ForensicAsia
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AFSN President's Address

Dear colleagues and friends,

A year has gone by so fast and we have just started a new year. 2020 has been a very special year, one where lives are interrupted and activities suspended, because of the coronavirus that has spread throughout the world. Although many events have come to a standstill, forensic laboratories are still working hard and round the clock to provide the critical support to the law enforcement agencies so as to keep the law and order throughout the regions. In addition, there are many forensic laboratories that are tasked with the responsibility to quickly set up laboratories to conduct COVID-19 testing or to support frontline activities. I would like to applaud all these unsung heroes behind the scenes who toiled silently in the laboratories for the safety and security of all nations.

On behalf of the AFSN Board, I would like to thank Pol. BG Rolando Hinanay, Dr Lorna Santos and their team from the Philippine National Police Crime Laboratory for their efforts in the organisation of the originally scheduled 12th AFSN Annual Meeting & Symposium in the Philippines in May 2020. This meeting unfortunately had to be initially postponed, and finally cancelled due to the prolonged travel restriction imposed by many countries in the attempt to control the spread of the virus. Although we could not meet physically in the Philippines last year, I am grateful to Pol. Supt. Dr Lisda Cancer, Department of Police Medicine of the Indonesian National Police and her team for stepping forward to host the first virtual AFSN Annual General Meeting on the 2nd of December 2020.

The organising team for the originally scheduled May Meeting of the 12th AFSN Annual Meeting & Symposium in the Philippines.

Appreciation also goes to the committee members of all technical workgroups and the Quality Assurance and Standards Committee for organising their respective scientific sharing and business meetings online in November and December 2020. I sincerely hope that all member institutes are able to join these virtual workshops and benefit from the scientific sharing.

In the past half year, the colleagues at the Institute of Forensic Science, China, have put in great efforts to translate the three International Forensic Strategic Alliance (IFSA) Minimum Requirement Documents (MRD) on Forensic DNA Analysis, Seized Drug Analysis, and Crime Scene Investigation into Chinese, which is one of the six official United Nations languages. Many thanks to these colleagues and I hope that the Chinese versions of the documents will assist the emerging laboratories in Chinese-speaking regions to achieve quality framework in forensic testing. These documents are available for download at the IFSA website: www.ifsa-forensics.org. In addition, the Department of Chemistry, Malaysia has also assisted IFSA to draft an MRD document for Toxicology Analysis. Sincere appreciation to all these colleagues for your contribution to building a quality culture. I would also like to thank all workgroups that had provided your valuable comments when being approached to review the IFSA MRDs.

The updated Chinese translation of the three IFSA MRDs on Seized Drug Analysis, Forensic DNA Analysis, and Crime Scene Investigation, and a draft Toxicology MRD.

Finally, I would like to thank Dr Lui Chi Pang, the Editor for ForensicAsia, all Guest Editors and Editorial Assistants, for the excellent work in publishing Issue 11 of our AFSN Newsletter even in the midst of dealing with the COVID-19 pandemic. I hope that all of you will enjoy reading this informative newsletter.

Dr Angeline Yap
AFSN President
Health Sciences Authority
Singapore

Editor's Address

Dear colleagues and members of AFSN,

As we are going through an unprecedented pandemic situation this year, some of us may have missed the conferences/workshops that have been planned for our forensic community in 2020. Nevertheless, I am very glad to see that our quest for developing forensic science has not slowed down. Indeed, we have received many articles across the forensic disciplines, including, 11 technical articles and 9 case studies, as well as one member's news and 6 articles on the new member institutes. As we cannot publish all of them in one single Issue, we have to arrange some of them to be published in the next Issue around July/August 2021.

In this Issue, we have a total of 6 technical articles and 3 case studies, including, trace evidence, forensic biology, toxicology, fires and explosions, digital evidence and footprint analysis. We also have the introduction from 6 new member institutes which joined AFSN recently, one AFSN news and one special article on member's news from Philippines.

I would like to thank those who have supported ForensicAsia by contributing your valuable research and studies, our guest editors who spent their precious time in reviewing the articles, and last but not least, our editorial assistants who have helped in the administrative matters and have designed the artwork for the online publication of this new Issue.

Happy reading and stay safe.

Dr Lui Chi Pang
Editor

Editorial Committee

For enquiries, feedback or contribution of articles, please email to asianforensic@outlook.com.
For contribution of articles, please read the guidelines at www.asianforensic.net.

Content

AFSN AGM 2020

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An unconventional meeting in an unconventional year. AFSN Annual General Meeting (AGM) 2020 was successfully held in December 02, 2020, and it was the first time the meeting took the virtual format. More than 280 colleagues from 34 member institutes of 14 different countries registered for the meeting.

Before the start of the meeting, a pre-event video with photos of past events and greeting messages was shown. Fond memories stirred up; bonds reconnected. Members took the chance to say hello and waved to one another.

At 10:00 am (Jakarta, Indonesia time), Police Brigadier General Rusdianto, Head of Centre for Medical and Health of Indonesian National Police (INP), opened the meeting officially. This AGM cannot be successfully held without INP's coming forward to be the host. Thank you, Police Brigadier General Rusdianto, Dr Lisda Cancer and all colleagues in INP.

Dr Angeline Yap, AFSN President, delivered a welcome address to the members. She summarized the challenges we faced this year and applauded the effort we made to tackle the difficulties albeit the restrictions and risks.

The Chairs or their representatives of the nine technical Workgroups and Committee, AFSN International Liaison Officer, ForensicAsia Editor, and AFSN Secretariat reported the work they have done in the past year of their term of service. Six new members introduced to the members the background and scope of services of their institutes.

The meeting was concluded with the announcement of the meeting arrangement in 2021 and 2022. In view of the uncertainties ahead, meeting in 2021 will continue to be virtual. For 2022, it will be a physical meeting in Jakarta, Indonesia.

See you again in 2021!

Police Brigadier General Rusdianto, Dr Angeline Yap, and all presenters in AFSN AGM 2020

Establishing the UPD-NSRI DNA Analysis Laboratory in the Philippines

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On the 24th year after its establishment, it is high time to finally document how the DNA Analysis Laboratory of the University of the Philippines came to be. The establishment of a forensic DNA Laboratory started out as an idea in response to the brutal rape-slay of a young UP Los Baños student, Eileen Sarmenta, on 28 June 1993. The perpetrators mercilessly killed the victim and her friend to prevent them from identifying the culprits. As a geneticist, the senior author thought of using DNA to find justice for this victim and other victims of heinous crimes.

At that time, forensic DNA profiling was being done by Restriction Fragment Length Polymorphism analysis. This was followed by Variable Number Tandem Repeat analysis and finally Short Tandem Repeat DNA markers which remains to be the most common method used today. Initial government support was channeled through the Presidential Anti-Crime Commission (PACC) which was the same agency investigating the Eileen Sarmenta case. The senior author explored the idea of converting an existing genetics laboratory already equipped with infrastructure and researchers into a DNA forensics laboratory. The senior author went to Japan, Australia and the US. Finally, her proposal was endorsed by UP to the national government which led to the formal signing of a memorandum of agreement between UP and PACC on 16 May 1996. Funds were made available to invite Professor George Sensabaugh, Dr. Charles Brenner and Dr. Mark Benecke to the Philippines to train students who would later form the initial forensic DNA team of the UP laboratory.

Meanwhile, the Philippine National Police Crime Laboratory (PNP) and the National Bureau of Investigation (NBI) also expressed their intention to establish their own laboratories that would process DNA evidence during investigations. Whilst PNP and NBI focused on criminal investigations, the UP laboratory worked to establish a Philippine population forensic genetic database and to validate molecular methods for handling evidentiary samples. In some instances, courts would order that parallel DNA testing be conducted by at least two or all three laboratories during an investigation in order to demonstrate the objectivity and repeatability of the science of forensic genetics. All three laboratories are active members of the Asian Forensic Science Network, migrating from the original Regional East Asia DNA Profiling Group (REAFD) that started in Malaysia in 2007 to become the DNA working group of the Asian Forensic Science Network in 2009.

In 2001, five years after the establishment of the UP DNA Analysis Laboratory, the Supreme Court decided that the results of DNA testing were admissible in court. And finally in 2007, the Supreme Court promulgated the Rule on DNA Evidence, a set of judicial rules that governed the use of DNA evidence in all Philippine courts. To date, the three Philippine forensic DNA laboratories continue to work towards the passing of a national DNA bill in Congress in order to maximize the use of this technology in ensuring the fair and swift administration of justice, whilst safeguarding the human rights of all.

Dr SC Halos is the founding head of the laboratory whose vision of DNA forensics as a novel technology to help the Philippine justice system, has opened the door for this technology to come to the Philippines. After its establishment, Dr SC Halos has taken other key positions in the Philippine government but continues to serve as a consultant of the laboratory. Dr. MCA De Ungria was appointed as head of the laboratory in 1999 and holds this position until the present. The authors acknowledge JM Jose who edited the final version of this article.

