Pistol Identification System Based on Breech Face Digital Images Analysis

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Abstract

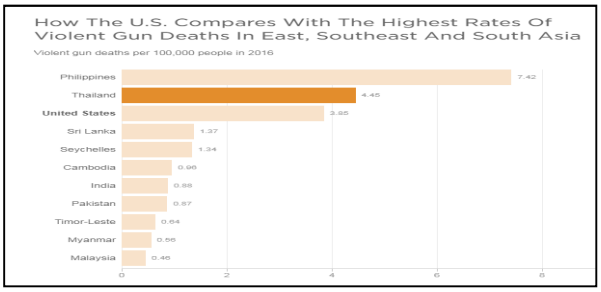
This study is an innovative research. The objectives of the research were **i)** to design and develop the Pistol Identification System for digital image analysis of the tool marks on the breech-face of cartridge cases and **ii)** to store, manage and match the tested digital image files to the digital image files using the database management technology. The samples used in this study were composed of 300 shelled gun cases used with .38 pistols. Other equipment used were included mobile phone, computer, Matlab language program, PHP language program, and Microsoft Access software. The digital images of the tool marks were analyzed and compared using a newly developed algorithm. Subsequently, the data were stored, managed and matched using the database management technology. The tested digital image files were compared to
the digital image files in the database. The accuracy of the matching results was more than 80%.

Keywords: Pistol, Shelling gun, Breech Face Digital Images

Introduction

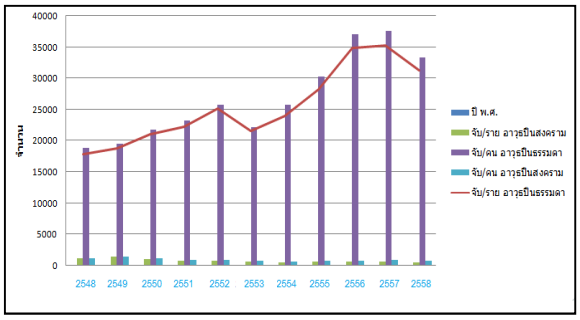
Forensic science is "applying all branches of science for legal purposes". The benefits as the law mentioned including legislation, solving problems and proofing facts in lawsuits for law enforcement and criminal convictions, by visiting the crime site, inspecting, searching, seizing, freezing the evidences and photographing, before bringing the evidences to prove in the courtroom. The procedures are required the knowledge and competence of the staff, and the budget for the operation. Nowadays, providing justice to the people must be fast. The procedures must have quality standards, transparency and good governance. Lack of any of these will affect the credibility and may result in bringing the wrong person to punishment.

Thailand is a country which has high crime. The study from the Institute for Health Metrics and Evaluation, University of Washington (2016) showed that Thailand had high rate of gun deaths in East, Southeast, and South Asia with 4.45 deaths per 100,000 populations (picture 1). It was also suggested that countries with good education and welfare could reduce the rate of gun deaths.



Picture 1: Graph showing statistics of gun deaths in2016 in Asian countries and the United States of America per 100,000 populations
Source: Institute for Health Metrics and Evaluation, 2018
the Elite + magazine website (http://www.eliteplusmagazine.com/home/content/177/8)

Picture 2 The graph shows the arrest of firearm arrests from 2005 to 2015.



The Royal Thai Police reported that the number of firearms taken from the crime scene has increased during 2005 to 2015 (picture 2). A number of pictures of those firearms as forensic evidences are still not identified, and cannot be matched (Royal Thai Police), because the investigation method was based on the comparison through the microscope by the examiners. As the comparison method done by human can easily make an error and time consume, it can affect the success of matching rate. The **Pistol Identification System Based on Breech Face Digital Images Analysis**is probably one of the current situations, which can help the forensic examination of firearms to be easier and more accurate for searching, comparing, and matching the pictures and other data of the evidences. Law enforcement agencies can be more assure in the investigation result, and hence quality of life. This newly developed software can be adopted by both young and experienced examiners to accelerate the success of the investigation of firearms. It can also reduce the budget for purchasing other expensive equipment.

Research objectives

1. To design and develop the Pistol Identification System for digital image analysis of the tool marks on the breech-face of cartridge cases by developing an algorithm to compare digital image together with database management technology.

2. To store, manage and match the tested digital image files to the digital image files using the database management technology.

Research scope

1. The Pistol Identification System for digital image analysis of the tool marks on the breech-face of cartridge cases by developing an algorithm to compare digital image together with database management technology will cover the test data in the area of the forensics center 7, the Royal Thai Police. Which data from the firearm and ammunition inspection group. The researcher knew that the pistol that was the most crime was the .38 caliber. So use the information from the gun shells fired from the .38 caliber guns as part of the experiment.

