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gED – A Quantitative Approach To Detect Explosives

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ABSTRACT

In this study, it is focused to detect the explosive material approximately over a range of 10meters and above by a system which should be cost effective ,low power consuming, harmless to the public and efficiently detect the explosives with standoff distance and to overcome the drawbacks of the existing traditional detecting systems. Our proposed detector consists of multiple ultrasonic transducers in all directions within the specified boundary allotted combined to form a neutral network to locate the hotspot by using the DASH7 technology that can be integrated with PC.

Keywords: *Metal Detector, Electron, X-Ray, Y-Ray, Spectroscopic*

1. INTRODUCTION

The detection of explosive materials is a complex task that demands responsibility. Explosives are widely used in military science and practice, and also for civilian purposes. This requires the development and implementation of sensors and devices that can quickly generate precise and objective information on the type of explosive material. The development of such devices is difficult in view of the nature of the objects being classified –substances with high fire and explosion hazard. Moreover, the classification has to be conducted with sufficient speed and precision. Although there is sufficient technology to detect metal weapons, detection of plastic explosives, such as C-4, with methods that are harmless to humans still remains to be a challenge. Metal detectors or X-ray facilities commonly used at airports and custom houses cannot find plastic explosives. Y-ray detection using irradiation of neutron beams is recognized as an effective method for C-4 detection at this point, but few actually use this method due to doubts about the safety of using nuclear radiation on the public. Hence, methods must be sought to carry out C-4 inspection safely, nondestructively, and without physical contact. Concerns relating to homeland security have given rise to increased research into explosive detection as well as further developments for existing analytical techniques to enable faster, more sensitive, less expensive and simpler determinations to facilitate the trace identification of explosives.

2. APPROACHES TO DETECT EXPLOSIVES

2.1 Spectroscopic Approaches for the Detection of Explosives

The principle of mass spectroscopic methods is that samples are drawn from the air into a mass spectrometer where they are ionized, the resultant ions separated by electrical and magnetic fields according to mass charge ratio and detected and quantified. These methods display very high sensitivities and selectivities but are often expensive and require laboratory based equipment.

There are many Spectroscopic products available in the commercial market for the detection of explosives.

2.1.1 Ion Mobility Spectrometry

Ion mobility spectrometry (IMS) is one of the most widely used techniques for the trace detection of explosives and other contraband materials. The principle of operation of an IMS is the spectrometer consists of two main sections: the ionization region and the drift region. In a typical IMS, ambient air is drawn into an inlet port at the rate of a few hundred cubic centimeters per minute (ccm/min). The purpose of the instrument is to analyze this air for explosives or other compounds of interest, which may be present in the air in the form of vapor or airborne particulate matter. The air first enters the ionization region, where electrons interact with the incoming molecules to form positive or negative ions. In the case of explosives, it is negative ions that are formed. The source of the ionizing electrons is a small, sealed piece of metal that has been coated with a radioactive material, usually nickel-63 (63Ni28). Once ions are formed, they are periodically admitted into the drift region through an electronically shuttered gate. The ions are drawn through the gate by a static electric field, which pulls them towards a metal collection plate at the far end of the drift region. This “drift” of the ions from one end of the drift region to the other occurs at atmospheric pressure, with many collisions between the ions and the various molecules present. The time that it takes the ions to travel the length of the drift region is called the drift time, and is a complex function of the charge, mass, and size of the ion. Typical drift times are on the order of a few milliseconds (1 ms = 0.001 s). The current collected at the metal plate is measured as a function of time, and an IMS spectrum is a plot of ion current versus time, with different peaks representing different specific ions.

2.1.2 Laser-induced Breakdown Spectroscopy

Laser-induced breakdown spectroscopy (LIBS) uses a high intensity laser to vaporize the sample under investigation creating a plasma plume and the light subsequently emitted from this plasma enables characterization of the sample. LIBS, as a detection technique, holds many advantages, especially in the field of explosives detection, some of which include: no need for sample preparation, the ability for real time results, apparatus that may be ruggedized and miniaturized for field work, a sensitive technique requiring only a small sample and the capacity for stand-off detection approach. a double pulse LIBS technique to diminish the effects of atmospheric interference. The double pulse increased the amount of excited atoms in the sample due to an increased plasma plume and it is believed that this also decreased the atmospheric gas density around the sample. This technique removed most of the atmospheric interference and aided discrimination between the explosive RDX and an organic material.