Forensic Services in Defence Services Medical Research Centre (DSMRC), Myanmar

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Defence Services Medical Research Centre (DSMRC) was established in 2008 at Nay Pyi Taw, Myanmar. Since then, it has provided a development of research and services on forensic medicine and science throughout the military community and hang together with Ministry of Home Affair. The DSMRC performs forensic and toxicology researches as well as scientific analysis, examination.

The DSMRC's vision is to be able to achieve the valuable and efficient research outputs and apply in healthcare sectors.

The DSMRC's mission is to perform basic research, applied research, social & behavioral research, molecular research and genetic engineering technologies, to get new approach in diagnostic methods, materials, treatment strategies, new treatment outlines and new drugs & vaccines, to provide services including forensic aspects and encourage the research cultures and evaluate continuous medical education that applied from new findings from certain research.

History

In 2008, the DSMRC was established as the military research institute under the Directorate of Medical Services. Basically, the DSMRC was composed with many research divisions and sections for different discipline and proper science subjects including forensic science and toxicology. Initially, forensic service was provided mainly in the examination of toxicology and food safety.

The service areas expanded to many disciplines including lie detection, personal identification, electron microscope assisted detection of gun powder residue followed by processing of DNA analysis now. In our institution, Biosafety level- 3 (BSL3) facilities have been certified by WHO since 2014. We can also provide the own institutional review board (IRB) which is accredited by US, HHS (FWA) for research including human subjects. Some of the research collaborations are Mahidol Oxford Tropical Medicine Research Unit (MORU), University of Maryland (Baltimore), University of South Alabama, The University of Tokyo, University of Otago (New Zealand), University of Cape Town (South Africa).

In order to facilitate the forensic investigations of mass disasters, a Mass-Death Victims Service Team including with forensic scientist was established together with humanitarian assistance and disaster relief (HADR).

Organization

The DSMRC has six main divisions which are principal disease research division, biomedical research division, clinical research division, traditional medicine research division, production and technology research division and special operation research division. Among them, some selected sections concerning with forensic and toxicology are as below:

- Toxicology Section
- Food and Drug Administration
- Electron Microscopic Research Section
- Molecular Research Section

Research Activities

The current research projects conducted by the DSMRC include personal identification for Myanmar population, combination of proper autopsy examination and laboratory assisted methods i.e. histology and IHC methods, the new assessment on narcotic and psychotropic substances uses with modern analytical methods (GC-MS, LC- MS) and a drug characterization, the applications of stable isotope ratio mass spectrometry to trace the geographical origin of evidence, and the application of radiological methods in autopsies. Now, we plan to achieve the construction of military population DNA database by using MiSeq FGx.

In conclusion, we are very delighted to be a very first member institute of Asian Forensic Sciences Network (AFSN) in Myanmar. We also look accelerative to collaborate jointly with other member institutes in all area of forensic science development.

Introduction to CPIB, Singapore

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First of all, I would like to thank for the opportunity to join AFSN network.

My name is (Mr) Chng Tze Wei and I'm an Assistant Director working in my law enforcement agency, CPIB, in Singapore for 16 years till date. My experiences here include a wide range between Investigation, Intelligence, Digital Forensics as well as utilizing Science & Technology. Allow me to briefly introduce my agency CPIB.

Introduction to CPIB

Singapore has constantly ranked high as one of the least corrupt countries in the world for many years. The Corruption Perception Index recently ranked Singapore as number 4 least corrupt nation in 2019, just below Finland, Denmark and New Zealand. The Index publishes annually and rank countries by their perceived levels of corruption as determined by expert assessments and opinion surveys. For this to happen, my agency, the Corrupt Practices Investigation Bureau ('**CPIB**') plays a pivotal role. It is an independent body which investigates and aims to prevent corruption in the public and private sectors in Singapore. Established in 1952, it is currently the world's oldest anti-corruption agency.

The CPIB is responsible for safeguarding the integrity of the public service and encouraging corruption-free transactions in the private sector. Although the primary function of the CPIB is to investigate corruption under the Prevention of Corruption Act ('**PCA**'), it is empowered to investigate any other seizable offence under any written law which is disclosed in the course of a corruption investigation.

Besides having the enforcement aspect, we have engaged other strategies to broaden our outreach and increase public awareness. We engage the community to help recognise corruption, report any cases that they might come across.

My role in Digital Forensics

In a gist, digital forensics capability was setup in CPIB in the year 2004, the same year that I had the privilege to join the agency and learn from it. In this constantly evolving field where finding digital evidence is common these days in almost every case we investigate, we had seen many evolutions in terms of both forensic techniques and technical capabilities.

I'm currently heading the digital forensics branch where we are primary trained in examining computer, mobile, cloud and video forensics. We are also equipped with the knowledge of cryptocurrency (aka blockchain forensics) as it can also be a vehicle for money transfer. Our forensic examiners are required to attend Court proceedings whenever required as an expert witness, to give opinions and explain our methodology, upon asked.

Conclusion

Corruption exists everywhere in our societies. It should not be viewed solely as a moral issue. It is a crime and a threat to national survival. The ills of corruption are manifold – it can have diverse, dire consequences that have a long-term impact on society and economy, which are not conspicuous to many people. It can increase business costs, reduce GDP, affect the standard of living, compromise public safety; and undermine law enforcement/subvert criminal justice. Corruption also runs counter to the value system of meritocracy in Singapore by depriving individuals of equal opportunities in life.

Modern days criminal offences often reply upon technology as a form of facilitation, convenience and anonymity. In joining AFSN, I am looking forward to share with others what we have learnt, as well as learning new knowledge from the others.

Department of Forensic Medicine, Thammasat University Hospital: A forensic medicine and pathology unit in Thailand

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The department of forensic medicine, Thammasat University Hospital was established in 2006 with the mission of being an important part of medical student training programs in the faculty of medicine, Thammasat University, and also servicing the death investigation processes under the criminal procedure code of Thai law (fig.1). We mainly provide strong education and training for the doctor of medicine program and support numerous academic programs including doctor of pharmacy, forensic science program, bachelor of laws, and other workgroups requiring forensic medicine knowledge.

Our department is responsible for death investigation services in the southeast area of Pathum Thani province. More than 1,000 medico-legal autopsy cases and 400 cases of examination at the crime scene each year were performed by the forensic physician team (fig.2). Our staff emphasizes not only the dead individual from unnatural causes but the patient dealing with a lawsuit who also requires special attention based on forensic science. Therefore, all of our forensic physicians still keep the role of healthcare professionals to examine the patient who needs special attention to support the legal process whether from body assault, accident, or sexual violence, etc. To promote our routine work, we operate 4 laboratory units simultaneously including histopathology, toxicology, DNA, and semen test (fig.3, 4). The royal college of pathologists of Thailand has certified the department of forensic medicine, Thammasat University Hospital as a competent and credible institute to perform forensic services since 2012.

Various forensic researches are always conducted in conjunction with our routine forensic medicine services to create and keep up-to-date forensic information in Thailand. We are developing to apply augmented reality technology to use as an instructional media for crime scene simulation for teaching medical student (upcoming project).

In the aspect of social participation, we are a member of the forensic physician association of Thailand. Our staff is always encouraged to join forensic organizations that conform to the hospital's policy. Social service roles are exhibited through various activities such as academic convention accompanied by the ministry of public health for medical personnel and a field trip of forensic autopsy for the general public.

More than 15 years at the Thammasat University Hospital, we have dedicated ourselves to develop our department step by step. We started from scratch among other developed departments. Nevertheless, we still keep moving to be one of the most acceptable institutes in the forensic field. Becoming a new member of the Asian forensic sciences network makes us proud and we are looking forward to joining and learning from all experienced AFSN members soon.

Figure 1. Thammasat University Hospital

Figure 2. The autopsy room

Figure 3. Forensic histopathology unit

Figure 4. Forensic toxicology unit

Introduction of Beijing Forensic Science Institute

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Beijing Forensic Science Institute (see Figure 1) is a government agency, which belongs to Beijing Public Security Bureau. The Institute is established in April 1950, covering an area of 14000 square meters, which has 98 uniform officers and 15 civilians working in it now. There are 11 units in our institute covering different kinds of forensic field. The institute was firstly accredited by China National Accreditation Service for Conformity Assessment in 2005.

Fig.1 Beijing Forensic Science Institute

The main tasks of our institute include five aspects: investigate major and sensitive cases scene in Beijing; carry out examination and identification of forensic evidence; do forensic research, forensic information and intelligent construction and dissemination of new technology; do forensic technical management, training and conduct; appointed by ministry of public security to offer forensic support to other province.

There are three characteristics in our institute:

1. The three most of the nation

Our fingerprint database has 110 million personnel fingerprint data, which is the world's biggest fingerprint and palm print database in forensic field; we firstly establish the explosive unit to carry out explosive case investigation and examination in the nation; we firstly establish the psycho-information probe unit and undertake almost all the psychology-related forensic work nationwide.

2. The four national centers

There are four national forensic centers in our institute, which are national fingerprint intelligent identification center, national digital evidence intelligent identification center, national crime video data center and national bullet information center (see Figure 2-5). These national centers are controlled and operated by the related unit in our institute, we can check nationwide information to give forensic support.

