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An Automated Device for Explosive Materials Detection on Postal Objects in Outdoor Mailboxes

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Abstract: *The increase in terrorist attacks at a global level has dramatically changed the way people live. New forms of terrorism have emerged, changing the everyday lives of ordinary citizens, who are often the "collateral losses" of these acts. In particular, the sending of "terror-packs" to target persons has highlighted the security gap in the provision of postal services and, in particular, the risk faced by both the universal service provider employees and the ordinary citizens, since the behavior of an explosive device is unpredictable even when it is simply moved or placed somewhere. Moreover, the inability of the postal provider to identify the sender and track simple postal items (PRIORITY B letter mail) that are dropped in outdoor mailboxes is another weapon in the hands of terrorists. This dissertation will present the design study of an explosive detection system contained in a postal item dropped in an open mailbox. In addition, it describes the way in which the provision and timely notification of the competent authorities and services are provided for their immediate intervention in order to avoid the extension of the damage. The permanent installation of such a system in outdoor mailboxes can focus primarily on the protection of human life and, secondarily, on the timely and immediate mobilization of competent authorities and services in case of detection of suspicious postal items, something that will be a pioneering initiative for Greece. These two points are also the purpose of this dissertation, in an attempt to use technologically advanced applications to contribute to safety and avoid human losses and material damage. In the main part of the dissertation the design criteria of the proposed system, sensor devices, the microprocessor, the supply and autonomy devices and the communication device are analyzed. The way of operation and the communication environment with the competent authorities and services are presented in detail through the description of the operating scenario. In addition, the dissertation will include financial and technical data concerning the operation and installation costs of the proposed system in outdoor mailboxes. The study is completed by recording the conclusions that the system is expected to use.*

Keywords -*explosives, ion mobility spectrometry, outdoor mailboxes, sensing detection device*

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I. Introduction

In recent years, humanity has witnessed many, bloody and fatal terrorist attacks, thus in many cases the victims are innocent, unsuspecting citizens. Busy places where celebrations and anniversaries take place, rail stations and airports are the first choices of terrorists to hit and cause as many losses as possible. Lately, another method of terrorism to which terrorists are particularly preoccupied with is the sending of “terror-parcels”. This is the sending of postal items that contain an explosive device or explosives. In this case, the target can only be the person - recipient of the parcel or letter. However, no one can rule out the possibility of serious injury or contamination of those involved in the process of collecting and distributing postal items. Terrorists, exploiting the anonymity offered by the simple mail order process, throw the “terror-parcels” in outdoor mailboxes, from which they are then collected according to the universal service provider's collection procedures and forwarded to their final destination. In the past, these acts of terrorist organizations have been repeated many times, sometimes successfully and sometimes not.

LABORATORY TESTS

The competent departments of the Greek Police carry out a thorough investigation and thoroughly check that any trace of explosive material is seized or is in explosive remnants to identify its nature, determine its type and chemical composition, be characterized (whether it is a military explosive or non-class, specialized, low or high power) and to make a first risk assessment. The analytical chemistry sector has a wide range of specialized and reliable methods and devices that help identify the main components of explosives even when the explosive is a mixture of different components and the sample is in very limited quantities. Also, explosion product residues remain intact, which remain unchanged after the explosion and are attached to fragments of the explosive device or materials around the point of the explosion.

In general, and in the case of a non-exploded explosive sample test, the usual analytical process involves an initial stage of separation of its components in organic and inorganic products. Subsequently, the components of the mixture and their identification are categorized. At this stage, the specialized methods and special devices used are based on the fact that each category of component of an explosive has a different degree of solubility in water and other organic solvents.

A similar procedure shall be followed by the competent police departments and in the case where the sample to be tested is derived from explosive remnants attached to fragments of explosive material or materials at the point of explosion. However, the procedure of washing the sample with organic solvents and water is preceded in order to obtain the organic and inorganic components. Then, there is an interfering method of cleaning the samples from impurities. The sample can now be inserted for separation and identification of its components, as in the previous case.