2.1.3 Raman Spectroscopy

Raman spectroscopy is the one of the most widely used techniques. A laser source illuminates a spot on the surface being scanned, whether vehicle, drum, left-behind luggage, etc. Any explosive residue present on the object produces Raman scattering. A laser source illuminates a spot on the surface being scanned, whether vehicle, drum, left-behind luggage, etc. Any explosive residue present on the object produces Raman scattering. The spectrum is compared with previously recorded Raman signatures of various explosives, and a match alerts the operator to the probable presence of explosive residue. **LDS** (Laser detect system) was developed for Israeli Police by an Israelian company**.** Able to detect micrograms of explosive material from up to 50 meter distance. And remote sensing of dangerous materials such IED’s (Improvised explosive device) from distances as far as 50 meters (150 feet).

2.2 Olfactory Type Sensors

Two types of olfactory sensor can be thought to exist, natural and artificial. Dogs have long been used to detect explosives and other species are being investigated, however the issues facing these methods are time and cost of training animals and lack of quantitative information. Electronic noses are being developed but as yet do not have the specificity and reliability for field use. Improving the performance of these artificial noses is necessary before they will be suitable for field work.

2.3 Electron Capture Detectors

An electron capture detector or ECD detects explosives and other types of molecules having high electron affinities. A schematic diagram of a typical ECD detector. In an ECD, a vapor sample is drawn into an inlet port, and this vapor mixes with a stream of inert carrier gas (usually helium or argon). The gas flow then travels through an ionization region to an exhaust line. In transit, the gas flow passes through a chamber with a radioactive material that acts as an electron source, as in an IMS. The source material is usually either nickel-63 (63Ni28) or tritium. The emitted electrons become thermalized through collisions with the gas in the chamber, and eventually are collected at an anode. Under equilibrium conditions, there is thus a constant standing current at the anode. The basic principle behind an ECD is that this standing current is characteristic of the gas mixture being drawn into the system. If the gas mixture originally consists, e.g., of helium and room air, the standing current will be reduced if the vapor of an explosive enters the chamber. This happens because the explosive molecules have a high electron affinity and thus a tendency to capture free electrons and form stable negative ions, leaving fewer electrons to reach the anode. Thus, a reduction of the measured standing current is evidence that an explosive or some similar species is present. As with a chemiluminescence detector, the ECD by itself cannot distinguish individual types of explosives from each other or certain interferents, so a gas chromatograph is placed on the front end to allow temporal identification of different explosives.

2.4 Using Metal Detectors and X-ray Scanners

A **metal detector** is a device which responds to metal that may not be readily apparent.

The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces an alternating magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected. The first industrial metal detectors were developed in the 1960s and were used extensively for mining and other industrial applications. Uses include de-mining (the detection of land mines), the detection of weapons such as knives and guns, especially in airport security, geophysical prospecting, archaeology and treasure hunting. Metal detectors are also used to detect foreign bodies in food, and in the construction industry to detect steel reinforcing bars in concrete and pipes and wires buried in walls and floors.

X-rays scanners, meanwhile, are once again in evidence in one of the newest scanners. Recently, full-body scanners have been deployed in some airports. The passenger stands in front of the machine while it snaps a full scan of his or her body. The controversial scanners (some think them a bit too revealing of the passenger) use weak X-rays that can reveal images of any hidden weapons beneath a prospective passenger's clothing. The radiation exposure is minimal, and the X-rays go about one inch (2.5 centimeters) under a person's skin. The rays bounce back in the opposite direction, where a camera captures the image. While the scanners are certainly more effective than a standard metal detector, some fear they might not be able to find weapons hidden in body cavities

Metal detectors and X-ray Scanners are commonly used to detect the explosives in Airports, Railways, Bus terminus, Government offices and Commercial complexes.

3. DRAWBACKS OF EXISTING SYSTEM

Drawbacks of traditional existing systems are their limited operational area except the Raman spectroscopy with the standoff distance range 30-50 meters but laser is very expensive and hazards to human eyes and skin so, it is commercially not applicable in public areas.

In the case of a metal detector door, we cannot determine the explosive unless and until explosive material pass through the door, Because of the short operational area. This makes the system less efficient. But we cannot fully discard these traditional systems. We can use these systems as a secondary detection mechanism which needs more accurate decision. Hand held explosive detector. We can see this hand held metal detector in most of the police men’s. This is a compactable device with highest accuracy in explosive detection, but still requires manual operation for proper working. Our Proposed Wireless Explosive Detection System can be used as the Preliminary detection mechanism and for more accurate decisions we can use traditional systems.

