DEVELOPMENT OF SMART TOOL FOR EFECTIVE LOGISTICS PROCESSES MEASUREMENT

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Abstract

Article deals with the realization of equipment were energy-efficient integrated circuits, which are connected with intelligent sensors. This device is equipped with motion, vibration, acceleration, temperature, humidity and other sensors. Our equipment collects data during transport in the logistics process of the selected organization. Connected storage media were used for data storage and of course an integral part forms and battery power with sufficient capacity were applied. The collected data will be used to improve the organization of its services and the ability to identify the failure of the service at a specific point in the logistics chain through smart sensor package.

Keywords: Ingelligent sensors, collects data, postal parcel, measurement, IoT

1. INTRODUCTION

This article deals with a specific conceptualization of the monitoring of postal mails within the postal sector. The introductory part of the paper depicts the basic concepts of monitoring mail, forms and evolution of mail monitoring. Article also describe and analyze an existing solution for the monitoring of postal mails using intelligent sensors. The aim of science part of article is to describe the realization of its solution through intelligent sensors. This part is suitably supplemented by a description of the measurement methodology, implementation and interpretation of measurement results.

1.1. Evolution in the monitoring of postal items

Under the term monitoring of postal mails we can imagine set of activities and technologies, which are with their synergies necessary to achieve specific information about postal mails bounded by time parameter. In the past, attention was fixed upon, under the monitoring of postal mails, especially on the letter. The argument for the control of this group of consignments demonstrated with needs to monitor the quality of services provided by postal operator and the related control time delivery of postal items. In addition to the delivery time the actual realization of transport was checked i.e. at what point of the postal transportation network and at a particular time were postal mail located. This control respectively collection of information was realized primarily in fixed points of the postal transportation network. [1] The method of monitoring of postal mails can be realized in the following ways.

Processed and analyzed data obtained from monitoring are then used in the evaluation of the quality of services. This data also provides valuable information for elimination of bottlenecks in the transport process of postal mails.

A milestone within the monitoring of postal mails could be uses of location devices. These devices extend the possibilities for monitoring of postal mails by recording the current position through GPS coordinates during the transport. By its nature these devices are used primarily for monitoring of the parcel items.

The next and nowadays the final milestone in conjunction with the monitoring of postal mails, could be intelligent sensors and its using in transport and logistics services. In previous cases we have identified position or point at the postal transmission network as the most important parameter. The philosophy of intelligent sensors enriches the quality parameter of other elements that are directly related to the way of realization of transport. So in simple terms, how the consignment has been tampered with during the transportation. For this purpose, we can use the aforementioned intelligent sensors, which provides collecting information in connection with the influences acting on postal mails during the transport processes. As in the case of uses the location devices also smart sensors are inherently useful, especially in parcel shipments. [2]

As we already mentioned in case of letter mails, the monitoring of postal mails is realized for controlling and providing of data for eliminating bottlenecks transport process. Likewise, with intelligent sensors can be processed and analyzed information used to enhance the security content of processed and transported postal mails. The range of development of this technology in the postal sector is all the more appropriate in terms of growth in the number of parcels. [3] Annual growth is still growing at around 6.3

Based on the information mentioned above we can summarize all methods in conjunction with monitoring of postal mails in following 5 points:

I. By manually collecting data - manually copy data from the shipment.
II. Automated and semi-automated - loading the data from the barcode by EAN reader.
III. Automated - loading data from the RFID tag through an RFID reader (active and passive RFID technology).
IV. Automated - retrieving GPS location coordinates via GPS module and recording the coordinates of time parameter to the internal memory or on-line sending coordinates via cellular modem.
V. Automated through intelligent sensors - reading diverse influences acting on the postal mail and recording of data with a time parameter of the internal memory or on-line sending this data via a mobile modem. [4]

3.1. Smart sensor package

Smart sensor package is the label named by us for tested Parcel item. This package consists with the tool for collecting and recording negative influences on the content of postal parcels. The proposal is made in two forms, namely the offline and online versions. The concept is more evident in the following **Figure 1**.

