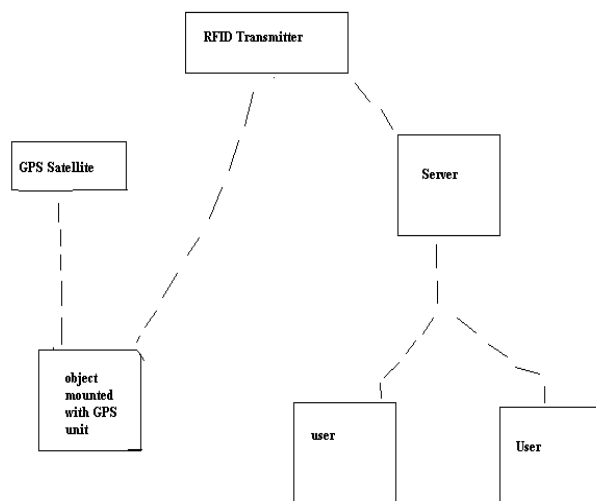


Figure 1: Block Diagram of System

I.INTRODUCTION

This paper describes a study on applying an integrated application of RFID, GPS and GSM technology for mobile, pervasive and ubiquitous tracking and locating of any objects in construction supply chain and logistics. Accurate and timely identification and tracking of resource are vital to operating a well managed and cost efficient construction project. RFID integrated with the GPS provides an opportunity to uniquely identify materials and to locate and track them in a real time basis using minimal or no worker input where transmission of data from the system to the central database will be carried out with the help of standard cellular phone communications networks technology such as GPRS and SMS[4].

Automatic object Location (AOL) is an advanced method used to track and monitor any remote object equipped with a software unit that receives and transfers signals through GPS satellite. Automatic object location is a combination of GPS, RFID Transmitter, GPRS and Geographic Information System (GIS), GSM that provides actual geographic real time position of each vehicle. The entire transmission mechanism of Automatic object Location setup depends on GPS satellite, a receiver on the vehicle, a radio system and PC based tracking software for dispatch. The radio communication system is generally the same as cellular phone network. The two most common AOL systems are like GPS based and Signpost based. The Signpost-based Automatic Object Location system was used earlier but with the development of modern satellites GPS used technology is more used now. For the applications which require real time location information of the vehicle, Automatic object Location system is used that can transmit the location information in real time. Real time object tracking system incorporates a hardware device installed in the vehicle (In-Vehicle Unit) and a remote Tracking server. The information is transmitted to Tracking server using RF transmitter if the distance between tracking server and vehicle to be track is less. Tracking server also has RF receiver that receives vehicle location information and stores this information in database[1].

Logistics has been defined efficient flow and storage of goods from their point of origin to the point of consumption. It is the part of the supply chain process that plans, implements and controls the flow of goods. A supply chain is a network of retailers, distributors, transporters, storage facilities, and suppliers that are involved, through upstream and downstream linkages, in various processes and activities that produce value in the form of products and services. Supply chain management is a process used by company's to ensure that their supply chain is efficient and cost-effective and focuses on minimizing the time taken to perform each activity, eliminating waste and optimizing response by maximizing value. Supply chain control is an integral aspect of supply chain management[4].

Traditionally, manual data collection is slow, inaccurate, error prone and produces large amounts of paperwork. During the past few years, quite a few research projects have been conducted to investigate the opportunity to implement the use of new technologies in construction supply

Chains and logistics to tackle their problems. Automated approach can deliver continuous results in real-time and thereby overcome much of the inconvenience and inefficiency associated with traditional tracking practices. Traceability of construction materials as they move through the supply chain from the suppliers to the point of installation on sites provides significant benefits. Radio Frequency Identification (RFID) tags and its related equipment in the supply chain can generate benefits by reducing unnecessary costs in the management of the material and information flows and reducing the number of process and errors. In using such a system the information becomes available faster and work is more efficient.

Given the mentioned monitoring and tracking problems above, the construction industry can benefit from the advantages of combining RF-based technologies with Geographical Information System (GIS) where RFID can be applied to collect the information by identifying resource automatically and the position of their external and internal transport vehicles (equipments) can be monitored with the help of Global Positioning System (GPS) in conjunction with GIS. The system will be used to improve and enable traceability and identification of tagged objects as they traverse the supply chain by connecting products, items/objects through a supply chain to central database. Therefore, the first purpose of this study is to develop an intelligent system based on RFID, GPS and Global System for Mobile Communications (GSM) technology for identification of the goods in construction supply chain, identifying its moving flow in logistics and tracking its location.