To achieve all of the above, conventional gas and liquid chromatography mass spectrometry devices, as well as other, highly sensitive sensors, are used. From the results of these tests, it is possible to study precisely the qualitative and quantitative composition of the explosive, even when the available quantity of the sample is too small [1].

TECHNIQUES FOR DETECTING EXCITABLE EXPLOSIVE MECHANISMS

Nowadays, new forms of terrorist attacks have proved to be more dangerous and more sophisticated, since even remote control methods of the improvised explosive mechanism, which is easily achieved through a common mobile phone device, are also used. An improvised explosive device is essentially an improvised explosive charge. The main part is the detonator, which can be either home-made or professional.

Activating the detonator requires the presence of explosives. An improvised explosive may be any chemical compound or mixture of chemical compounds, which under certain conditions may cause a reaction that leads to an explosion. The main components of an improvised explosive are inorganic salts that contain bonded oxygen molecules, such as nitrate, chlorate, perchloric acid or organic nitrate compounds or peroxides [2].

Today, more than a hundred types of military and commercial explosives are found. For their detection some specific characteristics are used, which are:

- Geometry - the metallic substance of the detonator can be detected by image and / or shape analysis,
- Density of material - the density of explosive materials is higher than most organic materials,
- Elementary composition - refers to methods of analysis of emitted vapors,
- Vapor emission – e.g. Specific chemical elements and their compounds, such as nitrogen, can be detected in a vapor sample.

The methods for detecting improvised explosive devices are divided into two categories: Mass Explosive Detection and Explosive Trace Detection.

In the case of Mass Detection, the mass of the explosive material is directly detected macroscopically, usually by viewing images from X-Ray scanners or other similar equipment. In the case of Trace Explosive Detection, the explosive is detected by the chemical identification of its microscopic residues. These residues may be either in the form of particles or in the form of gaseous molecules or in both of these forms.

The purpose of the mass detection method is to detect large quantities of explosives. On the other hand, gas detectors have the ability to detect quantities of less than one microgram. Hydrogen, nitrogen, carbon and oxygen are the main ingredients of an explosive.

Explosive concentrations are classified into three basic groups, according to the steam pressure they present: High, Medium and Low Vapor Pressure (Figure 1) [2].

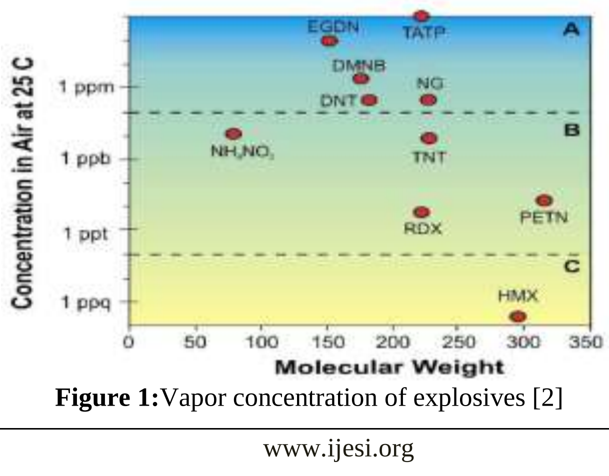

Figure 1: Vapor concentration of explosives [2]

1.1 BULK DETECTION SYSTEMS

The development of techniques based on X-rays, gamma rays, infrared rays, etc. have contributed to the effective detection of weapons and explosive devices. Briefly, the methods used for mass detection include:

- X-ray and gamma ray systems,
- Neutron methods
- Electromagnetic Systems.

The mass detection method is not applicable for direct scanning in humans, as it is likely to cause health problems.

