EXPLOSIVE DETECTION & DEACTIVATION BY WIRELESS SENSORS & NETWORKS

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Abstract—An increase in explosive attacks in present era has boosted the need to have a continuous monitoring of explosives in public places. This paper proposes an effective warning mechanism for security threats in public places such as stations, temples, community halls, offices so that security corps can take immediate action against explosive threats. Using a multi phase wireless sensor network, the system will provide a technique to reduce, control, warn about and provide essential security measures for the forthcoming terrorist activity by accurate and fast detection of explosives and deactivating them. Multiple wireless sensor nodes integrated with different types of sensors is used to identify the chemical composition of explosives. Based on different orthogonal techniques, the system collect data from the sensing nodes dynamically aggregate the data and forward to the sink node for further analysis. A mobile node has been introduced to confirm the suspected objects, thus contributing an enhanced target tracking mechanism that reduces number of false alarms. After suspecting the object a command (basically a code for deactivation) is sent to the object’s brain for system failure or deactivation of the explosive system.

INTRODUCTION

Now days a lot of attention is being paid to the development of methods and instrumentation for the detection of explosives. Initiated explosives have already killed thousands of people and injured several tens of thousands. Infrastructure facilities, like railway stations, airports, underground railways are preferred targets involving up to thousands of people. New forms of bomb attacks are more sophisticated, more dangerous, using remote control of Improvised Explosive Devices (IED). Initiation by mobile phones permits terrorists to initiate a bomb immediately. Therefore, detection systems with a reliable detection efficiency used in broad range of IEDs are an important problem. Traditional explosive detection systems are bulkier in size, expensive, and always require manual attention. Because of its public visibility intruder can easily bypass the system using another route.

A wireless sensor network consists of several types of autonomous sensors to co coordinateably monitor a particular activity. The system consists of a processor, a sensor and wireless transceiver equipment. The system collects the sensor data, perform local processing and transmit the required information to the security official’s . The basic agenda behind to design this system to provide prevention against various modern types of explosives. Such type of explosives includes explosives which are operated wirelessly from a far destination to place where they are placed for explosion. Basically computer operated devices, signal, satellite, sensor operated devices.

RELATED WORKS

DETECTION

Some previous works on detection are-

Ion mobility spectrometry (IMS)- This technique used for commercial applications of trace explosives detection. IMS systems operate under ambient conditions. Its price is moderate. Its disadvantage is it contain a small quantity of radioactive material as an ionizing source which harms operator health.

Chemiluminescence- In this IR light is produced which is directly proportional to the amount of NO present, which is related to the amount of the original nitrogen-containing explosive material that was present. A major disadvantage of CL systems is their inability to detect explosives that are not nitro-based.

Surface acoustic wave (SAW)- Detection depend on frequency changes that occur when materials are deposited on the SAW crystal surface. It’s too advantageous as it does not use radioactive material. Its drawback is that SAW is nonspecific. Due other chemicals may make explosives detection more difficult. Additionally, a gas container is required.

Mass spectrometry (MS)- Molecular weight and fragmentation patterns of explosive materials is used for identification. MS is available for field applications. The disadvantage of this system is it requires a gas supply or vacuum pump. It require long time for analysis.

Dual energy x-ray techniques- A single broad x-ray beam and a dual detector arrangement, or low-energy X rays and high-energy X rays is used to image materials. Two independent images of X-ray data are computer-processed to compare low-energy to high-energy x-ray absorption. Results are used to identify the various materials by their shape. Its major drawback is that it’s difficult to separate objects from one another in an image, when the object does not strongly interact with X rays. It does not determine a material’s thickness.

Computed tomography (CT)- It’s an x-ray technique. It produces two- dimensional images of cross-sectional “slices” through an object at many
angles and then combines these slices to obtain a three-dimensional image. Measurements are converted into an electrical signal and computer processed. These images have a more coarse spatial resolution & improved density resolution compared to conventional x-ray images. The advantage of CT is Detects explosives like materials and discriminates them from most other innocuous, low Z number materials because it can accurately determine the materials density. Only disadvantages are system complexity, high cost and low throughput.

**Current system** – It uses wireless sensors which continuously monitors for the IED (Improvised Explosive Device) in that particular location where wireless sensor is placed. Each and every IED contains some portions of chemical compounds which releases chemical vapors in to the atmosphere which then detected by the sensors placed in that area. The sensors receive this data and forwards the same to the expert system (at some other location). The system process this data and by using some type of algorithm the type of IED can be known. The major disadvantages are the exact location of the IED cannot be known. The sensors used are gas sensors and chemical sensors which are high cost and uses more battery power and the accuracy is low. As the atmosphere contains many chemical vapors besides the IED chemical compound vapors the false rate will be high. They are not energy efficient. The systems for detection are bulkier in size & mostly require manual operation. It is easy to bypass these systems due to its size and visibility e.g. metal detector door, metal detector for baggage checking.