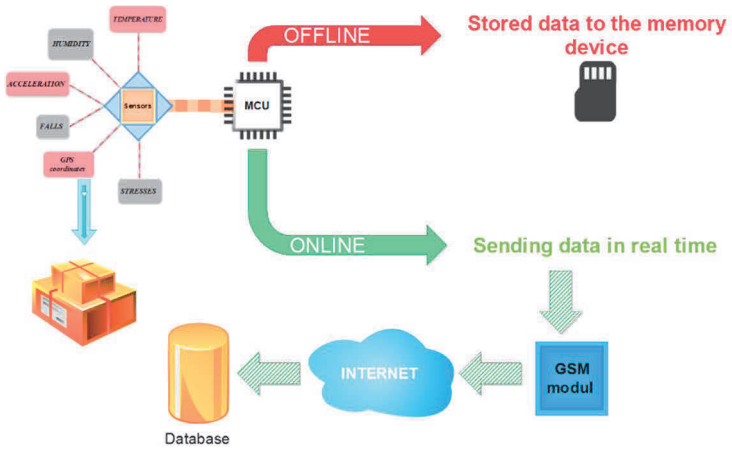

Figure 1 The model of smart sensor package

How we can easily deduced from **Figure 1**, the first option is used for data collection and evaluation to the realization of the transport function. The second option allows you to obtain and process data online, at doses at set time of intervals or after exceeding a set threshold for a particular sensor used etc.

The idea for the creation of this tool was an effort to push the limits in conjunction with the quality control o transport services. So we decided to build up a custom tools that would allow for the efficient collection of relevant data, which provide background information to reduce the risk of damage respectively damage to contents and packaging of parcel shipments. Among the following functionality is also to identify bottlenecks and measure the effects of negative impacts, testing the adequacy of packaging used etc.

3.2. Use the intelligent sensors in logistic

We realized secondary research in conjunction with the similar solutions that are used and implemented worldwide. The aim of this survey was to determine which logistic operators use devices equipped with intelligent sensors, in what area is most often used and for what logistical units are paired. Additionally were examined the types of sensors utilized in various solutions. The results of secondary research are given in **Table 1**.

Table 1 Analyze of uses intelligent sensors by logistics companies

Společnost	Název služby/zařízení	GPS	Light sensor	Temperature sensor	huminity	barometric pressure	Accelerometer	Geofencing	Door alarm	Gyroscope	Shock	Compas	On-lin sending data	Scope of application	The primary area of application
FedEx	Senseaware	YES	YES	YES	YES	YES	YES	NO	NO	UN	YES	UN	YES	parcels, crafts, transporter	pharmaceutical sector
DB Schenker	Smartbox	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	UN	YES	sea, rail, air larga container	Logistic sector
	SEAGsens	UN	UN	YES	UN	UN	UN	UN	UN	UN	UN	UN	NO	Package with drug or biological material	pharmaceutical sector
J. B Hunt Trnasport service	Cargo/Terion	NO	NO	YES	YES	NO	YES	NO	YES	NO	YES	UN	YES	truck, freight wagon	Logistic sector, pharmaceutical sector
Swift logistic	VeriWise	YES	UN	UN	UN	UN	UN	UN	YES	UN	UN	UN	YES	truck, freight wagon	Logistic sector, pharmaceutical sector
Werner Global Logistics	Orbcomm	YES	UN	YES	YES	UN	UN	UN	UN	UN	UN	UN	YES	truck, freight wagon	Security sector, logistic sector
Panalpina	ILC2000	YES	YES	YES	YES	YES	YES	NO	NO	UN	YES	YES	YES	sea and air container	Logistic sector
Xpress Enterprise	SkyBitz	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	YES	truck	Logistic sector
DHL	SmartSensor GPS	YES	YES	YES	YES	NO	YES	NO	NO	UN	YES	UN	YES	parcels, crafts, containers, large containers	Logistic sectors
	SmartSensor RFID	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	parcels, crafts, containers, large containers	Logistic sectors

In the table below you can see the most important companies, which use intelligent sensors within their processes or in the provision of its services. From the analysis implies that these new technologies for monitoring logistics units are designed and intended primarily for the healthcare and logistics, with an emphasis on safety. Even though the internet of things currently shifting possibilities of the ICT uses to industry, area that deals with monitoring of logistic units is the privilege of large corporations operating in the exclusive areas of industry.

