Car sticky Bomb detection using Laser triangulation

Lecturer Saad H. Abid **Lecturer Mustafa S. Mustafa**

Computer science department
AL-Mansour University College

Abstract

A sticky bomb is an explosive device, usually IED (Improvised Explosive Device), which can be affixed to a vehicle either by magnetism or an adhesive. Any person in our country has suffered from the effect of these devices, yet nothing can be done to avoid the threat only one has to inspect his car personally at each time he has to drive his vehicle, no tools are available for civilian and in an affordable price to detect a sticky bomb without risking a person's own life.

The existing methods are very expensive yet not available for civilians, further more it has a number of weakness points that we will discuss later, our proposed method is efficient, cheap, easy to implement and has no weakness point which may be exploited by terrorists, it depends on laser 3D scanning for the bottom of the vehicle to form a 3D initial model and store it into the systems memory, then when a person remotely activate the system it will rescan the surface for changes and tampers, if such change is found an alarm will be sounded reflecting the size of the change and locates the foreign body on the car's bottom surface.

This method can overcome the drawbacks of the existing methods and add a new level of robustness for sticky bomb detection techniques to save lives in our country.

1. Introduction.

In our country many threats arised due to war and terrorism acts, one of the most dangerous threat is the car sticky bomb, there are several known methods to identify a sticky bomb but unfortunately these methods still has drawbacks and weaknesses, in this paper a known laser scanning method and triangulation is used for the first time to identify a car sticky bomb and safely illuminate this threat by sounding an alarm informing the driver not to use the vehicle.

2. Literature review

After looking for many resources about this particular subject by following advanced military technologies to protect military personnel from such vulnerabilities of reading daily news and events and improvised most likely manual ways to look under the vehicles using a mirror and a light or inspecting it in check points by military personnel by a trench in the ground, all these approaches and the ones that invented later are described in the following section.

2.1 VAT Approach [1]

The Vulnerability Assessment Team (VAT) at Argonne wanted to see whether it would be possible to detect surreptitiously placed sticky bombs.

A sticky bomb is an explosive device, usually IED (Improvised Explosive Device) , which can be affixed to a vehicle either by magnetism or an adhesive. The diversity of these devices makes it difficult to create a single solution to detect them (as VAT suggests), which is why VAT considered a number of variables.

2.1.1 Method 1: Tire Pressure measurement

The first method depended on specific tire pressure measurements to detect any subtle changes in weight once the mock IED was placed either on the vehicle's under carriage or exterior. The pressure was measured using a Vernier 12-bit analog-to-digital converter to sample a MKS Baratron differential pressure transducer (model 223BD-1ABB). Using these devices in conjunction, a tire differential of up to 19 millionths of a pound per square inch could be detected.

The tire pressure measurements were made on a stationary 2004 PT Cruiser and recorded on a simple laptop. The first trial involved the placement of a 10 pound weight beneath the driver's floor. The readings were very distinct.

2.1.2 Method 2: Magnetic field effect detection

The second portion of the experiment involved magnetic measurements using two commercial DC measuring magnetometers. The more accurate of the two was recorded by the handheld Walker Scientific Triaxial FluxGate Magnetometer because it took all three axes into account as opposed to the PNI V2XE 2-axis Digital Compass.

VAT affixed a rare-earth magnet to different areas of a 1993 Subaru Legacy station wagon during their trials. The magnet had a holding strength of sixty pounds, which would most likely be excessive when considering sticky bombs, but was rationalized by VAT in the event that a terrorist "…wanted to be sure the sticky bomb remained on the vehicle as it traveled along bumpy roads."

Based on the results, it was deduced that a magnet with 1/10th of the strength of the magnet used in the experiment would have easily been detected by the tri-axial magnetometer. More magnetometers would be necessary for a larger vehicle[1].

2.2 Clear Path Technologies approach [2]

Car Bomb Finder 3C4 & 3C5 Atometer detectors are developed specifically to identify vehicles that are packed with nitrogen-based and chlorine-potassium-based concealed explosives with intent of using the vehicle itself as a bomb. With many advancements made to the original prototype, advanced under a research contract with the U.S. Army, as well as improvements to the core technologies, the team are produced the fourth generation of this device and finished the commercialization of both the CarBomb Finder 3C4 and CarBomb Finder 3C5 for sale by the year 2008.