2. Data management uses types of relational database structures.

3. Tools.3.1) The research tools were 50 pistols, .38 caliber, 300 ammunition, camera, mobile phone, Host computer, Client computers and other software. 3.2)Use Matlab and PHP to develop the system by connecting the database with Microsoft Access, database management system. 3.3) The developed program is able to record data, display data and manage data with the following details: a) Data recording can record firearm data and shooting data for the rear shell casings, Which can be added, updated, and deleted as per rights and opportunities. b) Display results showing firearms used to fire comparison results show the shelling of the rear plate. c) Data management able to retrieve data comparing evidence in the field (Firearms information and gun shell casings) through similarity comparison programs to identify firearms identity, copy / retrieve data and database. d) Digital images traces of the gun shell traces from the field can be compared and compared to the gun shell casings from the field. Via comparison program to identify the gun used to shoot as well as being able to link to the offender.

Research methods

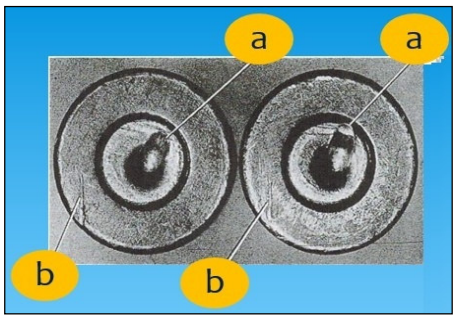
Insights that can tell that the traces on the stern plate appear from any firearms, If there is still no firing information. And store images of the end of the gun shell casings will have to bring that kind of gun come to shoot about 3 times at least and then take a images of the floating groove on the rear plate to import the database. Then brought the evidence for the case of a gun shell to compare, It can be linked to the gun that is used to shoot. In addition, Gun data can be used to link to the offender with firearms. With the following actions.

1. Compile various related documents the researcher has compiled both theoretical and conceptual documents and research related to the database. Traces information, rear plate, gun shell and firearms information in order to create a research framework.

2. Study the current work system that is relevant. Literature review related research documents. The researcher has studied the current work system that is related to traces information, rear plate, gun shell and firearms information at the forensics center 7, the Royal Thai Police. Ready to study the organizational structure, Found that when using

firearms to shoot in various cases. If the inquiry official receives a bullet or traces of the rear plate, the gun casings from the dead body wound or the scene want to know fire from any gun, the inquiry official must bring that suspect gun to send for comparison. Or the inquiry official would like to know ammunition or the shell that is used to fire from the same gun with the projectile in the field. In other cases, or the projectile or bullet casings in other cases that sent for comparison. That sent for comparison this is a very serious problem for investigating officers who cannot find the suspects guns. Or may not found a bullet or shell casings in other cases. These problems, the National Police Agency's probation, Constantly trying to solve. In addition, literature was also conducted. Related research documents.

3. User requirements from the system. The researcher analyzed various problems that occurred in order to determine the needs of users. By sample image Can be explained as follows.



Picture 3 The impact mark of the firing pin

From the bumps of the firing pin **a**. Are similar in both forms and the nature of the cracks **b**. This research will create a database to store traces of the gun shell casings. Firearms information and information about gun owners in the service provider's server. The operation focuses on comparing traces on the rear plate of the gun shell to link to the type of gun fired. When receiving the type of gun that was fired can bring traces of information to the rear plate of the gun shell firearms information gun ownership information stored in the database to connect to make known to offenders with firearms. The data in the client database can be used whenever needed. Which has collected the requirements from the system users as follows. 3.1) There is a master database which consists of images, rear plate, Gun shells and firearms information. 3.2) Can store and save images data for the rear shell casings that fired 3 shots per cylinder as well as the gun registration number. 3.3) Can import firearm possession data and firearms information stored in the master database. 3.4) Can specify identity of each gun can be identified by using photographs, traces, plates, shell casings or the information in the mobile phone that traces the gun shell casings by using the gun shell comparison program. 3.5) Can search for possession of firearms by using the gun data used to fire through the evidence comparison program linked to the owner of the firearm. 3.6) Able to retrieve data for comparison (Traces information, rear plate, gun shells and firearms information) through the evidence comparison program to search for possession of firearms. 3.7) Can reports for the firearm or possession of a firearm.