**Wireless Explosive Detection System (IWEDS)**- It can be used as the Preliminary detection mechanism and for more accurate decisions we can use traditional systems.

**Unattended Ground Sensors (UGS)**- UGS can support several types of sensors such as acoustics, seismic, opto-electrical, magnetic and infra red break beam devices. Its drawback is that it’s time consuming due to limited signal processing capability.

**Remotely monitored Battle field sensor system (REMBASS)** - This system over comes most of the drawbacks of traditional UGS.

**Explosive detection using thermal neutron activation**- In this work objects are screened through a highly penetrating radiation (energetic gamma radiations), these high radiations gamma rays are produced depending upon the characteristics of the particular elements. These rays are detected using an array of detectors placed near the object and analyzed using a computer. The computer program will study the nature of the radiation and gives you the result.

**MEMS**- Gravimetric MEMS Sensors are used for trace detection of chemical substances such as explosives, chemical warfare agents and toxic industrial chemicals.

**Collaborative signal and information processing (CSIP)**- Its vital when characterizing a heterogeneous network with a very big energy constrain. CSIP solves the problem of target tracking to a large extent by dynamically designing and grouping sensor nodes based on task requirement and resource availability.

**DEACTIVATION**

Manually- By manually means disposal of explosive manually by any bomb expert. Cutting of wire, damaging of explosive function system, decoding its code help of computer devices (codes may be digital, alphanumeric, sounds, heat & temperature etc.). This work is done by experts by wearing bomb suits etc.it is quite risky.

**Bomb Suits** - Some suits have advanced features such as internal cooling, amplified hearing, and communications back to the control area. This suit is designed to increase the odds of survival for the Technician should the munition or bomb function while they are near it. They protect them from harms if the explosion takes place. The suit combines fragmentation and blast protection that is prioritized over the most vulnerable parts of the body (head, face and torso).

**“Wheelbarrow” Remotely controlled vehicle (RCV)**- The role of the modern Bomb Disposal Operator is to accomplish their task as remotely as possible. Actually laying hands on a bomb is only done in an extremely life-threatening situation, where the hazards to people and critical structures cannot be reduced. Ammunition Technicians have many tools for remote operations, one of which is the RCV, or remotely controlled vehicle, also known as the "Wheelbarrow". Outfitted with cameras, microphones, and sensors for chemical, biological, or nuclear agents, the Wheelbarrow can help the Technician get an excellent idea of what the munition or device is. Many of these robots even have hand-like manipulators for the formation or bomb requires handling or moving. High-performance sensors that can detect and help interpret sounds, odors, or even the images from within the munition or bomb are also used in this. Once the technicians determine what the munition or device is, and what state it is in, they will formulate a procedure to disarm it. This may include things as simple as replacing safety features, or as difficult as using high-powered explosive-actuated devices to shear, jam, bind, or remove parts of the item's firing train.

**Portable x-ray system**- A 105 mm shell is radiographed with battery powered portable X-ray generator and flat panel detector. Portable X-ray systems are used to radiograph the bomb before intervention. The purpose is for example to determine if a chemical charge is present or to check the status of the detonator. High steel thickness requires high energy and high power sources.
Projected water disruptors-It use a water-projectile shaped charge to destroy bombs, blasting the device apart and severing any detonating connections faster than any fuse or anti-tampering device on the bomb can react. One example is the Boot Banger, deployed under the rear compartment of cars suspected to be carrying bombs. Projected water disruptors can be directional, such as the Boot Banger; or Omni-directional. "Pigstick"- is a British Army term for the waterjet disruptor commonly deployed on the Wheelbarrow. It fires an explosively-propelled jet of water to disrupt the circuitry of a bomb and thereby disable it with a low risk of detonation. The modern pigstick is a very reliable device and fires many times with minimal maintenance. It is now used worldwide. It is about 485 mm long and weighs 2.95 kg. It is made of metal, and can be mounted on a remotely operated vehicle (ROV). These factors make it a very effective, safe way to disarm bombs.

ZEUS-HLONS (HMMWV Laser Ordnance Neutralization System)-It is commonly known as ZEUS, was developed for surface land mines and unexploded ordnance (UXO). It uses a moderate-power commercial solid state laser (SSL) and beam control system, integrated onto a Humvee (HMMWV), to clear surface mines, improvised bombs, or unexploded ordnance (UXO) from supply routes and minefields.

Bomb containment chambers- These are sometimes dangerous suppression vessels that merely contain some of the fragments generated by the explosion. The other end of the spectrum features top-of-the-line gas-tight chambers that can withstand multiple shots while remaining able to contain chemical, biological, or radioactive agents. Containment chambers of all types may be fitted onto towed trailers, or specialized EOD vehicles.