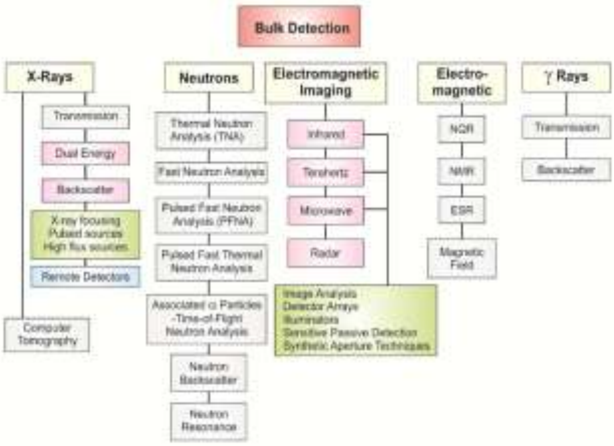

Figure 2: Overview bulk detection of explosives [2]

1.2 TRACE DETECTION METHODS

The methods by which vapors are detected are non-invasive and rely on the measurement of traces of certain specific characteristics of volatile compounds that evaporate from explosives. The degree of volatility varies from explosive to explosive. Volatility is a size characterized by the concentration of saturated vapor near the surface of the explosive. For the detection of vapors and traces of explosives, the following types of sensors are used:

- Electronic - Chemical sensors,
- Optical sensors,
- Biosensors [2].

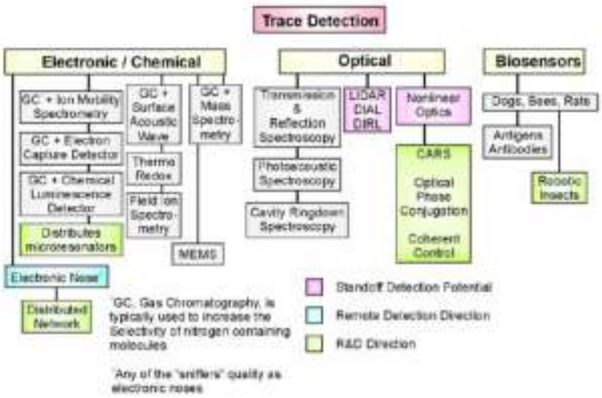

Figure 3: Overview traces detection of explosives [2]

OPERATING PRINCIPLE OF THE ION MOBILITY SPECTROMETER

The mobile phase switch is essentially represented by four sub-sections illustrated in Figure 4 and is as follows: i. Sample Introduction System (SIS), ii. Ionization Region, iii. Separation Region (where separation or selection takes place) and iv. Detection Region.

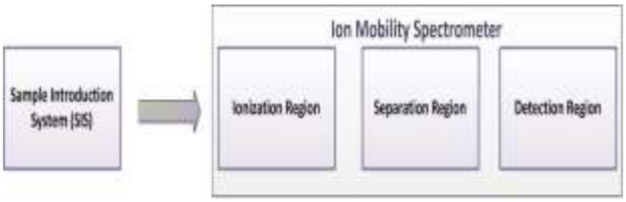

Figure 4: Elements of an Ion Mobility Spectrometer [3]

Initially and before the ionization process begins, the sample should be inserted into the device. The process by which a small but representative fraction of an unknown gas mixture is bound to be introduced into the apparatus is called "sampling". The composition of this small fraction should represent as much as possible the average composition of the material or population volume. Prior to initiating the actual sample analysis and recording measurements and results, the calibration of the device should be preceded. For the introduction of a gas, liquid or solid calibration sample into an ion mobility spectrometer, a plurality of devices are used, including permeation tubes, purge vessels and dilution glass flasks, central probes, pyrolyzers, evaporation units, membrane-inlet systems, thermal desorption units, solid phase micro-extraction units, Stir-bar sorptive extractors, chromatographic columns and supercritical fluid chromatographs. These devices are some of the most widely used SISs because of their low price and ease of operation and their primary role is to convert liquid or solids to volatile analyzers before they are identified. Essentially, the sample input system determines to a very large extent the potential of analyzing of an IMS instrument. Key factors for the proper selection of the sample input system are the analytical substance, the sensitivity and the selectivity required. In addition, potential interferences that may be caused during measurements such as those that may be caused by humidity or the presence of some foreign chemical compounds that are as volatile as the test substance at the same temperature can be minimized if the appropriate sample system is selected. Cost is another important factor that should be taken into account when selecting the sample input system.