This paper demonstrates a system for rapid tracking, identifying, and locating resource in the construction phase. The approach involves the use of RFID, GPS, GSM, and GIS technology to provide real-time information at the actual construction supply chain and logistics. Most of the technologies which are used in this research are inexpensive and commercially available. This paper first reviews previous research and work that has been done by others relating to applications of RFID in construction, followed by an overview of the enabling technologies which are used in this research. Then it reveals the architecture of our integrated system for improving construction supply chain management[2].

II. LITERATURE REVIEW

Locating tagged items effectively in construction supply chain and logistics can potentially facilitate great increases in productivity through efficiencies in coordination and allocation of resources. Many researchers reported that RFID can be used

for tracking, locating, and identifying materials, vehicles and equipment that lead to important changes in the construction supply chain management

Geolocation, position location and radiolocation are terms that are widely used today to indicate the ability to determine the location of an MS. Location usually implies the coordinates of the MS that may be in two or three dimensions, and usually include information such as the latitude and longitude where the MS is located. Vehicle tracking device is an outdoor geolocation application in which vehicle can be located using GPS while traveling on the road. Initially vehicle tracking systems developed for fleet management were passive tracking system. In passive tracking system a hardware device installed in the vehicle store GPS location, speed, heading and a trigger event such as key on/off, door open/closed. When vehicle returns to a specific location device is removed and data downloaded to computer. Passive systems also included auto download type that transfer data via wireless download but the system was not real time. [2, 11].

In another study, Caldas et al. investigated the use of GPS to track the position of fabricated pipe spools on lay down yards of an industrial construction project in order to improve the process and reduce the number of lost items (Caldas et al., 2006). Song et al. developed an RFID based method to automate the task of tracking, delivery, and receipt of fabricated pipe spools in lay down yards and under shipping portals. Ergen et al. conceptualized and applied the use of RFID and GPS combined with GIS technology in order to locate precast concrete components with minimal worker input in the storage yard, the position of a gantry crane was tracked by a GPS receiver while GPS data were written into RFID tags attached on the precast units being lifted. The authors associated the existing problems with double-handling, late delivery, and misplacement of components that lead to schedule delay and increased labor costs. Kaneko et al. have developed a construction logistics system using RFID technology for finely controlling several construction sites in order to improve the transportation and handling of construction materials. The authors found that carbon dioxide emissions were reduced by using RFID technology. Jang and Skibniewski developed an Automated Material Tracking system based on ZigBee localization technology with two different types of query and response pulses (Jang and Skibniewski, 2007). Project performance data in the construction supply chain are commonly collected using traditional manual methods (Navon and Shpatnitsky, 2005). The data collection process is labor intensive, costly, and error prone; the resulting data are often kept as paper-based records, which need to be post processed into digital format for computer-based analysis (Lu et al., 2009). Although, the aforesaid research has clearly proven the value and potential of using new technologies, studies focusing on detailed application of full automatic systems in construction supply chain and logistics are still scarce.

III. GIS, GSM & GPS

Geographic Information System (GIS) is a computer-based system (a collection of computer hardware, software, and geographic data) to collect, store, integrate, manipulate, analyze, and display data in a spatially referenced environment. GIS allows us to view, understand, question, Interpret, and visualize data from a variety of sources in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. Spatial information of resource can be displayed on an electronic geographical map using Web-based GIS (WebGIS) technology. The employment of WebGIS facilitates the dynamic visual representation of the spatial information of the resource distribution on an electronic map. WebGIS is a new technology that combines the Internet and GIS. End users can search and analyze the GIS data intuitively on the Internet using browsers.

