Hidden Explosive Detection Systems for Vehicle

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ABSTRACT
The hidden explosive material detection is a non-destructive investigation practice to identify explosive substances. It is widely deployed at airports, harbours, and sensitive areas of country specially the border areas. The basic detection arrangements are improving at their own pace but unauthorized movement of arms and illegal imports still happens. It is very common through vehicles by making false voids in their fuel tank or inside door panels. The hidden voids detection is a difficult task inside the compartments of vehicle. It is also unreliable, time consuming, and expensive. In conventional detection systems, canines and x-rays are the most common methods. Many advancements in the mentioned field have been proposed. This paper gives a comparative analysis of most significant explosive detection systems for identifying vehicle voids and compartments that may have explosives or illegal imports.

Keywords
Laser Vibrometer, Hide Explosive Detection, Tetra Hertz Detection system, Spectrum based IED.

1. INTRODUCTION
In present era, anti-social elements are using explosive materials for mass destruction. Control of such activities is very big issue for authorities. To stop the misuse of the explosive it is extremely essential to intensely inspect the corporeal belongings.

Table 1. Common Explosive Material

<table>
<thead>
<tr>
<th>NAME</th>
<th>CHEMICAL NAME</th>
</tr>
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<tbody>
<tr>
<td>RDX</td>
<td>Cyclotrimethylenetetranitramine</td>
</tr>
<tr>
<td>TNT</td>
<td>Trinitrotoluene</td>
</tr>
<tr>
<td>PETN</td>
<td>Pentaerythritol Tetranitrate</td>
</tr>
<tr>
<td>ANAL</td>
<td>Ammonium Nitrate and Aluminum Powder</td>
</tr>
<tr>
<td>Dynamite</td>
<td>Mixture of nitroglycerine and nitrocellulose</td>
</tr>
<tr>
<td>ANFO</td>
<td>Ammonium Nitrate and Fuel Oil</td>
</tr>
<tr>
<td>Black Powder</td>
<td>Gun powder or grain powder</td>
</tr>
<tr>
<td>HMX</td>
<td>Hexamethylene Triperoxide Diamine</td>
</tr>
<tr>
<td>TATP</td>
<td>Triacetone Triperoxide</td>
</tr>
<tr>
<td>C4</td>
<td>90% RDX+ Plasticizer</td>
</tr>
</tbody>
</table>

Fig.1 A U.S. Customs and Border Protection officer with an explosive-detection dog [5]

There exist numeral Hide Explosive recognition schemes based on vapor and trace adulteration. Krausa [13] said in his research that the materials that are volatile in nature with high vapor pressure are easily detectable [13]. But most of the current explosive composite exhibits very low pressure of vapor which makes vapor-based finding difficult. The materials of low pressure and high explosive capacity are considered the greatest threat to aviation security. However, there are a number of other materials that are used in IEDs. Cottrell has introduced the Contra band Detection System based on laser vibrometer [3]. That is more efficient for vehicle void detection with high range. Various explosive detectors technologies are used in present time. Some significant of them are considered here for this study. In rest of the paper, the section II represents Ion Mobility Spectrometry system. The part III covers the pulsed Tetra Hertz (THz) detection method, section IV give the description of Acoustic Wave’s Explosive Detection, and sector V covers the Laser Vibrometer for explosive detection. Finally section VI concludes the paper.

2. ION MOBILITY SPECTROMETRY
The Explosive substance recognition through Ion Mobility Spectrometry (IMS) is based on the ion velocities in an
unchanging electrically powered field. The detecting knowledge also necessitates the sample ionization of explosive materials that is basically proficient with Nickel-63 or Americium-241 radioactive materials [5].

3. TERAHERTZ SYSTEMS
The Tetra Hertz (THz) method is fundamentally broadband, with emanated power spread over some THz (usually 0.1-4 THz). The THz Detection system by using pulsed THz emanation in antennas based on photoconductivity. It is formed when the density of current $J$ of a subjective semiconductor is controlled in sub-picosecond times $E_{THz}OC (dj/dt)$ [6].

![THz frequency system based on photoconductivity](image)

This method consists of the various components in its complete system arrangement shown in fig. 2. The femtosecond pulsed laser for generation of the signal. Various number of beam splitters are required for the beam deflection. The parabolic mirror combination is used for the THz beam to focus on the target and collection of the beam from the target for further processing. The processing unit then makes the decision on the suspected material. This system is precisely planned for the stalemate explosives material finding, this high frequency THz stream of light is employed for echo spectroscopy from substantial target [2].

4. ACOUSTIC WAVE’S EXPLOSIVE DETECTION
An arrangement for detecting the presence of an explosive comprises a pulsed intensive energy basis located at a target distance away from a substrate, the magnitude of energy is sufficient to release the internal energy of an explosive. If it is present on the substrate and thereby generate an acoustic wave [4]. On the basis of reflected acoustic wave’s observation, the decision is taken on explosives. This system requires high energy that the nearby material should generate the waves for observation. The system is complex and of low efficiency.

5. EXPLOSIVE DETECTION USING LASER VIBROMETER
The arrangement for explosives detection (ED) and illegal imports in a vehicle includes at slightest one Laser Vibrometer (LV) to measure the vehicle vibrations.
The study of signal strength in laboratory were performed with materials dinitrotoluene (DNT), also with trinitrotoluene (TNT), and the RDX (Hexahydro-13, 5-trinitro-1,3,5-triazine, the explosive component of C4 plastic explosive). The other one TNT sample was a trace deposit, whereas the other explosives materials are taken in bulk amounts.

The 250 can laser pulses when; approx. 7 ns duration with a fluence at target of about 15 mJ/cm². The acoustic detector was a microphone. (Earthworks M30 HDM, Milford, N.H.) With at response that decreased beyond 30 kHz, which was positioned at a detection distance of about 4 inches from the sample [4]. A substantial signal can be observed from DNT, RDX, and TNT. The analysis of Spectrum of the signals identified by LV from the explosive RDX is revealed in Fig. 5. The Spectrum based IED is applied to subs.

Fig 5: The response of spectrum for RDX detection [4]

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6. CONCLUSION
The ED System must be able to identify the suspected material cavities privileged to the vehicles deprived of applying the x-rays. The toughness side by side is amendable, permitting the users to vary the detection severity toward toughness during great menace stages and ease in flexibility during lower risk stages. The THz system is very much expensive, and the acoustic wave system is complex in workability. Both the above systems are of low range as compared to the LV system. The device LV is economical, portable and easily accessible than the other recent ED recognition methods. The LV detection is non-invasive system with the capability to adjust search toughness according to risk stages. The latest laser vibrometer technique performance is proved to be the best among all the method for vehicles Explosive Detection. The image fusion analysis have a more accurate description of the scene, may also be applied for machine perception [12].

7. REFERENCES
8. AUTHOR PROFILE

Yashwant Kurmi received the B.E. degree in Electronic and Communication Engineering from IEC Jabalpur, RGPV University of Bhopal, in year 2006. He acquired his Masters of Digital communication in 2013 from Maulana Azad National Institute of Technology (MANIT), Bhopal. Presently he is a Research Fellow in the department of Electronic and Communication Engineering of MANIT, Bhopal, India. He has 5 international Journals and one patent. His research interest includes image compression, image fusion, object detection and antenna design.

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