Fig.2 National Fingerprint Intelligent Identification Center

Fig.3 National Digital Evidence Intelligent Identification

Fig.4 National Crime Video Data Center

Fig.5 National Bullet Information Center

3. The five national first

Since foundation, we have introduced and developed many methods and working mode, some of them are still used by colleagues.

We firstly developed electronic shoeprint lifter in 1970s, which used to lift dusty shoeprint at crime scene. This method has greatly improved shoeprint lifting efficiency and is still widely used; we introduced superglue method to China in 1980s, which is still a main latent fingerprint developing method in practice; we developed intelligent scene investigation technology recently which lead to new changes in scene investigation field (see Figure 6); the forensic online integrative comparison platform we developed makes case serialization more easier and efficient; the interprovincial linked face recognition system in our video unit has the highest daily queries in the country.

We have always attached great importance to foreign exchanges, we have talents introduction project every year to invite forensic experts worldwide for academic exchanges. Since its establishment, many forensic experts have visited our institute.

It is our great pleasure to join Asian Forensic Science Network, we sincerely welcome you to visit our institute and have a wonderful journey in Beijing.

Fig.6 Intelligent Scene Investigation Lab

Member Institute

Introduction of the Ministry of Home Affairs and Home Team Science and Technology Agency

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The Ministry of Home Affairs (MHA) of the Republic of Singapore, comprising 10 different departments and agencies, collectively known as the Home Team, is responsible for homeland security, public safety, civil defence, border control, correction, narcotics and immigration.

HTX (Home Team Science and Technology Agency)

HTX (Home Team Science and Technology Agency) is a new statutory board formed under MHA in late 2019 to develop a wide range of science and technology solutions as well as deliver cutting-edge capabilities to empower the Home Team Departments in their mission tasks and daily operations such as law enforcement, crime solving, border security, cyber security, public safety and emergency response, to keep Singapore safe and secure.

Both Forensics and Digital Forensics are two key Centres of Expertise in HTX that seek and develop transformative solutions to meet the current and future needs of our investigation and forensics community in the face of rapid advancement of technology and changing nature of crime. HTX strives to develop deep forensic capability and capacity, through partnering notable science and technology thought champions, practitioners and industry leaders in continuous research and innovation in the following domains:

Criminalistics

Our Crime Scene Specialists are responsible for the initial crime scene response to ensure crime scene evidence recovery, proper chain of custody of the evidence, documentation and analysis of the crime scene, as well as conducting forensic examinations and fingerprint comparison. The forensics functions performed by our Crime Scene and Drug Forensic Specialists embedded within the Singapore Police Force (SPF) and Central Narcotics Bureau (CNB) respectively, also support MHA's core investigation functions in other specialised domains such as Traffic Accident Reconstruction, Bloodstain Pattern Analysis, Investigation of Drug Scenes and Testing of Drug-Related Items, and Imagery, to name a few.

Forensic Biology

HTX provides forensic biology capabilities to the Home Team Departments through the Home Team Investigation Laboratory, which conducts DNA profiling, and research and development into associative lead-generating capabilities to sharpen the Home Team's forensic edge, such as the prediction of physical traits and inference of ancestry lineage, in order to generate quick leads and point investigations in a useful direction.

Fire and Explosives

HTX forensics specialists are deployed within SPF and the Singapore Civil Defence Force working alongside investigation officers and fire investigators to conduct investigations into the origin and root cause of a fire or explosion, perform fire hazard assessments and identify gaps in fire safety and hazards control measures, as well as post-blast investigation and analysis, including the collection and identification of post-explosion debris and components, explosives and explosive devices at explosion and bomb scenes.

Digital and Information Forensics

HTX provides frontline support to SPF through digital evidence recovery and analysis to produce fast and actionable leads. This is primarily achieved through the identification, extraction and preservation of electronic data, enhancement of audio/visual quality in digital media, and the development of game-changing tools that empower frontliners to analyse and review digital evidences on their own, thereby reducing the overall lead time in accessing digital evidences for swift investigative follow-up.

Document Forensics

Detection of forgeries in travel documents such as passports and visas is another key priority for MHA given one of its key functions of border security undertaken by the Immigration and Checkpoints Authority. Our specialists are responsible for examination of suspicious and forged documents, monitoring of trends in forgery methods and innovations in authentication, and conduct document examination courses for all immigration officers to ensure they stay in step with the latest forms of passport forgery.

Currently, MHA is a member of three expert workgroups in the Asian Forensic Sciences Network, and will work towards seeking official membership in two more, namely the DNA and Questioned Document workgroups, to enhance collaboration and knowledge exchange.

Master Program of Forensic Science, Postgraduate School, Universitas Airlangga, Indonesia

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Background

Master Program of Forensic Sciences, Universitas Airlangga began in 2008, based on the Rector's Decree Number: 4311/JO3/OT/2008 and the extension of study program permits based on the Rector's Decree Number: 142/UN3/KR/2017. Students admission started since 2009/2010 academic year. This study program is the only one in Indonesia and in Southeast Asia.

Universitas Airlangga

Master Program of Forensic Sciences is a study program managed by the Postgraduate School Universitas Airlangga, Jalan Airlangga 4-6 Surabaya, East Java, Indonesia.

Master Program of Forensic Sciences, Postgraduate School, Universitas Airlangga has been accredited with A rank (very good) based on the LAM-PTKes (Indonesia Accreditation Agency For Higher Education in Health) decision Number: 0294/LAM-PTKes/Akr/Mag/VI/2019. The accreditation is valid until 28th June 2024.

Postgraduate School Universitas Airlangga

Curriculum

Master Program of Forensic Sciences has 36 Credits minimum or 50 Credits maximum for 4 semesters or two years. It can be taken for 3 semesters and maximum 6 semesters including thesis preparation. After finishing this study program, students will get M.Si (Magister Sains a.k.a Master of Science) degree. The Masters Program of Forensic Sciences has three concentrations of scientific studies, i.e.

- **Forensic Biology**: Bioterrorism, Forensic Molecular Biology, Forensic Pathology, Forensic Clinical Pathology, Forensic Toxicology, Forensic Laboratory Molecular Methods.
- **Forensic Chemistry**: Sample Preparation and Instrumentation Techniques, Validation of Analysis and Micro Analysis Methods, LADME Drugs in the Body, Analysis of Toxins, Drug and Doping, Explosive Materials.
- **Forensic Physics**: Trace Analysis, Audio Forensic Technology, Document Testing, Ballistic Technology, Blasting and Fire Technology, Forensic Microscopy.

Facilities

Master Program of Forensic Sciences, Postgraduate School, Universitas Airlangga has facilities including:

- Lecture rooms
- Reading rooms
- Seminar rooms
- Sophisticated and complete research laboratory

Role in The Criminal Justice System

The role of our institution in the criminal justice system in Indonesia is as a forensic institution that provides support in investigating forensic cases in Indonesia. If there is a case that requires a forensic examination such as DNA, autopsy, corpse/victim/perpetrator identification, or investigation related to a criminal act that requires a related examination, the law enforcement authorities will provide a letter of request to us to carry out these examinations. Furthermore, in collaboration with Indonesian DVI and INAFIS, our institution's playing a big role in delivering, coordinating and organizing delegations, volunteers, and forensic scientist in various scientific fields (DNA, fingerprint, odontologist, anthropologist, etc) needed in the process of identifying victims of mass disasters, such as:

Research

Publications for the past two years:

- Thirteen Publication in Proceedings of the 2nd International Conference Postgraduate School, July 10-11, 2018 Vol. 1 - 978-989-758-348-3.
- Three Journal of Punjab Academy of Forensic Medicine & Toxicology, January to June, 2019, Vol. 19, Number: 01, ISSN: 0972-5687.

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Research Progress of Wire Arc Beads Inspection Methods in Electrical Fire

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Abstract

Electrical fire is the most common type of fire in China, and the metal wires are one of the most frequently physical evidence in electrical fire scene. By analyzing the forming process and mechanism of the arc beads, it can provide the basis for determining the cause of electrical fire and play an important role in the timely determination of electrical fire cases or accidents.

With the rapid development of China's economy and society, the electricity consumption of industry and residents continues to be maintained at a high level, and various electrical fires have also increased sharply. Especially since entering the 21st century, the situation of electrical fires in China has become more severe. Fire statistics for China reveal that electrical fires accounted for 27.9% of the total number of fires during 2006–2015, especially in major fires, where electrical fires accounted for as much as 50%, causing immeasurable losses to people's lives and property.