GSM is a digital cellular technology and the world's leading standard in digital wireless communications that is used worldwide. Short Messaging Service (SMS) is one of the non-voice data and messaging application in GSM and General Packet Radio Services (GPRS) is a GSM service for end-to-end packet switching. SMS is an older, simple and convenient way of sending information so long as they are text based where each message is limited to 160 characters. GPRS is a non-voice value added service that allows data (text, pictures and sound) to be sent and received across a mobile telephone network. GPRS is a packet switched "always on" technology supporting Internet Protocols (IP) with a theoretical maximum speed of up to 114 kbps which dial-up modem connection is not necessary (Ward et al., 2004). Typically, in GPRS based transmission, system can send more data and quicker

Most modern vehicle tracking systems use Global Positioning System or GPS. The Global Positioning System is a global navigation satellite system developed by the United States Department of Defense and managed by the United States Air Force 50th Space Wing. Many systems also combine a communications component such as cellular or satellite transmitters to communicate the vehicles location to a remote user [12].

A. Working of GPS

Global Positioning System satellites transmit signals to equipment on the ground. GPS receivers passively receive satellite signals; they do not transmit. GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or near tall buildings. GPS operations depend on a very accurate time

reference, which is provided by atomic clocks at the U.S. Naval Observatory. Each GPS satellite has atomic clocks on board. Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are farther away than others. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions

B. Determining Position through GPS

A GPS receiver "knows" the location of the satellites, because that information is included in satellite transmissions. By estimating how far away a satellite is, the receiver also "knows" it is located somewhere on the surface of an imaginary sphere centered at the satellite. It then determines the sizes of several spheres, one for each satellite. The receiver is located where these spheres intersect. There are at least 24 operational GPS satellites at all times plus a number of spares. The satellites, operated by the US DoD, orbit with a period of 12 hours (two orbits per day) at a height of about 11,500 miles traveling at near 2,000mph. Ground stations are used to precisely track each satellite's orbit.

C. GPS Accuracy

The accuracy of a position determined with GPS depends on the type of receiver. Most hand-held GPS units have about 10-20 meter accuracy. Other types of receivers use a method called Differential GPS (DGPS) to obtain much higher accuracy. DGPS requires an additional receiver fixed at a known location nearby. Observations made by the stationary receiver are used to correct positions recorded by the moving units, producing an accuracy greater than 1 meter. When the system was created, timing errors were inserted into GPS transmissions to limit the accuracy of non-military GPS receivers to about 100 meters. This part of GPS operations, called Selective Availability, was eliminated in May 2000.

IV. RADIO-FREQUENCY IDENTIFICATION (RFID)

RFID is a technology that uses communication through the use of radio waves to transfer data between a reader and an electronic tag attached to an object for the purpose of identification and tracking. RFID makes it possible to give each product in a grocery store its own unique identifying number, to provide assets, people, work in process, medical devices etc. all with individual unique identifiers - like the license plate on a car but for every item in the world. This is a vast improvement over paper and pencil tracking or bar code tracking that has been used since the 1970s. Furthermore, passive RFID tags (those without a battery) can be read if passed within close enough proximity to an RFID reader. It is not necessary to "show" the tag to the reader device, as with a bar code. In other words it does not require line of sight to "see" an RFID tag, the tag can be read inside a case, carton, box or other container, and unlike barcodes RFID tags can be read hundreds at a time. Bar codes can only read one at a time.



Figure 2: Basic component of RFID system

Some RFID tags can be read from several meters away and beyond the line of sight of the reader. The application of bulk reading enables an almost-parallel reading of tags. Radio-frequency identification involves the hardware known as interrogators (also known as readers), and tags (also known as labels), as well as RFID software or RFID middleware. Most RFID tags contain at least two parts: one is an integrated circuit for storing and processing information, modulating and demodulating. A radio-frequency (RF) signal, and other specialized functions; the other is an antenna for receiving and transmitting the signal [10]. An RFID system is always made up of two components:

1. The transponder, which is located on the object to be identified,
2. The detector or reader, which, depending upon design and the technology used, may be a read or write/read device. A reader typically contains a high frequency module (Transmitter and receiver), a control unit and a coupling element to the transponder. In addition, many readers are fitted with an additional interface (RS 232, RS 485, ...) to enable it to forward the data received to another system (PC, robot control system, ...). The transponder, which represents the actual data carrying device of an RFID

system, normally consists of a coupling element and an electronic microchip. When the transponder, which does not usually possess its own voltage supply (battery), is not within the response range of a

reader it is totally passive. The transponder is only activated when it is within the response range of a reader. The power required to activate the transponder is supplied to the transponder through the coupling unit (contactless) as is the timing pulse and data [3].