Sample analysis using ion mobility spectroscopy alone cannot be considered as reliable since many measurement results based solely on this method have proved to be inadequate. The main reasons why the exclusive use of this method is considered to be insufficient is the frequent overlapping of the peaks and the tendency for the ions to interact with each other in the area of ionization. In order to address these problems, the substances to be analyzed are separated before being introduced into the spectrometer and this is achieved by combining different techniques. For example, analysis of the ion mobility spectrometer is improved using a coupled chromatographic column. Also, real-time monitoring of specific volatile analytic compounds is accomplished using a solid phase extraction unit in combination with a spectrometer. Electro spray ionization (ESI) systems and laser-assisted laser ionization systems assisted by matrix material (Matrix-Assisted Laser Desorption Ionization, MALDI) have the greatest advantages, as both are able to analyze high molecular weight compounds and thermally unstable compounds.

Radioactive Atmospheric Pressure Chemical Ionization (R-APCI) is the most common ionization method in an ion mobility spectrometer. A source of this type of ionization is a β-source radioactive isotope, such as a small Ni-63 sheet. Other elements that have been used as sources of radioactive isotope are tritium (T or H^3, β-radioactive isotope of hydrogen H) and dietary dioxide (Am^{241}). Another method of ionization is photon ionization, which takes place at atmospheric pressure (Atmospheric Pressure Photo Ionization, APPI) and is based on ultraviolet light (UV). The Corona Discharge Atmospheric Pressure Chemical Ionization (Corona Discharge Atmospheric Pressure Chemical Ionization, CD-APCI) is another technique of chemical ionization. This technique uses a high voltage electric field, which develops between a needle or a very thin cable and a metal plate or discharge electrode. Finally, Laser Desorption Ionization (LDI) is used as the source of ionization. The ionization method to be used determines whether nitrogen and oxygen will be ionized. In this case, the positive and negative ions of nitrogen and oxygen (N_2^+ και O_2^-) react with water vapor molecules. This results in ions ($(H_2O)_n(H_3O)^+$and $O_2^-(H_2O)_n$) being formed, which are called reacting ions. Spectroscopy shows the peaks of these ions, called Reactant Ion Peak (RIP). Also, there are the potential to form other ion groups, such as $(H_2O)_nNH_4^+$, the tops of which may be depicted in the mobility spectrum as small peaks of ammonia groups. The peaks of these compounds appear before the reactive ion peaks (RIPs) and are called pre-RIP.

Charging a sample molecule M can be ionized either positively (M^+) or negatively (M^-). Possibly, the molecule, after its positive or negative charge, may participate in various reactions. However, the most interesting reactions involved are those taking place with the neutral molecules that lead to the formation of monomeric compounds (MH^+,$(M-H)^-$ or MO_2^-), and those leading in the formation of dimers (M_2H^+) or trimers (M_3H^+) at high concentrations of the analyte. These coupling reactions should also include those resulting from the induction of hydration reactions which lead to the formation of ion clusters, such as $M^{\pm}(H_2O)_n$ [3].

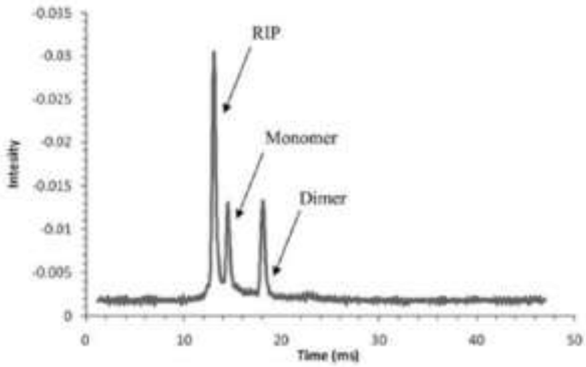

Figure 5: Typical IMS chromatogram showing the reactant ion peak (RIP), monomer and dimer [3]

Since it goes through the procedure of alignment with the corresponding section of the lens, it is guided in the next part of the device, which is the drift or partition or drift tube. Applying an intermediate step between the ionization and segregation sections was considered necessary in some spectrometer devices to provide a more efficient and efficient focusing of the ions before they enter in the separation section. Two different ion gate systems are used for this purpose: the Bradbury-Nielson gate (BNG) and the Tyndall (TG) gate. The principle of operation of these portal systems is based on the creation of an electric field between two rows of fine wires, which are located scattered and submerged along the deflection tube.