2.3 DOGS

The dog remains the unique tool for trace detection. The sensitivity of dog nose is higher than we can see at the best electronic detectors. This is the reason, why the dog is able to detect explosives even at low temperatures at which most detectors are not fully effective. In fact, we have not quite exact knowledge about the mechanism of dog sniffing, but this is not decisive for practical application.

Dogs have their place in search for hidden IEDs in various scenarios and the efficiency of dogs has been confirmed by steady rise of dog numbers used in security missions.

Now many system are there to detect sticky bombs we listed the most common and the other system are pretty much based on these detection techniques.

3. Drawbacks of existing detection techniques

In VAT's first method, they realized that noise from a nearby construction site was disrupting their readings. The apparent vibrations in the tires made the detection of the 1 pound and 4 ounce weight more difficult. Possible explanations include a slow leak, temperature changes in the tire, and an incoming weather pressure front. The instruments were clearly very sensitive and their readings were in conclusive.

The second method , although the rare earth magnet detection is an efficient method yet it cannot detect bombs that uses adhesive, fast penetrating screws, straps, zip ties or putting the bomb in a cavity under the car.

Dogs also has their own drawbacks since they are living beings they need caring feeding and cannot be used personally and some people allergic to dogs also it is religiously prohibited for Muslim to come in contact with dogs and do their prayers.

There are many drawbacks exists in these systems we are noted the most common and its noticeable that in Iraq still only manual inspection and observation is the most efficient way yet it is still the most dangerous.

4. The Proposed system

The system is basically a web cam like camera mounted on a moving arm that enables the camera to have two main movements, the first one is to lower the camera to the lowest point possible under the car to obtain the most angle possible, this is important to reach to the last point of the undercar and to reach a near perpendicular angle to the surface of the undercar. The other movement of the arm is scroll twist that moves the camera along the undercar from the rear bumper to the front one in slow sequential motion each time (sample) a triangulation is calculated in laser projection to find the depth and height of the undercar surface to build a 3D model or compare an existing one, figure 1.1.

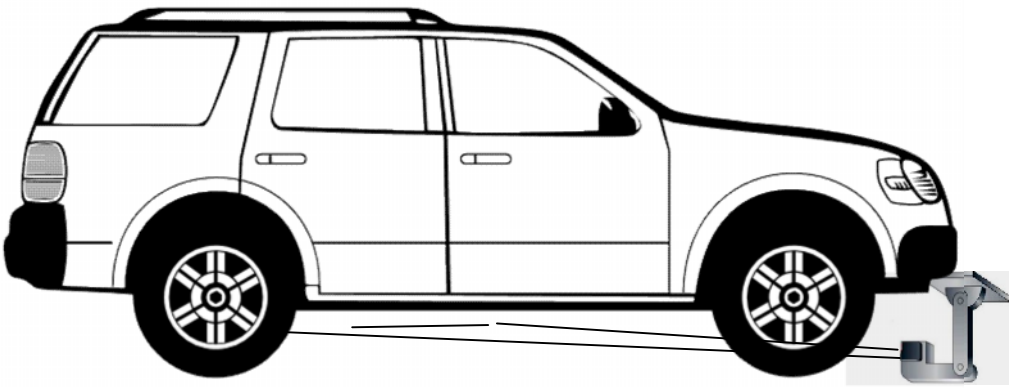

Figure 1.1 an Sub Urban Vehicle with system attached to front bumper

The camera arm and mount should be retractable which means that it can be folded inside an armored compartment to protect it from being tampered or sabotaged by intruder or malicious person.Figure 1.2 illustrates a simple arm that supports the camera and the laser emitter.