2. MATERIALS AND METHODS

The above-mentioned research was conducted in two forms, namely in the laboratory and in real condition of postal operator named as Slovak Post, a. s. From the large scale or number of laboratory testing and measurements the huge volume of data base was obtained. This information was the basis for us to evaluate the data in real traffic. The main variables that we examined were the data from gyroscopes, accelerometers and sensors combining temperature and humidity. Our aim was to test and verify our solution and determine whether the influences on the consignment are not excessively negative. For testing purposes was selected the processing centers of postal operator. In this place there are usually a top-tier influences on postal mails. Selected postal operator states that the packaging has to answer nature of postal parcel. Thus, the postal parcel must be modified to allow a fall from a height of 150 cm. This figure was subsequently evaluated in the context of laboratory testing.

2.1. Materials

As was mentioned above the testing in real conditions was carried out in the mail processing center of postal operator. It is a closed building and that was the reason why for this testing was used offline version of our device. The package and the device itself can be seen in **Figure 2**.

Figure 2 Cover and smart sensor package

2.2. Measurement procedure

The entire testing was under the supervision of competent person who is responsible for operations in this processing center of the postal operator. Additionally, this person provided additional relevant information about the individual workflows. On the basis of such was created plan of measurement and testing was realize. The entire measurement procedure reflecting the real operation is more evident in the **Figure 3**. Due to collect real data, testing was realize during full operation of processing center. At this time, it realized the collecting a processing of postal items. In order to reveal this part of transportation process were record values obtained from temperature sensor, accelerometer and gyroscope. This means the sensors, which are relevant for fulfilling the objectives of this testing. Number of experiment was set for 20 reps. Number of repetitions was determined having regard to the possible occurrence of abnormal values during testing. Latency data collection was set at 50 milliseconds, i.e. 20 series of data per second. All data were collected offline to the internal device memory. Also was realize manual recording time date on entry postal parcel to individual parts of processing parcels. This recording has been instrumental in the detailed evaluation of the collected data.

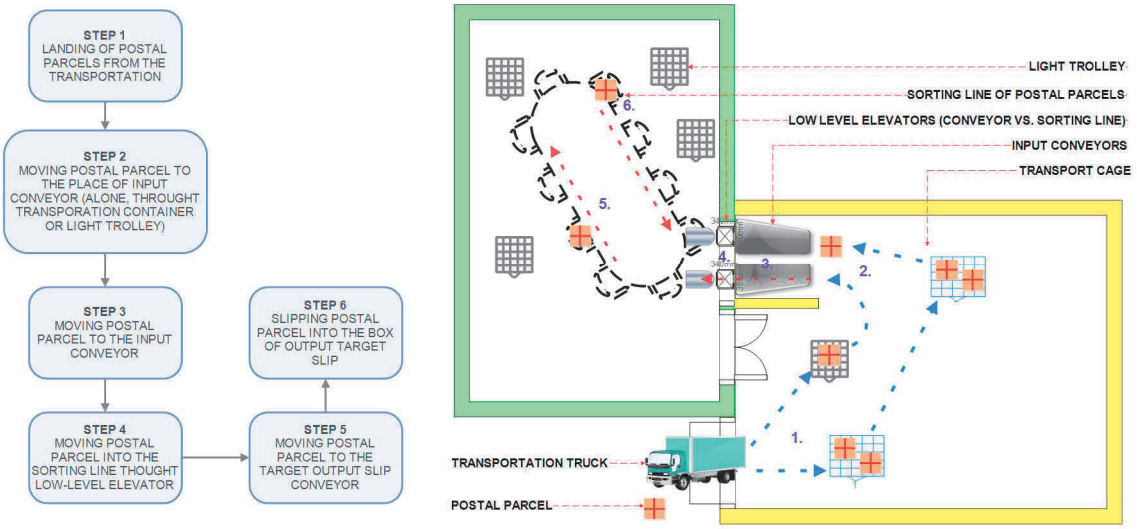

Figure 3 Measurement procedure - step by step, shown in the illustration

2.3. Results of experiments

It was acquired b 89, 742 sets of data from the testing. All data were analyze and gave the following information:

- 19 experiment showed similar values of realized measurement (similar values are meant values of dispersion 7%).
- 1 experiment showed in the last two parts of the transport processes of different values (in relation to unforeseen circumstances).
- Subsequent laboratory tests comparing the measured values, it is noted that neither on series of values doesn´t exceed a value representing a fall postal package from a height of 150 cm.