For moving the ions into the diverting tube, a gaseous medium is used. The movement of the ions and the gaseous medium into the deflection tube is achieved due to the effect of an electric field E. In their movement, the ions accelerate due to the Coulomb forces exerted and slow down due to inevitable collisions with the gaseous molecules. When the ions are in equilibrium they move in the same direction on average with a constant displacement velocity v_d, which is proportional to the electric field: v_d=K*E. The intensity of the electric field differs from device to device.

For the last portion of an IMS spectrometer, which is the detector, a Faraday plate (Faraday's plate) is usually used. The use of the Faraday plate is done in conjunction with an aperture grid. The sizes measured at the detector output require amplification before being sent to an automatic logger. There, with the use of appropriate software, the data is stored and ready for editing. It is common for the output data to be current intensity values. Thus, the ion mobility spectrum is represented by a graph of the ionic current intensity as a function of the deflection time, i.e. the time required for the ion, once it passes the ion gate, to reach the detector portion [3].

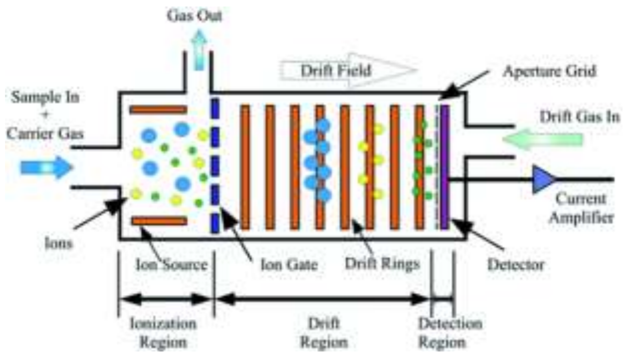

Figure 6: Schematic of a conventional drift time IMS (DTIMS) system [3]

1.3 PHYSICAL AND CHEMICAL PROPERTIES OF EXPLOSIVE SUBSTANCES

Physical and chemical properties of explosive materials are the key elements of the traceability detection process. Explosives are essentially some chemical compounds, which under certain conditions undergo decomposition. Decomposition of explosives leads to sudden release of heat and pressure. The rate of combustion of explosives is a criterion for their classification in high or low combustion explosives.

The combustion rate of low combustion explosives amounts to cm / sec, while the velocities with which explosive combustion explosions explode can explode to the rate of km / sec. High explosive explosives are further separated into primary and secondary explosives according to the degree of stability they present. Primary explosives exhibit an excellent sensitivity to external stimuli, such as friction and thermal and electrical sparks, which are capable of causing an explosion. Instead, secondary explosives, such as TNT and RDX, are highly stable, and a primary explosive is required to cause an explosion.

Home-made Explosives (HMEs), due to their simple composition, can easily be manufactured using commercially available materials. The main feature of these explosives is the very high vapor pressure, which is due to the presence of Volatile Organic Compounds (VCOs) including, such as acetone. In addition, they are highly unstable and therefore very careful handling and special care is needed to avoid their burning.

The most common and widely used explosives show very low ambient pressure. Because of this extremely low vapor pressure, the molecules of these compounds exhibit sticky behavior and tend to adsorb onto surfaces very easily. However, the very low vapor pressure of these compounds can grow rapidly with the simultaneous, rapid increase in temperature. And this is another feature of explosive, chemical compounds. The result of the rapid rise in temperature is to create vapors, which are condensed and adsorbed very quickly by cooler and cooler surfaces.