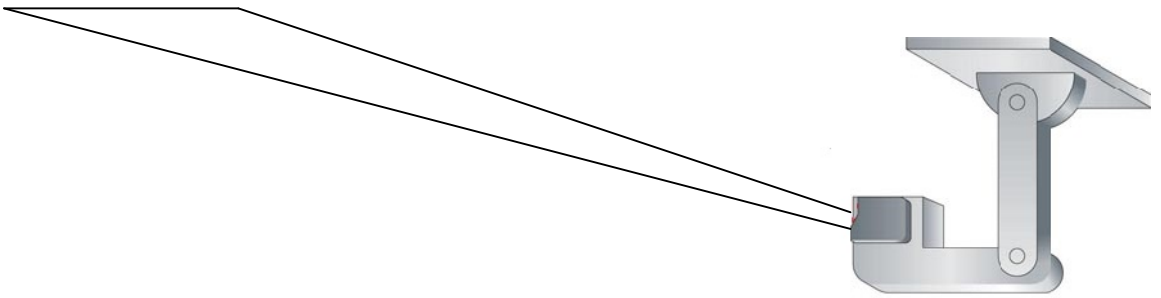

Figure 1.2 the arm and the camera projecting linear laser beam

The unit that's mounted on the arm consists of a linear laser projector and a CMOS camera that takes a sampled picture from the undercar subjected

to the laser beam, the following figure shows a typical laser-CMOS sensor that's used in the system[3].

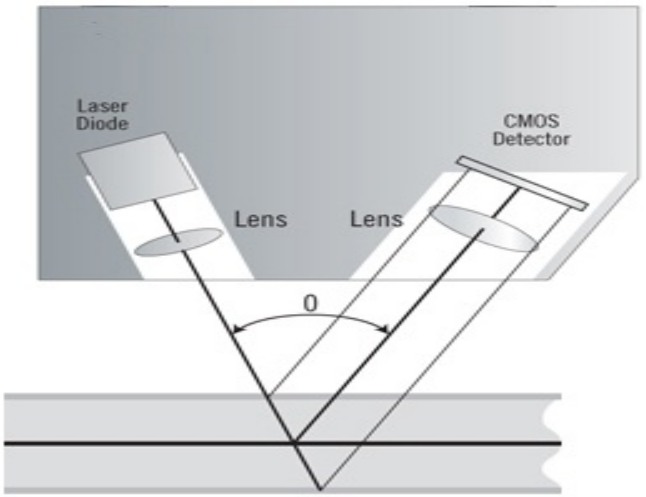

Figure 1.3 a laser-CMOS sensor

5. Laser triangulation [4]

Laser triangulation is based on the projection of a laser over an object and the image is captured by a digital camera. The 3d position of the laser beam over the object can be calculated by trigonometry, if we know the distance between the laser source and the camera (called baseline) and the angle between the baseline and the laser beam. An example of the triangulation system configuration is shown in Figure (1.4).

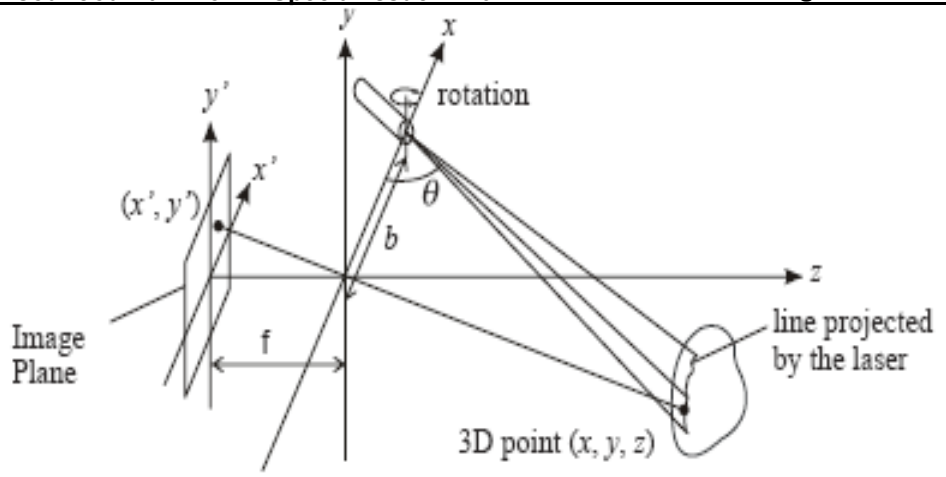

Figure 1.4. Example of triangulation system

The coordinate (x,y,z) of a 3D point in real space which is projected onto the image pixel (x', y') can be found from equations (1), (2) and (3):

$$x = \frac{bx'}{f\cot\theta - x'} \qquad (1)$$

$$y = \frac{by'}{f\cot\theta - x'} \qquad (2)$$

$$z = \frac{bf}{f\cot\theta - x'} \qquad (3)$$

Where b is baseline, θ is laser beam angle and f is the focal length.