As already mentioned, one experiment showed standard values. These substandard results differ from the standard, not only the duration of treatment (extended by 4 minutes and 12 seconds), but especially in the results accelerometer and gyroscope. Different values were measure only in two last steps (i.e. steps 5 and 6). These two steps represent a slip of postal parcel from sorting lines. The following **Figure 4** compares summarized value of 19 experiment to standard values and 1 experiment with non-standard values. The first part of figure presents illustration points after slipping postal parcels on gravitation slip. I tis characterized by lean postal parcel at an angle that is equal to the angle of gravitation slip of sorting lines. The second part of figure presents illustration non-standard values at 1 experiments. The reason why the values are different lies in the following facts. The postal parcel does not slide after slip, but that postal parcels fell after slipping in the rotation until to the output tray.

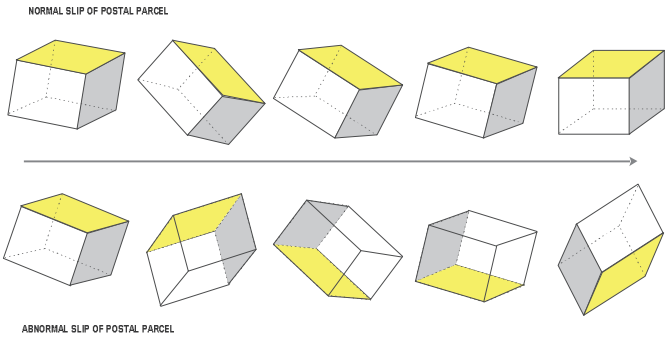

Figure 4 Differences in measurement (slip sorting line)

Even though postal parcel fell unpredictably in gravity slip, so the measured values aren´t still responded laboratory values (i.e. a fall from a height 150 cm). The question arise only if the laboratory values are comparable, because the laboratory tests weren´t designed for multi-level falls in the rotation. The main reason for these values was a condition that can be called overflow sorting line. And it is also true that this condition is rare. Sorting lines was filled because one postal parcel locked output to the tray, which reported its overcrowding. Consequently, there was a faster rate of empting of the individual transport trays, once to remove the problem.

3. CONCLUSIONS

The current increasing trend in the parcel delivery opens the door to a new area of monitoring of transport postal parcels. We are not talking only about compliance with the time of delivery of postal items, as well as adherence to technological processes and security. Thus preventing the loss, theft or damage of postal parcels. This target is currently heading the only one path, and that is the philosophy of IoT. There are already several solutions, but which mainly serves as additional services for customers of the postal operator. As part of this research were realize just one of the first small steps, which aimed to monitoring the entire process chain. Our research has so far been realized only at one point in transport process of postal parcel. And it was processing center of postal items. At this point exist assumption that can cause negative impacts on the parcel. This assumption was not confirmed in any of the experiments. In the future we plan to realize new measurement using different sizes and different weights of postal parcels.

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REFERENCES

[1] BUKOVÁ B., BRUMERČÍKOVÁ E., KOLAROVSZKI P. Zasielateľstvo a logistika. Zodpovedný redaktor: Mária Bali-Jenčíková. Bratislava: Wolters Kluwer, 2014.

[2] MADLEŇÁK R., MADLEŇÁKOVÁ L., ŠTEFUNKO J. The variant approach to the optimization of the postal transportation network in the conditions of the Slovak Republic. Transport and telecommunication, Vol. 16, No. 3, 2015, pp. 237-245.

[3] P. KOLÁŘ AND J. P. RODRIGUE, “Improving the Bottlenecks: The Czech Republic as a Central European Intermodal Transport and Logistics Platform,” in IAME Conference 2014. Norfolk: Maritime Institute, Old Dominion University.

[4] KEBO V., STAŠA P., BENEŠ F., ŠVUB J. RFID Technology in Logistics Processes. In SGEM 2013: 13th International Multidisciplinary Scientific GeoConference, Albena, Bulgaria, 2013, pp. 219-226

[5] VOJTĚCH, L. - NERUDA, M.: Application of Shielding Textiles for Increasing Safety Airborne Systems - Limitation of GSM Interference. In The Ninth International Conference on Networks (ICN 2010). Los Alamitos: IEEE Computer Society, 2010, pp. 157-161.

[6] DÁVID, A. Innovation of Handling Systems in the World Container Ports and their Terminals. Transport means 2013 - proceedings of the 17th international conference, Kaunas University of Technology, Lithuania, pp. 250-253, ISSN 1822-296X.