4. Design a new work system after analyzing the system requirements Therefore, the system design is divided into 8 parts as follows. 4.1) Population design and samples. Quantitative and qualitative research, survey research, the researcher carried out the steps to comply with the research objectives set forth. Therefore has designed designs related to

the population and the following sample group. **a.** Population and samples include traces of data for the rear shell, Firearms information. In which each information will have different details as explained in the topic file storage. **b.** The research tools were 50 pistols, .38 caliber, 300 ammunition, camera, mobile phone, Server computer, Client computers, and various software. **c.** The algorithm of the experiment using 50 pistols to shoot 3 rounds per shot. Take a picture of the gun and the rear plate of the gun shell. d. Data collection. The results from item **c** by 1 casing are stored in the database and the other 2 casing for comparison. **e.** Data analysis uses an algorithm developed to compare to identify the identity of the gun. By using the shooting data of the rear shell casings in the database with images data of the rifle shells from the field Linked to the possession of a firearm. 4.2) Design of the data flow diagram (Data Flow Diagram Design). 4.3)Design of the menu (Menu Design). 4.4) Design of the input data form(Input Design). 4.5) Design of the output report(Output Design). 4.6) Design of the file (File Design). 4.7) Design of the database (Database Design). 4.8) Designing security systems for operating systems (Program Security Design).

5. Develop the algorithm. In the development of this algorithm, the researchers used Matlab and PHP to connect with the MS Access, database management system. To support the system requirements that has been compiled and analyzed.

6. Test and improve system performance. Have tested the program according to various functions by allowing the system users to participate.

7. Installing a new system and training users. For system users to train and actually use by training in accordance with the documentation of operation.

8. Import data such as trace data, rear plate, gun shell, Firearms Information and gun user information.

9. Summary of research findings, recommendations and complete documentation.

Procedures and methods of experimentation

1. Create a master database consisting of a data table, images, end plate, shell casings and firearms information.

2. Firing 3 shots per barrel, shooting the rear shell casings of all 3 guns by choosing the image type as JPG, PNG and BMP.

3. Import to the main database, including the firearm data file. Through the program to store images of the rear shell casings, the 1^{st} gun casing.

4. Import to the main database, including files, images, end plates, shell casings through the images storage program, rear plate, shell casings for guns 2nd and 3rd

5. Use similarities and enhancements. And prepare the images by calling firearms Information and the images data of the rear plate of the gun shell to compare by using the traces of the trailing plate, the gun shell stored in and data files to identify the firearms used

to shoot and use the program to create reports, making reports which are as follows. 5.1) Import images by **a.** Read values. **b.** Store data. 5.2) Improve and prepare the image **a.** Adjust the image parallel to the ground. **b.** Adjust the brightness of the imported image and in the database to be equal. **c.** Adjust the image to a circle. **d.** Convert the image to binary. **e.** Find the edge. **f.** Cut the edge. **g.** Resize to 500 * 500. **h.** Separate the backdrop (new picture - with picture blank background). **i.** Select the part to be used. **j.** Eliminate noise. 5.3) Compare the images. **a.** Find the desired trait characteristic. **b.** Determine the boundary. **c.** Find the area / find the volume / depth **d.** Find the width of the trace **e.** Find the length of the circumference. **f.** Find the center of gravity. **g.** Comparison of images (Firing pin marks, Breech Marks, Ejector Marks and Extractor Marks).

Suggestion

Once the algorithm has been obtained can be compared to the gun shell casings from the field in comparison to the gun shell casings stored in the database If the picture is shot from the same cylinder, it can be discovered and linked to the gun owner. With an algorithm developed to more than 80% accuracy, with the .38 pistol casings, which in the future can develop the algorithm to be used with pistol casings with traces of the rear gun shells of other types in the same way.

References

ThikaphanCharoenphong. (2015). Application of MATLAB for digital image processing, CharanSanitwong Printing.

Etter, D.M. (1997). "Engineering Problem Solving with MATLAB," 2nd. Prentice Hall..

MATLAB Graphics Reference Manual : Version 5.1. (1997). MathWorks Inc.

MATLAB Notebook User's Guide : Version 5.1. (1997). MathWorks Inc.

DuangkaewSawamipak.. (1997). Database system, Bangkok: SE-EDUCATION.

DATE, C.J. (1986). An Introduction to Database System, Volume 1 (Fourth Edition), Addison-Wesley Publishing Company, Inc.

AtthaphonChamsuwanawong and Others. (2001). Forensic Science 2 for Investigation. (Forensic Science). Downlerk.

Reddy,B.S. and Chatterji,B.N. (1996). An FFT-based technique for translation, rotation, and scale-invariant image registration. IEEE Transaction. 5(8), 1266-1271.

THAILAND HAS A HIGHER RATE OF GUN-RELATED DEATHS THAN THE US, Elite+, 20-02-2016. From: http://www.eliteplusmagazine.com/home/content/177/8The U.S. Is A World Leader In Gun Deaths, NPR, 08-12-2015. From: http://www.npr.org/sections/goatsandsoda/2015/12/07/458815891/the-u-s-is-a-world-leader-in-gun-deaths