PROPOSED SYSTEM
This proposed system for explosive detection & deactivation is able to overcome the limitations in both the systems (traditional and the current systems) that are using for explosive detection. In the proposed system the combinational sensors are used for the detection & deactivation of various explosive devices. These sensors consists inbuilt communication system and these sensors are coated with chemical compounds that are frequently used in explosive devices. These combinational sensors are combination of different types of sensing technology which can sense chemical vapors, can sense orthogonal properties of chemical composition, can pass beams of different rays and waves to obtain patterns, images & graphs for analysis and then detect the compound. These system works by detecting the traces of chemical compounds and directly detect the type of explosive without any expert systems. A combination of longitudinal and latitudinal beams (a 3 dimensional combination) from sensors are passed from the sensing system under the desired region of sensing system (can be a community hall, auditorium, office). This combination of rays forms an architecture which is able to sense anything in the desired region. If any type of explosive comes under the region, the data is sent to the computer expert station. At the computer expert station from images of sensors and from 3D graphical representation of beams of sensors the exact location of explosive device can be located & the type of device can also be determined (signal operated, sensor operated, satellite operated, human operated, time bombs).

The main feature of the proposed system is going to be described in next line.

If the explosive device satellite operated, signal operated (radio, audio, video) or sensor operated (odour, heat, temperature) and affixed with a code then the computer expert station generates a code to deactivate the explosive device (because each such explosive device needs a processing unit). This code is sent to the explosive device by detecting its receivers address of processing unit. The code send to the device may change the processing code of explosive device. Due to which the explosion can’t take place since the processing unit of explosive device isn’t able to provide orders or communicate to explode. This is major improvising feature of the proposed system.

If the explosive device is type of time bomb content it can be disposed by wheelbarrow. Human operated bomb is also detected by same process and can be deactivated by manually or remote controlled devices.

SYSTEM ARCHITECTURE

WORKING OF SYSTEM

OPERATION
As we have already seen the drawbacks of traditional as well as current systems. We can now look through
our intelligent explosive detection system. A wireless sensor network consists of thousands 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. This consists of several hundreds 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. 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. This concentrates more on passive sensor based operation, which take less power or rather no power at all. Firstly when the system is activated (system needs to be in active position continuously so to detect any explosive when it enter into systems region) the beams from sensors latitudinal and longitudinally spread all around the region and form a 3 dimensional pattern. The sensing system and radar system starts working. If any type of explosive device enters in the region the radar station or sensing station get informed by tracing the vapors of explosives in the atmosphere. The radar starts tracing the explosives. All data acquired is send to the computer expert station.

DETECTION
The communication unit is used to communicate with the wireless sensors nodes in that area and it is also used to send the data between expert system and sensing and radar station. Sensing unit trace the vapors of explosives in the atmosphere. Various data from sensing and radar station is fetched by deactivation unit. Now data is analyzed and depending on the type of chemical compounds the type of explosive device is detected. Now initialized data is compared with the data present in the library of the expert system .Then the type of explosive and chemical compound is obtained by matching the data. The result is generated as in the form of which type of chemical compound is & which type of explosive is? The type of explosive (signal operated, sensor operated, satellite operated) is obtained by doing a check for receiver at the explosives exact location. If the explosive is human operated or time depending explosive then it should be deactivated directly by manually or wheel barrow or if the explosive is signal operated, satellite operated or sensor operated then deactivation is done under deactivation unit.

DEACTIVATION
The results from the detection unit moves towards the deactivation unit. At deactivation unit decoding platform works on explosive deactivation. By analyzing the results from detection unit that which type of explosive device is? The decoding platform generates a code to deactivate explosive device. This code is send to the explosive device through wireless networks of sensing and radar station with the help of expert window. Expert window specifies the path to communicate with the receiver of explosive device, to crack its firewall or simply to hack the receiver of the explosive device. The decoding code decodes or corrupts the codes or internal programming of the explosive device so the explosion cant takes place. The decoding code also can insert some false codes to deactivate or interrupt the processing of the explosive device.

MERITS
• Since the sensing station is set up by the combination of all types of sensors it can detect any type of explosive device.
• Its reaction time is very less as compared to others.
• Deactivating the explosive device wirelessly from a far station is made possible.
• Computer operated modern explosives can be detected and deactivated is the major feature of this system.
• Manual operations are negligible so there is very less possibility of causing any type of harm to health.

AREA’s of APPLICATION
• It should be majorly used in the area where public gathering is conducted e.g. community hall, auditoriums.
• It should be used at offices.
• It should be used at railway stations, industries, malls, cinema halls etc.

CONCLUSION
The proposed automatic explosive detection & deactivation system has the ability to automatically detect & deactivate the explosive device without any human intervention. That proposed system is too advantageous when compared with the old & current detection & deactivation of explosive techniques. Its key feature is its efficiency, less analysis time & effective solution. With the help of this proposed system the exact location of the explosive device can easily located and can be deactivated immediately so that many lives can be saved .After all what to worry after life.

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