The adsorption rate is even greater than surfaces with high surface energy, such as metal and metal oxide, compared to low energy surfaces such as polymers and plastics. Also, condensation of molecules of explosive compounds at room temperature is caused due to this sticky property. Therefore, in order to obtain a safe result in the process of detecting the molecules of explosive compounds and given their very small number, a more specialized way of sampling and a particular sample preparation is required [4].

1.4 SAMPLE-COLLECTION AND PRE-CONCENTRATION

A complete layout is required for the process of collecting sufficient quantity and sample quality. This device is essentially the first piece of an integrated detection system. As mentioned in the previous section, most widely used explosives are characterized by their low vapor pressure. A large amount of clean air is required so that a satisfactory and representative sample can finally be obtained.

From the quantity and quality of the sample, the final number of bound molecules of the explosive will be determined for analysis. It goes without saying that the higher the sensitivity of the detection device, the smaller the amount of analytical molecules required to be collected. Most explosive detection sensors do not have a fairly satisfactory degree of sensitivity in real time and therefore a very good way to collect a sample is required. A solution to this problem came from the design and construction of a pre-concentrator, which is used to sample explosive analysis.

Pre-concentrator operation is simple: initially, with a pump, a large amount of air is introduced into it. It is actually a mixture of many different molecules, including molecules of explosives at very low concentrations. Subsequently, the explosive molecules are bound by the use of special materials. In order for these special materials to absorb the molecules, they should be heated beforehand. The binding mechanism is based on the adsorption effect on large surfaces [4].

1.5 PROPOSED DEVICE'S GENERAL DESCRIPTION

Diagram 1 below illustrates the proposed explosive detection device for postal items dropped in outdoor mailboxes:

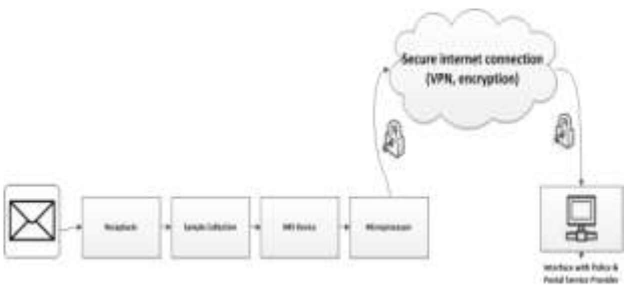

Figure 7: General diagram of proposed layout.

The postal items enter the outdoor mailboxes through a slot, quite wide, located on the front of the mailboxes. In order to check for the presence of traces of explosives inside or on the surface of postal items, they are initially placed in an antechamber, specially formed inside the mailbox and fixed to the height of the slot. From this antechamber, the postal items enter serially in an empty box, where the sampling process takes place. The box is vacuum-free to prevent any contaminants with other molecules in the surrounding area and thus enhance the purity of the sample. A clear air supply is provided inside this box to release molecules located inside or on the surface of the postal object. The amount of clean air along with the released molecules enters the pre-concentrator by means of a pump, where the process of binding molecules of explosives, as described above, is now taking place. Finally, a satisfactory percentage of pure samples enter the ionization region of the IMS device and its analysis and identification process is followed.

1.6 IMS SENSOR

The IMS sensor device studied belongs to the Drift Time Ion Mobility Spectrometer (DTIMS) class.

The modern development of nano-technology has helped in the compact design and construction of such IMS devices. Today, these devices have a very high sensitivity and fast response, tracing traces of ppb-ppt explosive within msec interval, operating under atmospheric pressure, and being able to separate isomeric compounds.

Tiny, easy-to-assemble, low-cost nano-ions are made of Low Temperature Co-Fire Ceramic (LTCC) and include a Integral Resistor Network). Essentially, the design and construction of such a tube results in the removal of up to 150 individual components, drastically reducing the size of their formerly equivalent explosive detection devices

Additionally, the combination of these materials has led to the production of an internal, chemically inert surface, thus helping to improve the performance of the device.

The results of the device's controls and measurements can be analyzed using digital signal processing technology and determine the type and concentration of the explosive. For this purpose, the calibration of the device is required [5].