The high percentage of electrical fires requires fire investigator timely determine the cause of fire. Short-circuit failure is the main cause of electrical fires. At the moment of short-circuit, a strong arc will generate a high temperature of 2000°C ~ 3000°C and release a large amount of heat, which will instantly melt the metal wire. Upon cooling, the molten wire often assumes a roughly-spherical shape and this resolidified zone is called an 'arc bead'. When analyzing the causes of an electrical fire, the arc beads are always important physical evidence. In general, if a fire originated because of the short-circuit failure, the arc beads can be called 'cause' beads. Conversely, the fire broke out before the wire short-circuit, which means the short circuit caused by the fire, the beads from such an event can be called 'victim' beads[1]. Both of the beads belong to the action of instantaneous current and are very similar in appearance. They cannot be directly distinguished from the appearance, but these arc beads generated from different stages of the electrical fire, different characteristics will be left inside the metallographic structure of the arc beads, which will affect the formation of the microstructure of the arc beads[2-3].

At present, metallographic analysis and macroscopic observation are the most commonly used methods to distinguish arc beads in electric fire in China. The use of the metallographic analysis is mainly to observe the differences between the microstructure of arc beads under different thermal conditions, and to judge the cause of fires according to their microstructure characteristics[4]. The metallographic structure of the cause arc bead is mainly composed of fine grains, due to when the wire is short circuited, the temperature at this point can reach 2000°C ~ 3000°C, while the rest of the wire id only about 70°C, the temperature gradient and the short solidification time prevents the molten droplets growing sufficiently, resulting in the fine grain in the cause arc beads. And due to the relatively low ambient temperature when the short circuit occurs, the molten metal wire cools quickly, leading to the gas inside the molten wire to escape too late. However, relatively few combustion products are produced in the short circuit process, so the holes in the metallographic structure are small and few, and most of them appear to be round or elliptic. And the metallographic structure of the victim arc bead is mainly composed of large grains, this is because when the short circuit occurs, the surroundings are already in the condition of fire, the temperature of the rest of the wire except the short circuit point is relatively high. The higher ambient temperature leads to a slower solidification rate, and the molten metal has sufficient time to nucleate and grow, so the metallographic structure is usually large grains. When the short circuit occurs, the cooling time of the molten droplets is relatively long, the gas in the molten metal has sufficient time to escape. But the environmental conditions of the fire scene are extremely complicated, there a lot of water vapor, smoke, dust and various combustion products. These impurities will also enter the molten metal droplets, thereby forming more large holes with irregular shapes in the arc beads.

In the investigation of the electrical fire, the residue metal wire arc beads can generally be found, the appearance can represent the environment conditions at that time in some cases, thus macroscopic observation can also play a role in certain situations. The diameter of the copper wire cause arc beads is usually 1~2 times of the wire diameter, while the aluminum is usually 1~3 times. The cause arc beads are usually located at the tip of the wire or on one side. And there are oxide films, pits and burrs on the surface of the aluminum arc beads. There is a clear dividing line at the junction of short circuit weld mark and the wire matrix. The diameter of the copper wire victim arc beads is relatively larger than the cause beads, tiny pits are located on the surface. While there is a layer of dark oxide film, small pits, cracks and collapse on the surface of aluminum victim arc beads. There is no obvious boundary between melting and unmelting at the junction of short circuit melting mark and the wire matrix.

In the field of forensic scientific, fire debris/arson analysis is an important research content, and the concept of crime reconstruction has gradually infiltrated the investigation of electrical fire. In 2010, Babrauskas[5], the chief electrical fire investigation expert in the United States, emphasized the need for a comprehensive analysis of the occurrence mechanism, ignition process and trace characteristic, which fits the concept of crime reconstruction in forensic science. When investigation the fire scene, it is important to identify the short melting mark on the electrical circuit and determine the ignition point, and this is called “arc mapping” in NFPA921[6]. The current research on the mechanism of short circuit mainly focuses on the process of short circuit faults caused by the radiation of the hot smoke layer in indoor fires and its generation mechanism. The university of Maryland, Tokyo university of Science and Technology, and Eaton Electric Research Center are in a leading position. There are two short circuit mechanisms for electrical circuits damaged by high temperature, physical short and arcing short respectively. Hagimoto et al.[7] proposed two short circuit mechanisms for non-metallic sheathed power lines after radiation. The difference between them is the change of the leakage current. In 2013, Novak et al.[8] studied the occurrence time of short circuit faults for non-metallic sheathed power lines after radiation, and added high-speed voltage and current measurements. It can be seen that the investigation of electrical fire has entered a new period of development, and more forensic science reconstruction and scientific investigation concepts need to be incorporated.

At present, the investigation of electrical fire has been carried out earlier in the field of forensic science in China. By means of macroscopic and microscopic comprehensive analysis of the arc beads, the short circuit can be distinguished in some cases before or after the fire, which can provide the basis for determining the cause of the fire. However, as the extremely complex conditions at the fire site, the heating process of the arc beads in the fire site is more complicated, so in the application of metallographic analysis, a comprehensive analysis and judgment must be combined with the site investigation to make a correct identification of the cause of the fire.

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Population Genetic Data of 21 Autosomal STR Loci for the Thai Population

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Abstract

Allele frequency and statistical parameters analysis of 21 autosomal STR loci were determined in 3,000 unrelated individuals from Thai population. 21 autosomal STRs were amplified using GlobalFiler™ Express (Life Technologies). The markers included D3S1358, vWA, D16S539, CSF1PO, TPOX, D8S1179, D21S11, D18S51, D2S441, D19S433, TH01, FGA, D22S1045, D5S818, D13S317, D7S820, SE33, D10S1248, D1S1656, D12S391 and D2S1338. The Hardy-Weinberg Equilibrium and statistical parameters were examined including observed heterozygosity (Hobs), expected heterozygosity (Hexp), probability of exact test (P value), power of discrimination (PD), power of exclusion (PE), match probability (pM), poly- morphism information content (PIC) and paternity index (PI). The study reveals that the expectations of the Hardy-Weinberg Equilibrium (HWE) were confirmed for all loci. SE33 is the most informative locus in this population. The combined power of discrimination and the combined power of exclusion for 21 STR loci were 0.999999999999999999999999999999 and 0.9999999980, respectively. Allele frequencies and statistical analysis of 21 autosomal STR loci indicated its utility and efficacy for human identification and paternity testing.

Introduction

In recent years, the expansion of thirteen core Combined DNA Index System (CODIS) have been introduced to the forensic community in order to increase the discrimination power of identification[1, 2]. The new commercial kits were developed and the short tandem repeat (STR) markers were extended to reach the minimum requirement. The studies of the informative markers and allele frequencies are essential due to the variability among the population.

In Thailand, several studies have been conducted to evaluate the informative markers and allele frequencies of Thai population. The allele frequencies of fifteen loci were initially reported in 2009 [3]. Furthermore, 21 autosomal STRs of Thai population in southern border of Thailand have been examined in 2017[4]. In 2020, 21 autosomal STRs of the population in each six geographical regions of Thailand have been evaluated. The allele frequencies and the statistical parameters of each sub groups were reported[5]. Nevertheless, the allele frequency of 21 autosomal STRs representing whole Thai population never been reported yet.

The purpose of this study was to investigate the distribution of 21 STR loci (D3S1358, vWA, D16S539, CSF1PO, TPOX, D8S1179, D21S11, D18S51, D2S441, D19S433, TH01, FGA, D22S1045, D5S818, D13S317, D7S820, SE33, D10S1248, D1S1656, D12S391 and D2S1338) in Thai population to assist the interpretation of the forensic DNA evidences.

Populations

3,000 Thai individuals were randomly selected from six regions: central, north, south, west, northeast, and east of Thailand, representing each regional population. All individuals were of the same ethnicity. All individuals gave informed consent and destinated as self-declared Thai. The DNA samples were collected inform of buccal swab on FTA card (Whatman® FTA® card technology).

PCR Amplification

All samples were directly amplified using GlobalFiler™ Express PCR Amplification Kit (Life Technologies) according to the manufacturer's instructions [6]. 3 µl of low TE Buffer (pH 8.0) was added to 96-Well Reaction Plate. The 1.2 mm diameter of FTA card was punched into each well and 12 µl of GlobalFiler master mix was added. The 21 autosomal STRs (D3S1358, vWA, D16S539, CSF1PO, TPOX, D8S1179, D21S11, D18S51, D2S441, D19S433, TH01, FGA, D22S1045, D5S818, D13S317, D7S820, SE33, D10S1248, D1S1656, D12S391, and D2S1338) were amplified by 27 cycles with the thermal cycling conditions as 95°C 1 minutes, 94°C 3 seconds and 60°C 30 seconds for 27 cycles, 60°C 8 minutes, and hold at 4°C .

DNA typing

DNA typing was performed on the Applied Biosystems 3500XL Genetic Analyzers. Data were analyzed using GeneMapper® ID-X software v 1.4[7]. Allele designation was determined by comparison of the sample PCR fragments with those of allelic ladders provided with the kit.

Data analysis

Allele frequencies and forensic parameters were performed using PowerStats version 1.2 software[8]. GENEPOP 4.7.5 was used to perform Hardy-Weinberg exact tests [9, 10].

Quality control

Kit controls.

Results

See Table 1.