Resulting from these equations an x,y,z point that will be used to construct the 3D model to be compared with the template taken for the vehicle earlier, the system can be activated autonomously and remotely from a security key chain remote control without approaching the vehicle itself, this will preserve lives of course.

If any mismatch in the surface scan and the 3D model is found then the anomaly shape can be isolated using simple image difference and the size and the type of the explosive device can then be identified and a counter methods can be applied more efficiently especially when we know the threat itself.

6. Conclusions

It is clear that there are many conclusions can be found in this paper regarding of the ability to save human live but also it can improve a crucial security system concept, it overcome the problems in the existing systems eliminating all it defects, not to mention being reasonably cheap and affordable by an average person, furthermore it is a mobile system that is attached to the car and can be used anywhere and in any climate, it can identify the specific type and size of the explosive device rather that detecting it only with a possible of errors due to external parameters.

7. References

[1] Roger G. Johnston, Jim Vetrone, and Jon S. Warner**, "Sticky Bomb Detection with Other Implications for Vehicle Security**," *Journal of Physical Security* 4, no. 1, Paper 5 (2010): 36-46

[2] Clear Path technologies official site "Greater protection through Superior detection" http://www.clear-path-tech.com/products-solutions/car-bomb-finder-3c4-3c5/

[3] Petr Mostak, Miroslav Stancl **"IEDS DETECTION BY EXISTING DETECTION TECHNIQUES"** Research Institute of Industrial Chemistry, Explosia 53217 Pardubice-Semtin, Czech Republic pp38, 2006

[4] Joao Guilherme D. M. Franca, Mario A. Gazziro, Alessandro N. Ide, Jose H. Saito**, "A 3D scanning system based on laser triangulation and variable field of view",** IEEE International Conference on Image Processing, ICIP 2005, Vol. 1, pp. 425-428, Sept. 2005.

كشف العبوات اللاصقة في السيارات باستخدام التسقيط المثلثي لليزر

م.مصطفى صباح مصطفى م.سعد حميد عبد

قسم علم الحاسوب ونظم المعلومات

كلية المنصور الجامعة

المستخلص:

القنبلة أو العبوة اللاصقة هي جهاز متفجر في طبيعتها، والذي يمكن إلصاقه على السيارة إما عن طريق الخاصية المغناطيسية أو المواد اللاصقة. كل شخص في بلدنا عانى من تأثير هذه الأجهزة المروعة، ولكن لا يمكن فعل شيء لتجنب خطرها سوى على المرء أن تفقد سيارته وبصورة شخصيه وفي كل مرة يحتاج فيها إلى قيادتها ، حيث لا تتوفر أي من الأدوات للمدنيين بغية استخدامها للكشف عن القنابل اللاصقة دون المخاطرة بحياة الفرد الثمينة.

الأساليب الحالية غالية جدا رغم أنها ليست متاحة للمدنيين ، وبالإضافة أيضا لديها عددا من نقاط الضعف التي سنحددها في وقت لاحق ، البحث المقترح هو طريقة كفوءة ، ورخيصة وسهلة التنفيذ وتسد الثغرات التي يمكن أن تستغل من قبل الإرهابيين ، فإن هذه الطريقة تعتمد على المسح بالليزر ثلاثي الإبعاد للجزء السفلي من السيارة لتشكيل نموذج ثلاثي الإبعاد بصورة أولية وتخزينها في ذاكرة النظام ، ثم عندما يريد الشخص تفعيل النظام فانه سيقوم بإعادة تفحص السطح للبحث عن أي تغييرات أو عبث فيه، إذا وجد مثل هذا التغيير فانه سوف يطلق التنبيه بصورة تعكس حجم ونوع التغير في أسفل السيارة والإشارة لوجود جسم غريب تحت السيارة .

هذه الطريقة يمكن أن تتغلب على المساوئ الموجودة في الطرق الموجودة حاليا، وابتكار مستوى جديد من الموثوقية لإضافته إلى تقنيات الكشف عن العبوات اللاصقة لإنقاذ الأرواح في بلدنا.