V. SYSTEM AND ITS FUNCTIONING

The intelligent system developed in this research could be divided into two parts, the system and central station. This mobile intelligent system mainly consists of three types of hardware components; namely, (i) RFID technology (RFID readers, antenna) (ii) GPS technology (GPS receiver) and (iii) GSM communication technology, therefore takes advantage of the respective strengths of each. Passive Ultra-High Frequency (UHF) band RFID tags will be used for identifying and monitoring the objects by the help of RFID reader which is connected to the system. GPS technology will be used for locating and positioning the equipment that transports the materials and the current location of objects. Collected data (ID, date, location etc.) retrieved from RFID readers and GPS is transferred via GSM technology in the form of GPRS or SMS. Therefore, data collection is done continuously, autonomously, and it is not influenced by the conditions on-site, such as line of site and weather. The central station consists of two servers, application server and database server. Application server is a monitoring station, where accurate position of each construction resource is displayed on a GIS map, and the information of each resource can be queried. A schematic model and a photo of the system are shown in figure 3

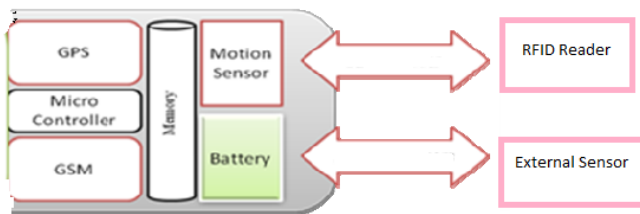
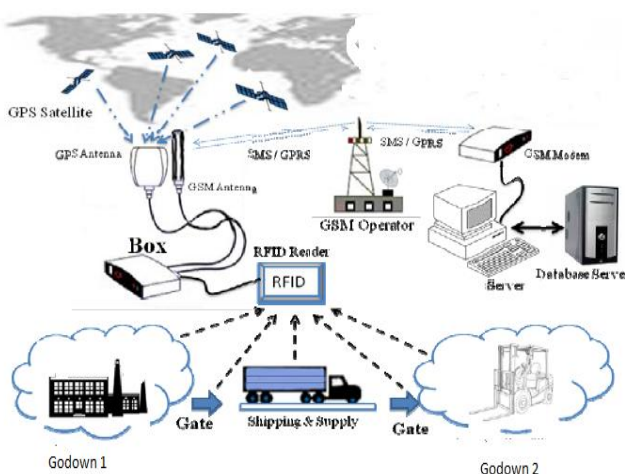


Figure 3: schematic model of object tracking system

In this approach, tracking process begins with RFID tags that contain unique ID numbers which can be placed on any object (engineered-to-order/ materials) and all of the related information such as item specific information or instructions will be stored in databases which will be indexed with the same unique ID of objects. Suppliers will attach RFID tags to all objects such as materials and possibly some bulk materials which are to be delivered in unit sets. At the times of moving or picking up of any pieces, ID information of the piece is captured by the RFID reader and the location of the piece is read from a GPS receiver. The ID and location information of the piece is then sent to a database via GSM technology. Figure 4 illustrates the simple architecture of the integrated system using RFID, GPS, and GSM technology for automatic data collection in construction supply chain and logistics.



The delivery vehicle, the gates and some key workers should be equipped with a system. This intelligent system could be programmed to send back information via SMS when RFID reader or user defined sensors which are connected to the system receive new data, for example from uploaded component to the truck or detected data by sensors. Extremely heavy foliage or underground places like tunnels would cause the signal to fade to an extent when it can no longer be heard by the GPS or GSM antenna. When this happens, the receiver will no longer know its location and the in the case of an intelligent system application, the vehicle is technically lost and central office won't receive information from this system. In this case to locate vehicles inside GPS blind areas, intelligent system will use RFID reader to save tag-IDs in the way through the tunnel or parking -each tag-id shows a unique location- the device will store all information inside internal memory as a current position, and the system will send unsent data to central office when network re-established. To give an accurate last point to locate vehicles driven in an area such as underground tunnels only GPRS should be used. A schematic model of supply chain management and control in construction is shown in figure 5.