Allele frequencies and forensic parameters for 21 STR loci in Thai population (*N*=3,000)

	CSF1PO	D10S1248	D12S391	D13S317	D16S539	D18S51	D19S433	D1S1656	D21S11	D22S1045	D2S1338	D2S441	D3S1358	D5S818	D7S820	D8S1179	FGA	SE33	TH01	TPOX	vWA
5																			0.0003		
6				0.0007											0.0002	0.0002			0.1060	0.0002	
7	0.0057	0.0003		0.0035										0.0275	0.0065				0.2960	0.0005	
8	0.0017	0.0005		0.3193	0.0110			0.0042				0.0003		0.0013	0.1665	0.0010			0.0728	0.5800	
9	0.0262	0.0002		0.1325	0.1880	0.0002	0.0055	0.0012				0.0013		0.0525	0.0718	0.0010			0.3823	0.1202	
9.1												0.0097			0.0023						
9.3															0.0002				0.0760		
10	0.2015	0.0003		0.1327	0.1218	0.0017	0.0003	0.0038		0.0002		0.2138		0.2293	0.1768	0.1462			0.0640	0.0347	
10.1												0.0010			0.0003						
10.3															0.0002						
11	0.3062	0.0038		0.2267	0.2837	0.0058	0.0022	0.0712		0.1827		0.2892		0.2887	0.3663	0.1163		0.0003	0.0022	0.2462	
11.1												0.0002			0.0003						
11.2							0.0003														
11.3												0.1637			0.0002						
12	0.3728	0.0432		0.1378	0.2670	0.0590	0.0582	0.0340		0.0018		0.1327	0.0007	0.2290	0.1770	0.1163		0.0027	0.0003	0.0173	
12.1										0.0002											
12.2							0.0077											0.0007			
12.3												0.0030			0.0002						
13	0.0757	0.3338		0.0360	0.1113	0.1308	0.2488	0.1038		0.0077		0.0180	0.0047	0.1577	0.0250	0.1720	0.0003	0.0042		0.0007	0.0010
13.2							0.0342											0.0002			
13.3												0.0002									
14	0.0097	0.2288	0.0002	0.0100	0.0165	0.1780	0.2497	0.1050		0.0398	0.0003	0.1510	0.0400	0.0110	0.0058	0.1665		0.0037		0.0003	0.2553
14.1						0.0002															
14.2							0.0900											0.0005			
14.3																		0.0002			
15	0.0007	0.2472	0.0098	0.0008	0.0007	0.2468	0.0847	0.2753		0.3612	0.0002	0.0148	0.2932	0.0030	0.0003	0.1888	0.0002	0.0112			0.0327
15.2							0.1658											0.0008			
15.3								0.0045								0.0002		0.0007			
16		0.1117	0.0048			0.1690	0.0172	0.2083		0.1872	0.0170	0.0012	0.3422			0.0765	0.0033	0.0283			0.1335
16.1																		0.0002			
16.2							0.0297											0.0003			
16.3								0.0087										0.0002			
17		0.0277	0.0852			0.0800	0.0013	0.0855		0.1965	0.1005		0.2380			0.0132	0.0013	0.0640			0.2507
17.2							0.0038											0.0007			
17.3			0.0007					0.0562													
18		0.0025	0.1912			0.0420		0.0135		0.0222	0.0833		0.0720			0.0018	0.0172	0.0682			0.2005
18.2							0.0005											0.0010			
18.3			0.0003					0.0202													
19			0.1975			0.0322		0.0022		0.0007	0.2097		0.0090				0.0700	0.0770			0.1045
19.1																		0.0002			
19.2			0.0003				0.0002										0.0002	0.0015			
19.3			0.0002					0.0023													
20			0.1752			0.0220		0.0002			0.1095		0.0003				0.0605	0.0618			0.0205
20.1																		0.0002			
20.2																	0.0018	0.0045			
21			0.1275			0.0135					0.0445						0.1322	0.0385			0.0008
21.1																		0.0008			
21.2																	0.0160	0.0153			
21.3																	0.0002				
22			0.1035			0.0120					0.0515						0.2017	0.0127			0.0005
22.1																		0.0002			
22.2																	0.0143	0.0235			
23			0.0630			0.0035					0.1852						0.1708	0.0025			
23.2																	0.0107	0.0397			
24			0.0227			0.0020					0.1398						0.1290	0.0008			
24.2																	0.0162	0.0497			
24.3																		0.0002			
25			0.0132			0.0010			0.0002		0.0503						0.0883	0.0005			
25.2																	0.0073	0.0512			
26			0.0038			0.0003			0.0002		0.0068						0.0422	0.0003			
26.1																		0.0002			
26.2																	0.0015	0.0698			
26.3																		0.0002			
27			0.0010						0.0033		0.0012						0.0098				
27.2																	0.0005	0.0813			
27.3																		0.0002			
28									0.0520		0.0002						0.0028	0.0007			
28.2									0.0008								0.0002	0.0897			
29									0.2440								0.0007	0.0002			
29.2									0.0008									0.0723			
29.3									0.0002												
30									0.2472									0.0005			
30.1									0.0002								0.0007				
30.2									0.0422									0.0548			
30.3									0.0010												
31									0.0715									0.0002			
31.2									0.0773									0.0303			
32									0.0282									0.0002			
32.1																	0.0002				
32.2									0.1617									0.0167			
32.3																		0.0003			
33									0.0033												
33.1									0.0003												
33.2									0.0567									0.0083			
34									0.0002												
34.2									0.0073									0.0042			
35.1									0.0002												
35.2									0.0013									0.0010			
36.2																		0.0002			
H_{obs}	0.7170	0.7530	0.8560	0.7883	0.7893	0.8437	0.7437	0.8303	0.8337	0.7570	0.8613	0.7943	0.7203	0.7737	0.7670	0.8550	0.8693	0.9360	0.7350	0.5757	0.7877
H_{exp}	0.7204	0.7602	0.8550	0.7913	0.7855	0.8484	0.8274	0.8418	0.8339	0.7607	0.8660	0.8031	0.7337	0.7834	0.7699	0.8529	0.8769	0.9427	0.7400	0.5873	0.8018
P	0.5770	0.7088	0.8723	0.9118	0.2779	0.1044	0.2258	0.4366	0.8977	0.8459	0.5580	0.1220	0.0933	0.7104	0.4556	0.3681	0.5233	0.1818	0.6041	0.4808	0.4609
*p*M	0.1271	0.0949	0.0381	0.0730	0.0797	0.0405	0.0508	0.0419	0.0480	0.0934	0.0321	0.0661	0.1164	0.0798	0.0862	0.0397	0.0274	0.0066	0.1073	0.2236	0.0671
PD	0.8729	0.9051	0.9619	0.9270	0.9203	0.9595	0.9492	0.9581	0.9520	0.9066	0.9679	0.9339	0.8836	0.9202	0.9138	0.9603	0.9726	0.9934	0.8927	0.7764	0.9329
PIC	0.6716	0.7214	0.8379	0.7615	0.7523	0.8310	0.8059	0.8244	0.8139	0.7239	0.8514	0.7746	0.6867	0.7492	0.7373	0.8346	0.8645	0.9393	0.7013	0.5336	0.7724
PE	0.4550	0.5149	0.7067	0.5776	0.5794	0.6824	0.6184	0.6565	0.6629	0.5218	0.7173	0.5886	0.4604	0.5511	0.5393	0.7047	0.7333	0.8687	0.4845	0.2627	0.5764
PI	1.7668	2.0243	3.4722	2.3622	2.3734	3.1983	2.6362	2.9470	3.0060	2.0576	3.6058	2.4311	1.7878	2.2091	2.1459	3.4483	3.8265	7.7720	1.8868	1.1783	2.3548

H_{obs}	observed heterozygosity	PD	power of discrimination
H_{exp}	expected heterozygosity	PIC	polymorphism information content
P	probability value of Hardy-Weinberh equillibrium exact test	PE	power of exclusion
*p*M	match probability	PI	Typical Paternity Index

Discussions

In the present study, no significant deviation from HWE was observed (p> 0.05). SE33 showed the highest power of discrimination (PD = 0.9934), the highest power of exclusion (PE = 0.8687) and most informative locus (PIC= 0.9393). Otherwise, TPOX was the least informative locus (PD = 0.7764, PE = 0.5336 and PIC = 0.2627). The higher discrimination power of a locus increases the efficiency of discriminating between individuals in population. The combined power of discrimination and the combined power of exclusion for 21 STR loci were 0.99999999999999999999999999999 and 0.9999999980, respectively. The genetic relationships among the six subpopulations have been studied and reported. The people from six regional groups showed non-significant genetic distances [5]. This study suggests that all these 21 STR loci can be used as a powerful tool in forensic analyses including identity and paternity testing.

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Automated Disposable Pipette Extraction with GC-MS for the Determination of Free Cocaine in Urine

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Introduction

Forensic toxicology laboratories have historically used liquid-liquid extraction (LLE) or solid phase extraction (SPE) methods for analysis of drugs and metabolites in urine. However, they have many disadvantages, such as, consumption of considerable amounts of organic solvent, time consuming, and manual operation. Disposable pipette extraction (DPX) is a new technology in sample pre-treatment [1] which can be combined with the working platform to achieve automation. Automated DPX technology can address the drawbacks of traditional methods. Loose sorbent is pre-loaded in a DPX tip. During the sample preparation process, the sorbent is mixed with the sample or solvent using robotic liquid handlers, by simple aspirating and dispensing actions. The DPX work platform can automate the entire process and eliminate the tedious and labor intensive aspects of sample preparation.