1.7 IMS DEVICE CALIBRATION PROCEDURE

Basic and necessary step before analyzing real samples is the calibration of a device. The calibration of a device is how it is set up, it takes place before measurements of real samples are taken and is intended to ensure the accuracy of the results of the measurements to follow. The standard in the calibration process of a device is to precede the measurement of a standard substance, called a calibrant [3].

The calibration of an IMS device is based on the determination of the relationship between a standard solution (reference value) and the substance under analysis. Proper calibration of the IMS device targets both qualitative (detection) and quantitative (quantitative) analysis of the explosive. The composition of the standard solution (calibrator, calibrant) is as similar as possible to the composition of the explosive substance under analysis. The use of this kind of chemical standard solutions aims at calibrating IMS devices, while avoiding interference from other, foreign materials.

Therefore, a series of such external standard solutions, including the explosive substance under investigation, are prepared at known, quantified concentrations. Each time a specific sample is inserted into the device, the signal is output at its output, and a series of matches between the composition of the standard solution and the known quantified concentration of the explosive substance are obtained. A basic output signal is the blank signal, which is the response of the device to a sample that does not contain the explosive substance at all. From the results recorded, a calibration curve shows either their graphical design or their appropriate adaptation to a mathematical equation [6]. Measurements and recording of a device's responses during its calibration process are always performed under specific, fixed and predetermined conditions [7].

The measured, proportional size at the output of the device studied is a current, which requires amplification by means of a suitable electronic amplifier. Subsequently, the amplified signal is passed through an A/D converter (A/D converter). From the resulting calibration curve, a Lookup Table is created, which is then used as the basis for the microprocessor programming.

II. The Raspberry PI 3 model B+ microprocessor

The microprocessor tested for explosives detection device in postal items thrown in outdoor mailboxes is the Raspberry PI 3 model B +. It is a powerful, small and lightweight computer, based on ARM technology. More specifically, it has a four-core processor company ARM (Broadcom BCM2837B0, Cortex-A53, ARM v8), 64-bit SoC (System on Chip) at 1.4GHz. The advantage of this tiny component is that it has a much better heat output, making it able to operate almost at the 1.4GHz maximum of the 4 core processor [8]. Another useful feature of this particular microprocessor model is the extensive 40-pin pins that function as General Purpose Inputs / Outputs (GPIO). The low-power microprocessor memory is 1GB of LPDDR2-900 SDRAM. The feature that is a novelty of the series in the connectivity segment is the presence of dual-band wireless LAN, operating at 2.4GHz and 5GHz and covering all IEEE (802.11.b / g / n / ac), as well as Bluetooth (version 4.2 BLE).

In addition, there is a Gigabit Ethernet port via USB2.0, with a maximum transmission rate of 300Mbps. Finally, the connectivity capabilities provided by the microprocessor include four USB 2.0 ports [9]. The microprocessor requirements for power supply are low (5V / 2.5A DC) and there are many possibilities, depending on the application. The microprocessor can be powered either via a micro USB connector or via the GPIO terminal [9] [11]. Finally, this series model provides PoE (Power over Ethernet) power, but requires a separate PoE HAT [10].

III. Power Supply Requirements of the proposed layout

The feed requirements of the proposed layout are easily covered, since most outdoor mailboxes are located very close to the front of the company's designated universal service provider and its agents. This is an advantage for the supplying needs of the proposed device, since its power supply can be done by means of a cable coming underground from the shop premises.

With respect to the device's autonomy system, this may consist of rechargeable battery systems which will be used and suitably adapted to the interior of the outdoor mailboxes in order to provide the necessary autonomy of the device and ensure its continuous, uninterrupted operation for a large time interval [12].

IV. Telecommunication System of the device

The current, rapid development in the telecommunications sector provides enormous speed capabilities, which are supported by the proposed microprocessor model for this layout. At the same time, unbelievable and cost-effective data storage and storage solutions provided by Cloud Computing services make the design and development of the telecommunication system for the proposed layout a relatively easy and fast process.