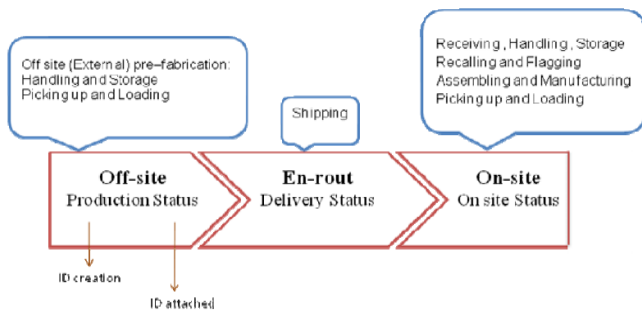


Figure 5: Supply Chain Management and Control Model

The central station can get the current location of a materials and estimate the travel time of them before it arrives at a predetermined construction site by using functions in a GIS system. GIS facilitates the complete management and control of the system for tracking and monitoring the construction resource e.g. materials and equipments. Citing factors such as screen size for RFID reader, outdoor readability, battery power, physical unit size and robustness are important considerations in the selection of appropriate hardware for the construction site. To minimize the performance reduction of selected technology under harsh conditions (e.g., rain or possible impacts from different pieces of equipment) and while in contact with metal and concrete, RFID tags will be encapsulated or insulated [4].

Tracking server maintains all information received from Vehicle which contains goods or object into a central database. This database is accessible from internet to authorized users through a web interface. Authorized users can track their vehicle and view all previous information stored in database. Tracking server has a GSM/GPRS modem attached to it that receives SMS from In-Vehicle units and sends those messages to the server through serial port. Tracking server saves this information into database[3]. The flow chart of main program shown in below figure 6

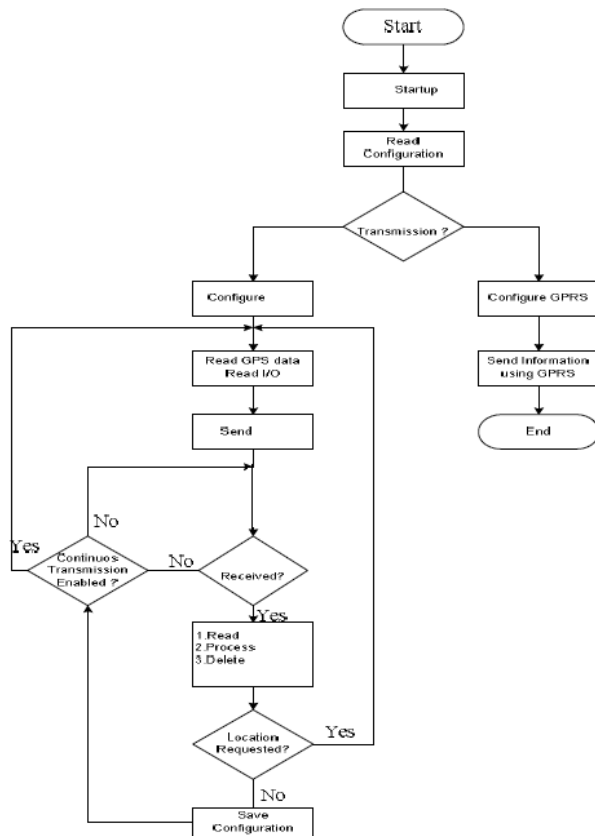


Fig. 6 Flow chart of Main program

To begin with the building of the system, we have to identify those locations where the tags have to be placed. The first step is to identify the object. This can be easily obtained from the website. This is done by identifying geographical information (latitude and longitude) of those intended points from the website as shown in fig.7