In this article, we describe a new method, automated DPX work platform with GC-MS for the determination of free cocaine in human urine.

Materials and methods

1) Chemicals and Reagents

Cocaine and proadifen were purchased from National Institute for the Control of Pharmaceutical and Biological Products, Beijing, China and the purity was above 98%. Automated DPX sample processing was performed on Integra Assist with VIAFLO Pipette (12Ch, 50-1250µL) and DPX tips (25mgHLB, 75-125µm). They were purchased from WuXi MicroSep Biological Science Co. Ltd. All other necessary chemicals and reagents were purchased from commercial sources in high purity and used with no further purification.

2) GC-MS Conditions

Cocaine analysis was carried out using a Thermo Scientific Trace1310 Gas chromatography (GC) combined with ISQ LT single quadrupole mass spectrometry (MS). A VF-5ms capillary column (30 m×0.25 mm×0.25 µm) was applied for the separation, with a helium flow rate of 1 mL/min and splitless injection at an injector temperature of 280°C. The column oven was initially held at 80°C for 1 min, programmed to 280°C at a rate of 20° C/min and held for 5 min. Thermo Scientific AI1310 auto sampler with a 10 µL Thermo syringe was used to inject 1 µL of the extracts into the GC-MS.

3) Sample Pretreatment by automated DPX

During the procedure, 1.0mL methanol, water, urine (containing 100ng proadifen as internal standard), 5% methanol, and ethyl acetate were placed separately in 96-well plates which were loaded onto the Integra Assist. The VIAFLO Pipette was installed to the Integra Assist (Fig. 1).

Fig. 1. The photo of the automatic DPX system

The DPX-HLB tips were then loaded onto the VIAFLO Pipette and conditioned with methanol and water, respectively. After conditioning, urine was aspirated and dispensed from the DPX tip five times in order to bind the cocaine. 5% methanol was then aspirated and dispensed from the DPX tip to remove impurity. Finally, cocaine was eluted by 1.0 mL ethyl acetate. Eluent was collected in a vial and evaporated to dryness at 50°C under a nitrogen flow. 50 µL methanol was added to the vial to reconstitute the extract. 1.0 µL was injected into the GC-MS. The flow chart of DPX is shown in Fig.2.

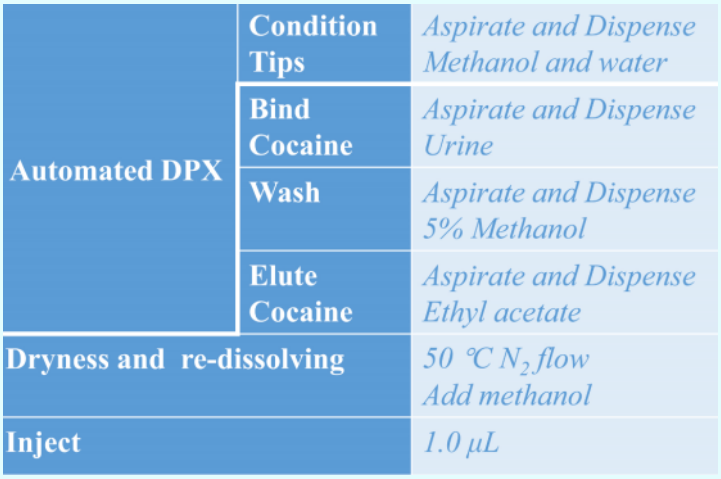

Fig. 2. Flow chart of DPX

Results

Analytical results were linear, accurate and precise. The quantification ion of cocaine was 82 m/z, and the monitored ions of cocaine were 82 m/z, 182 m/z and 94 m/z. The analytical performance was shown in Table 1. The limit of detection (LOD) was 12 µg/L, obtained based on signal to noise (*S/N*) ratio of 3. The limit of quantification (LOQ) was obtained as the lowest concentration in the linear range that can be measured by the regression equation. Linearity ranged from 40 µg/L to 1000 µg/L. Coefficient of correlation (R^2) was 0.9991.

The extraction recovery of cocaine was calculated by comparing the peak area of the extracted drugs with the peak area of untreated standards of the drugs at the same concentration, measured on the same day. The recoveries, assessed through three pools of fortified matrix samples at the following concentrations: 40 µg/L, 200 µg/L, 1000 µg/L, were range from 78.5% to 82.7%. Relative standard deviation was calculated using 6 replicate extraction and range from 1.7% to 4.2%.

Analyte	Linear range µg/L	R^2	LOD µg/L	Add ng	Recovery %	RSD %
				40	82.7	4.2
Cocaine	40-1000	0.9991	12	200	78.5	1.7
				1000	79.6	2.0

Table.1. Linear range, R2, LOD, recovery and RSD (n=6) of cocaine

Conclusion

In this article, a new method, automated DPX with GC-MS for determination of free cocaine in urine, has been developed. It has high extraction efficiency, good repeatability and selectivity, low LOD and LOQ, as well as good linearity over the investigated concentration range. The automated DPX method may be a convenient and efficient procedure, which can be well applied to determination of other drugs in human urine.

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Petrol Bomb Formulation in Hong Kong

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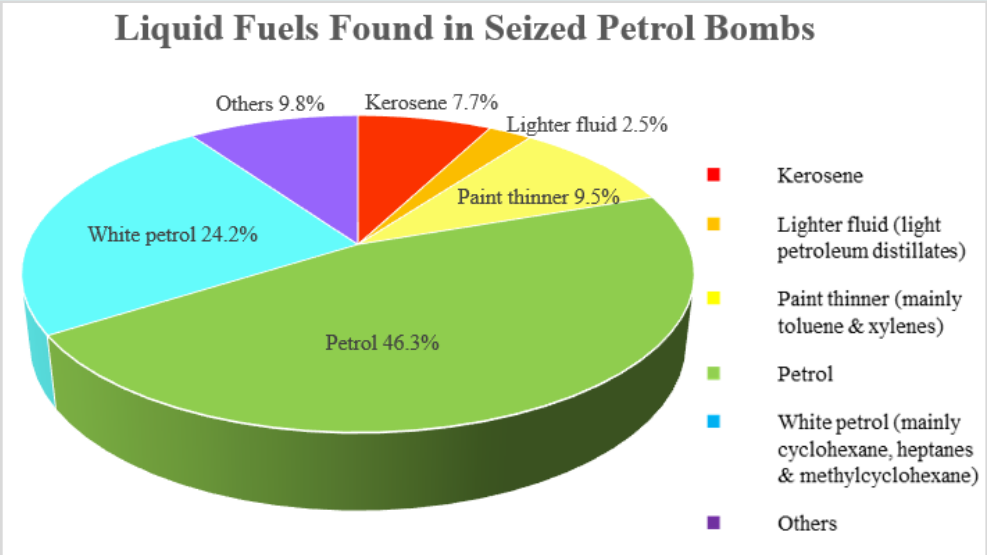
Introduction

Petrol bombs are improvised incendiary devices known for their destructive powers to cause harm to humans and properties[1]. Essentially, a petrol bomb consists of a glass bottle containing liquid fuel with a wick on the bottleneck for ignition. It is then thrown, breaking the bottle on landing, and dispersing a flammable vapour which is set alight[2].

Hong Kong has one of the lowest crime rates in the world and violent crimes are rare. However, this changed dramatically since the second half of 2019 when Hong Kong experienced serious social unrest, and the use of petrol bombs became prevalent. At the height of the protests in mid-November 2019, two major seizures totalling about 8,000 petrol bombs became headlines in the local press. The local social media became a hotbed of information exchange for tips and procedures for making petrol bombs. This article describes a preliminary study of petrol bomb formulation found in Hong Kong during the recent unrest, and to shed light on their chemical nature and destructive potential.

Materials and Methods

The Government Laboratory provides independent forensic testing services for law enforcement agencies in Hong Kong. Between August 2019 and February 2020, over 250 requests were received for the analysis of flammable liquids, including over 300 'complete' petrol bombs. The distribution of liquid fuels in the petrol bombs examined is shown below:



Additives which allegedly increase the potency of petrol bombs were also found. Some of these, categorized as solid and liquid additives, are summarized below:

Solid Additive	Liquid Additive
Sugar	Bleach solution
Starch	Conc. sulphuric acid
Sulphur	Detergent liquid
Detergent powder	Cooking oil
Rags or plastic fragments	Liquid paint

Discrete solids were also seized from premises suspected to be petrol bombs manufacturing sites. Examples such as phosphorus, magnesium (ribbons, turnings or powder) and even thermite mixtures were found, with notes boasting their effects.