Due to the nature of the data generated by the proposed explosive detection device that will need to be stored for some time, a good and efficient solution would be to design and develop a computational model based on a Community Cloud development model and will take advantage of the Infrastructure as a Service. Members of the community will be all competent police authorities and the universal postal service provider. Storage data that will belong to the Cloud infrastructure will be able to store the data that will be obtained from the proposed layout that will be installed in the outdoor mailboxes. Through a specific interface point and specific access rights, competent officers, certified police officers and the universal service provider will be able to manage and process the specific data.

V. Operation Script

The combination of high telecommunication speeds and cost-effective storage solutions meets one of the key requirements of the proposed provision. However, timely notification and notification of the police officers and officers of the universal postal service, in case of explosive detection in an open mailbox, is a top priority issue.

Data resulting from device metrics is sent via real-time wireless communication to a central server in the Cloud computing, where they are stored for a certain amount of time in order to undergo some form of processing at a later time. In the event that explosive matter is detected on a postal item, along with the sending of data to the central server, an e-mail will be automatically sent to predefined e-mail addresses or a text message to mobile phones from the heads of the competent police authorities and the company's officers universal postal service.

This message includes information about the results of the explosive detection process and its location, i.e. the coordinates (latitude and longitude) of the location of the outdoor mailbox. Immediately after being informed of the detection of a postal item containing explosive, all such actions shall be taken by the competent police authorities in accordance with the formal procedure followed in such cases.

VI. Indicative cost of the proposed device

The cost of the proposed layout can be essentially broken down into three separate key components: the cost of the explosive detection device, including the pre-concentrator, the cost of the telecommunications system, including the microprocessor and the GPS module, and the cost of power supply and autonomy (battery assembly). After an Internet search, a very affordable price for the proposed provision amounts to € 11,000 [12], [13], [14], [15], [16] as shown in Table 1 below:

Table1: Indicative cost of the proposed device

Section	Price (€ / pcs)
IMS Section (+battery autonomy system)	11.000
Raspberry PI 3 model B+ microprocessor	40 ~ 56
GPS module	23 ~ 30
Total	11.063 ~ 11.086

The total cost should also be added to the cost of using the Cloud Computing infrastructure that will be required to store the data and implement the corresponding processing application. For this purpose and in order to reduce the total cost of the project, the Cloud Services provided by the Information Society (IS) [17] to the Greek State could be an excellent solution.

VII. Conclusions – Improvements

The use of the explosive detection device to fit properly inside the outdoor mailbox can greatly increase the chances of avoiding a possible explosion and all its negative consequences. Primarily, human life is avoided and serious injuries to innocent civilians are sustained. Material disasters are prevented and are definitely confined to a single point: in the open mailbox where the postal item containing the explosive was placed.A very large and important role is also expected to have the use of the device in the timely and immediate notification and notification of the competent police authorities. In such cases, the sample of the explosive will remain unchanged, thus allowing for more accurate examination, analysis and identification, while at the same time receiving other very useful information about how it is manufactured. In addition, other useful data such as fingerprints that may be on the postal item will not be destroyed and will lead to the identification of potential terrorists. Detecting traces of explosives is now a challenge for the scientific world. Scientific teams around the world analyze and study the chemical behavior of these materials in order to design and construct new-based devices to achieve even more reliable and sensitive explosive detection instruments. Other new and promising explosive detection methods that are in the research phase include the use of chemical fluorescence sensors [18], the creation of a sampling device for the detection of explosive materials, which can operate remotely and without contact, by exploiting the desorption of sources laser on the scale of picoseconds and nanoseconds [19],

The simultaneous detection and discrimination of five different kinds of explosives with a special quantum dots [20], while the promise and construction of an integrated circuit [21], which is an extremely sensitive and highly selective platform, capable of detecting, distinguishing and identifying explosive chemical substances.

The operation of the platform is based on the use of large-scale electric dwarf-sensors, which are highly efficient. The research list is constantly increasing and enriched, leaving the impression that in the future the ion mobility sector will bring many more positive results to the detection of traces of explosives.

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