4. FEATURES OF PROPOSED SYSTEM

The proposed system is designed to overcome the drawbacks of the traditional existing system.

a) Expanded operational area and capacity to detect explosives approximately over a range of 10m.
b) We used only commercially available sensors and also ultrasonic sensors are harmless to public.

c) Using the DASH7 technology to interconnect with the other ultrasonic transducers.

d) Our system consists of the DASH7 technology hence it is a power efficient explosive detection system.

5. DESCRIPTION OF PROPOSED SYSTEM

Our proposed detector system consists of multiple ultrasonic transducers in all directions within the specified boundary allotted combined to form a neutral network and the ultrasonic transducers are acting like a nodes (here after ultrasonic transducers are referred as nodes) to locate the hotspot by using the DASH7 technology. A wireless sensor network consists of many number of nodes distributed in a random nature. The nodes have the ability to communicate with each other and can take decisions based on the sensor data. We are also focusing on the same technique here. Our system consists of several no of nodes depending upon the geographical area we are going to cover. Each node should be able to communicate with the other node and update the information if necessary. Tracking of the target can be done in an easier and faster way because all the nodes are synchronized. Our system consists of the DASH7 technology hence it is a power efficient explosive detection system. Most of the times nodes will be in the idle state, unless and until positive presence of an explosive is found. which take less power or rather no power at all. This makes our system more power efficient. Another key factor is its compact design.

6. CONCLUSION

Now day’s terrorism is the major threat to the world. We know about many bomb blasts all over the world. In order to protect the valuable human life, our proposed system will be cost effective, low power consuming, harmless to the public, compact design and efficiently detect the explosives with standoff distance and overcome the drawbacks of the existing traditional detecting systems. By using our proposed system we can detect the explosive materials in car, bus, government buildings, train compartments & railway tracks.

REFERENCES

[1] Explosive Detection System Based on Thermal Neutron Activation Tsahi Gozani, Peter Ryge and

Patrick Shea; Science Applications International Corporation; 2950 Patrick Henry Drive

[2] MEMS-Based Gravimetric Sensors for Explosives Detection; Richard Mlcak*, Dharanipal Doppalapudi, Paul Pyzowski, Patrick Gwynne, Scott Purchase,Jeffrey Bridgham, Gerald Schultz, Martin Skelton, David Pelletier, Harry Tuller; Boston Microsystems, Inc.IEEE 2010.

[3] Collaborative Signal and Information Processing: An Information Directed Approach; Feng Zhao, Jie Liu, Juan Liu, Leonidas Guibas, and James Reich;PROCEEDINGS OF THE IEEE, 2003

[4] A Line in the Sand: A Wireless Sensor Network for Target Detection, Classification, and Tracking; A. Arora, P. Dutta, S. Bapat, V. Kulathumani, H. Zhang, V. Naik, V. Mittal, H. Cao, M. Demirbas1 M. Gouda, Y. Choi ,T. Herman3, S.Kulkarni, U. Arumugam,M. Nesterenko, A. Vora, and M. Miyashita Department of Computer Science and Engineering, The Ohio State University; ACM 2003

[5] D.S. Moore, "Instrumentation for Trace Detection of High Explosives," Rev. Sci. Instr., vol. 75, no. 8, 2004,

[6] Kunz, private communication.

[7] Moore, "Instrumentation for Trace Detection."

[8] R.B. Cody, J.A. Laramée, H.D. Durst, Versatile new ion source for the analysis of materials in open air under ambient conditions, Anal. Chem.

[9] J.M. Nilles, T.R. Connell, S.T. Stokes, H. Dupont Durst, Explosives detection using direct analysis in real time (DART) mass spectrometry, Propellants Explos Pyrotech.

[10] J.M. Wells, M.J. Roth, A.D. Keil, J.W.Grossenbacher, D.R. Justes, G.E. Patterson, D.J. Barket Jr., Implementation of DART and DESI Ionization on a Fieldable Mass Spectrometer, J. Am. Soc. Mass Spectrom.

[11] N.L. Sanders, S. Kothari, G. Huang, G. Salazar, R.G. Cooks, Detection of explosives as negative ions directly from surfaces using a miniature mass spectrometer, Anal. Chem.

[12] E. Schramm, J. Hölzer, M. Pütz, R. Schulte-Ladbeck, R. Schultze, M. Sklorz, A. Ulrich, J. Wieser, R. Zimmermann, Real-time trace detection of security-relevant compounds in complex sample matrices by thermal desorption-single photon ionization-ion trap mass Spectrometry (TD-SPI-ITMS) Spectrometry (TD-SPI-ITMS), Anal. Bioanal. Chem.