Experimental Setup for Simulations

To study the combustion behaviour and evaluate the effect of different ingredients found in those petrol bombs examined, a series of simulations was performed. These were done by throwing ignited petrol bombs onto a vertical wall at a distance of about 5m whilst capturing the action with a Canon video camera set at a frame rate of 500 fps. The containers used were 330 mL glass beer bottles, with white cotton towels as wicks. A Cole-Parmer digital thermometer with 9 thermocouples was used to record the temperature changes at various locations on the target wall. On the day of the experiments, the average temperature was about 19^{o}C with a relative humidity of about 75%.

Results and Discussion

The fire development upon shattering of the petrol bombs filled with 250 mL of petrol captured at the moment of impact, and at 10, 20, 40, 80, 150 ms post-impact, are shown in Figures 1-6. When the glass bottle filled with petrol was thrown and impacted onto the vertical wall, the bottle shattered scattering flammable droplets. In the meantime, the flame on the wick ignited the flammable petrol vapour/air mixture triggering a rapid chain of combustion propagating radially outwards. The flame of the combustion accompanying with intense heat (measured ~600^{o}C) accelerated the vapourisation of the petrol droplets and expanded the volume of the cloud of petrol vapour/air mixture. The rapid propagation of the flame on the unburnt petrol fuel led to the development of a fire ball of about 2m in diameter within 150 ms after impact. For bottles filled to half capacity or below, the fire ball reduced to about 1m in diameter after the same period of post-impact time.

Petrol bombs comprising other readily ignitable liquid fuels, such as white petrol, paint thinner mixture and lighter fluid, showed combustion temperatures similar to petrol. However, petrol bombs prepared with kerosene or diesel showed limited size of fire development.

The addition of solids such as sugar, flour, detergent powder and magnesium turnings showed negligible contribution to size of fire development whereas the effect of liquid additives varied. Generally speaking, aqueous liquids immiscible with petrol produced no significant effects whereas organic liquids did. Detergent liquids, which formed emulsions with petrol, doused the fire drastically whilst a concoction of cooking oil and petrol caused the fuel mixture to burn longer, albeit with a reduced horizontal spread owing to increase in viscosity. Figures 7-8 show the effect of aforesaid liquid additives at 150 ms post-impact.

Conclusion

Petrol is the most common liquid fuel found in petrol bombs examined, followed by white petrol. Petrol bombs made with flammable liquids, such as petrol or white petrol, would develop fire balls of over 2m diameter in about 150 ms upon impact with a hard surface, which commensurate with previous studies[3]. Solid additives, such as sugar and starch, did not show any enhancements to the development of instantaneous fire balls while the effect of liquid additives, such as cooking oil and detergent, varied. The formulation cited in the local social media for allegedly enhancing the “potency” of petrol bombs largely turned out to be damp squibs.

Acknowledgement

The assistance and provision of experimental venue of the Fire Service Department of Hong Kong SAR is gratefully acknowledged. Sincere thanks to Dr. WM Sin, the Government Chemist, and Mr. BKK Cheung, the Assistant Government Chemist, and Mr. YM Cheung, Chief Chemist, for their support and encouragement in this work.

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Figure 1) Moment of impact: glass broke scattering liquid

Figure 2) 10 ms post-impact: liquid scattered but fire yet to develop

Figure 3) 20 ms post-impact: liquid scattered and fire began to develop

Figure 4) 40 ms post-impact: ~1m diameter fire ball had developed

Figure 5) 80 ms post-impact: ~1.5m diameter fire ball had developed

Figure 6) 150 ms post-impact: ~2m diameter fire ball had developed

Figure 7) 150 ms post-impact: fire development with detergent/petrol at ratio of 1:1

Figure 8) 150 ms post-impact: fire development with cooking oil/petrol at ratio of 1:1

Potential Application of CAN Bus Data Packet and Event Data Recorder in Vehicle Forensics Investigation

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Introduction

Modern cars are fitted with multiple sensors to fully or partially replace driving function traditionally performed by a human driver[1]. This technology works by integrating navigation system, sensing devices, roadside Intelligent Transport System and traffic monitoring data to automatically and efficiently run the vehicle (Figure 1). When implemented, the benefits are:

1. Increase in traffic safety
2. Driver productivity
3. Road capacity
4. Travel Speed
5. Energy Consumption
6. Vehicular emission

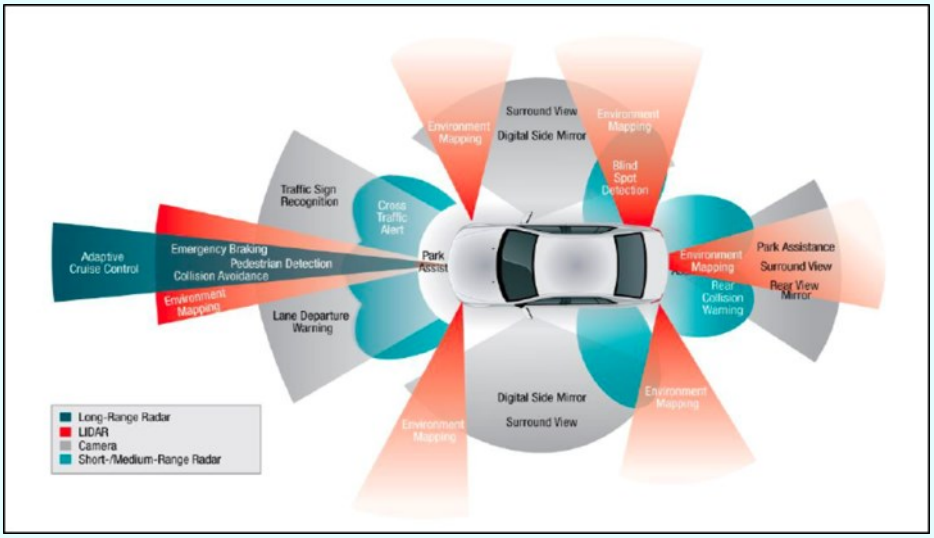

Figure 1: Driving automation with sensing technologies and control intelligence

In vehicle forensics context, it is focused on obtaining and preserving information extracted from a vehicle. Communication technology advances that were expensive a decade ago, is now considered the standard – digital instrument cluster, infotainment systems, and others. These devices may include persistent memory that stores information regarding the vehicle's performance status.

Source of data

A car may contain a series of computer nodes called Electronic Control Unit (ECU) connected along a bus network architecture. Various ECUs in the car perform distinct operations, and function as individual nodes within the automobile network architecture[2].

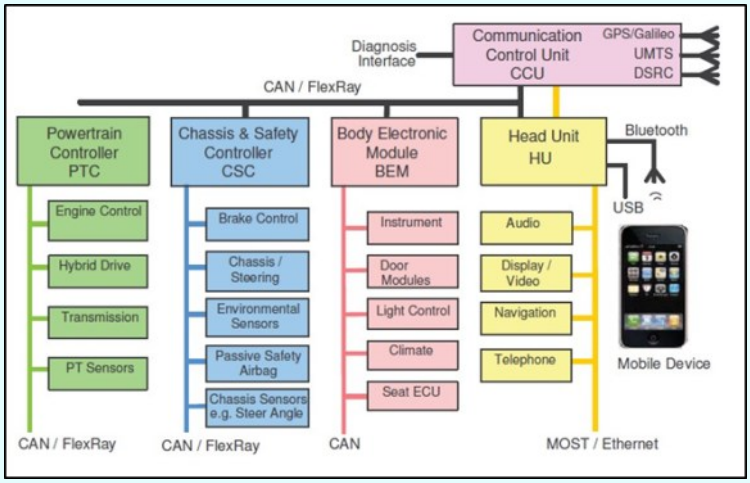

Figure 2: Block diagram for a generic Vehicle Communication Network

Without a centralised computer, each system or ECU node in a vehicle is connected to a specialised bus network called Controller Area Network (CAN) bus. As shown in the Figure 2 above, different nodes may connect to different network protocol depending on its use case.

Another source of valuable data that can be found in a vehicle is Event Data Recorder. An Event Data Recorder is a part of the Supplemental Restraint System ECU that records data for some types of collision events [3].

The data is recorded continuously, overwriting past information until a trigger is activated as shown in Formula 1. When an impact or accident happens that has exceeded the rapid change in speed threshold, the event data recorder automatically saves up data for a period of time depending on how long it is capable of recording. Some vehicle can record pre-crash data that took place before the impact occur. This can be recorded for up to 5 seconds.