Fig.7. Determining Latitude and Longitude of Any Location

VI.CONCLUSIONS

The research is to develop an intelligent system in order to automate collecting data in construction supply chain and materials moving flow in logistics based on RFID, GPS and GSM technology. The system is consists of mobile system and server side. Three type of hardware in mobile, pervasive and ubiquitous system are GPS combination with RFID in conjunction

with GSM and application and database servers are central station. The aim of this research is to identify opportunities for applying advanced tracking and data storage technologies in Object supply chain management and to develop a model that explores how these technologies can be used in supply phase. Approached intelligent system permits real-time control enabling corrective actions to be taken which leads to reduction in costs and handling unnecessary traffic of resource. In addition, up-to-date information is available. And RFID technology paired with wireless modem proves to be a powerful, robust and redundant system method for tracking of transport, which is expected to be a boon for the daily commuters. The RFID tags require zero maintenance and once placed, require no power and their cost is also very low .For more distance, GSM/GPRS modem on GSM network by using SMS or using direct TCP/IP connection with tracking server through GPRS is used. For this, tracking server also has GSM/GPRS modem that receives vehicle location information via GSM network and stores this information in database. This information is available to authorized users of the system via website over the Internet. Thus this proposed system will help for real time tracking of object without any illegal off-load and delay.

REFERENCES

- [1] DEVYANI BAJAJ, NEELESH GUPTA .GPS Based Automatic Vehicle Tracking Using RFID .International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 1, January 2012.
- [2] Muruganandham, P.R.Mukesh .Real Time Web based Vehicle Tracking using GPS .World Academy of Science, Engineering and Technology 2010.
- [3] R.VIVEK Dr.J.ROOPCHANDREVERSE .RFID Based Tracking of Public Transport. International Journal of Engineering Science and Technology (IJEST) Vol. 4 No.07 July 2012.
- [4] Javad Majrouhi Sardroud Mukesh C. Limbachiya .Integrated Advance Data Storage Technology for Effective Construction Logistics Management. International Symposium on Automation and Robotics in Construction (ISARC 2010)
- [5] Chien-Ho Ko, Jiun-De Kuo, and Karel Nosek RFID Object Tracking in Civil Engineering: An Academic Literature Review. International Conference on Engineering, Project, and Production Management 2010.
- [6] I. Antić, T. I. Tokić RFID: Past, Present, and Future
- [7] AKINCI, B., KIZILTAS, S., ERGEN, E., KARAESMEN, I. Z. & KECELI, F. 2006. Modeling and analyzing the impact of technology on data capture and transfer processes at construction sites: a case study. *Journal of Construction Engineering and Management*, 132, 1148-1157
- [8] BEHZADAN, A. H., AZIZ, Z., ANUMBA, C. J. & KAMAT, V R. 2008. Ubiquitous location tracking for context-specific information delivery on construction sites. *Automation in Construction*, 17, 737-748.
- [9] ERABUILD 2006. Review of the current state of Radio Frequency Identification (RFID) Technology, its use and potential future use in Construction
- [10] ERGEN, E., AKINCI, B. & SACKS, R. 2007. Tracking and locating components in a precast storage yard utilizing radio frequency identification technology and GPS. *Automation in Construction*, 16,354-367
- [11] Goodrum, P.M., McLaren, M.A., Durfee, A., (2006). The application of active radio frequency identification technology for tool tracking on construction job sites. In *Automation Construction*, 15(3), 292-302.
- [12] G. T. French (1996) Understanding the GPS. 1st Edition. Bethesda, GeoResearch Inc.
- [13] J.B. TSUI (2000) Fundamentals of Global Positioning System Receivers. 1st Edition. John Willey & Sons Inc. GPS Images.
- [14] Song, J., Haas, C.T., Caldas, C.H., (2006). Tracking the location of materials on construction job sites. In *Journal of construction engineering and management*, 132(1), 911-918.
- [15] R. CLARKE. *Packaging RFID For The Real World*, Michigan State University School of Packaging. East Lansing, MI. 9, 8 (2005).
- [16] Alfred Kleusberg & Richard B. Langley., The Limitations of GPS, *GPS World*, march/april, 1990
- [17] T. Halonen et al (2003) GSM, GPRS and EDGE Performance. 2nd Edition. Chichester, John Willey & Sons Ltd.
- [18] R. Parsad, M. Ruggieri (2005) Applied Satellite Navigation Using GPS, GALILEO, and Augmentation Systems. London, ARTECH HOUSE.
- [19] Elisabeth ILIE-ZURDOR, Zsolt KEMENY., The RFID technology and its current applications, Proceedings of The Modern Information Technology in the Innovation Process of the Industrial Enterprises- ISBN 963 86586 5 7, pp.29-36