{ "speed", start record EDR data} {speed > threshold of normal driving }

Formula 1: Event that trigger Event Data Recorder to start recording

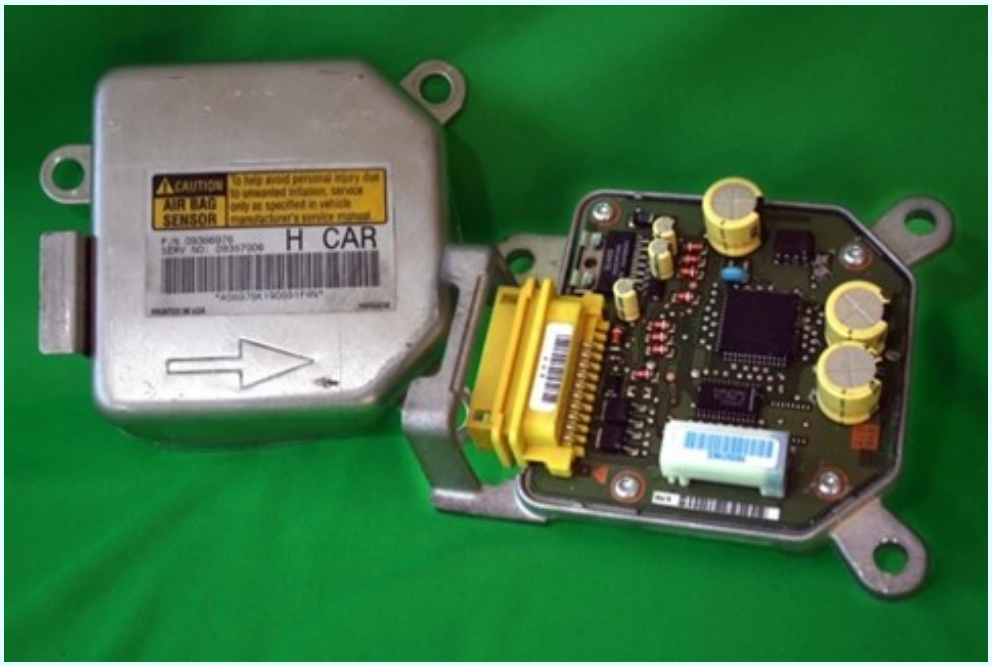

Figure 3: Event Data Recorder

Listed are information that is kept in Event Data Recorder:

1. Vehicle speed
2. Front seat position
3. Number of crashes
4. Accelerator position
5. N times car has been started
6. Airbag deployment
7. Brake application & antilock brake activation
8. Crash event duration
9. Occupant size
10. Safety belt engagement
11. Engine rpm
12. Forward and lateral cash force
13. Stability control engagement
14. Steering wheel angle
15. Vehicle roll angle

Figure 4 shows an example of report created from data collected via event data recorder. This data is from a frontal impact event that was above event data recorder threshold [3].

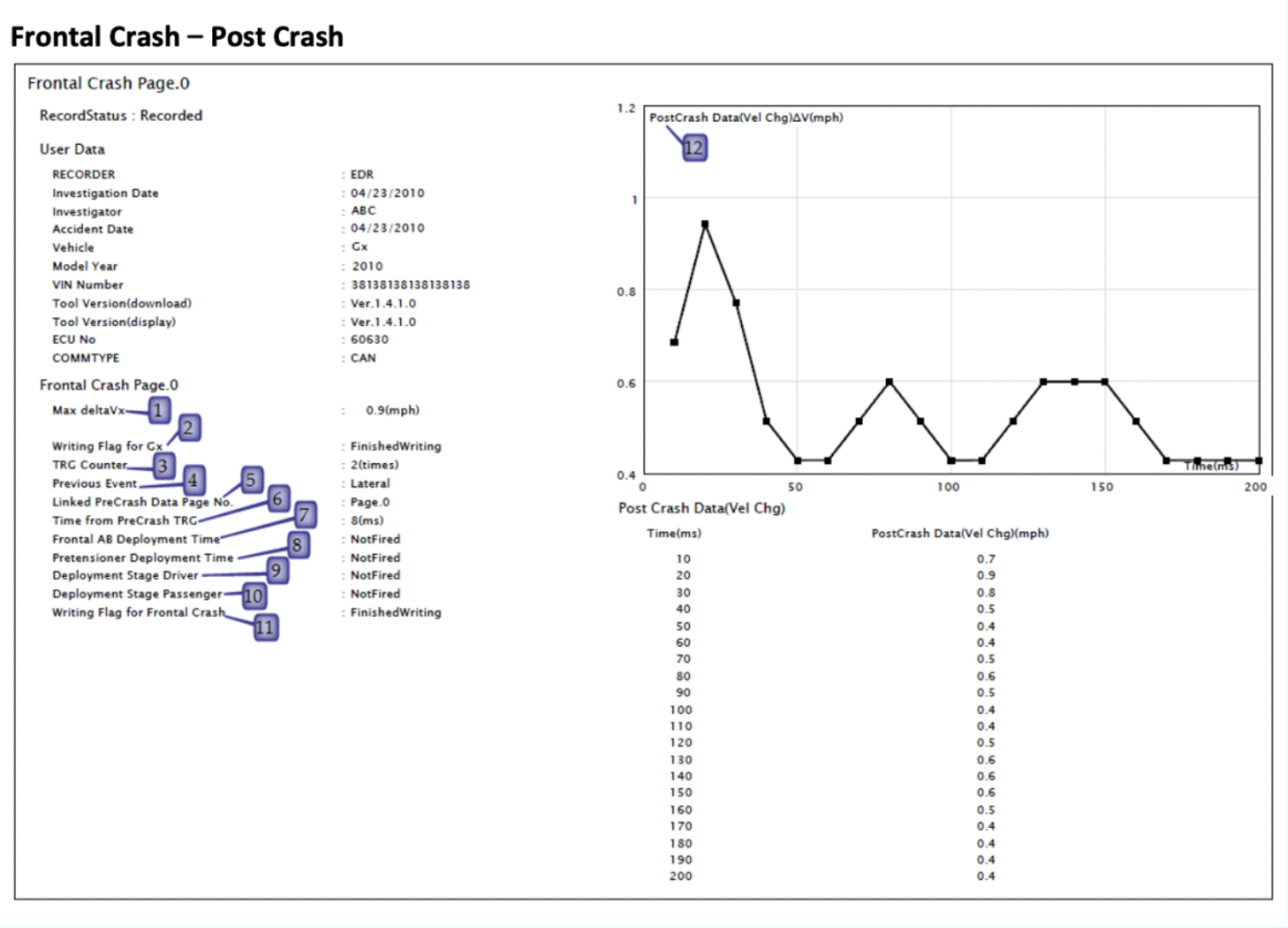

Figure 4: Example report of Event Data Recorder

No. in report	Definition
1.	Maximum change in longitudinal speed
2.	Indicates whether data during impact was transferred to the permanent EDR memory
3.	Number of EDR event triggers
4.	Type of previous event
5.	Page number of linked data
6.	Time range from PreCrash trigger to start of delta V calculation
7.	Time range from event trigger to airbag deployment
8.	Time range from event trigger to pretensioner deployment
9.	Deployment level for multistage airbags
10.	
11.	Indicates whether data during impact was written to the permanent EDR memory
12.	Change in vehicle longitudinal speed in mph over milliseconds

Table 1: List of data from event data recorder report and its definition

Data extraction

CAN Bus Data Frame

CAN bus data can be logged and extracted using CAN bus data logger (Figure 6). The CAN Bus data logger needs to be connected to the car's OBD-II port and it records raw CAN data to an SD card in MDF4 format [8]. A converter is needed to transform the data to readable format such as CSV for further data analysis. CAN messages are transmitted by frames. A node that sends out a message (frame) is called a transmitter while a node that is not sending a message is a receiver. These frames are data that are packaged into a single unit that travels along a network. The following is how a packet / frame looks like according to CAN 2.0A standard of the CAN Protocol [5]. A CAN Bus data logger needs to be connected to the OBD-II connector in a car.

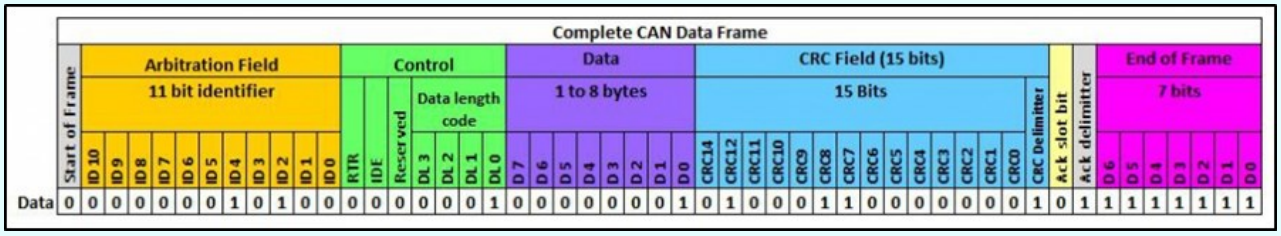

Figure 5: CAN 2.0A Standard Format (11-bit identifier)

Figure 6: CAN Bus data logger

Figure 7: BOSCH Crash Data Retrieval kit

CAN is widely used in powertrain communication, the chassis domain and the body domain and 2418 signals [7] transmitted through CAN Bus can be in on-demand values, signal values, constants, multi-value fields and counters. Some signals that are meaningful in vehicle forensics investigations are velocity, brake pedal pressure, clutch and accelerator pedal positions, RPM (round per minute), steering wheel angle, steering wheel momentum, frontal acceleration and lateral acceleration[6][7]. Note that meaningful CAN IDs vary significantly across vehicle makes and models and these are only for standardised lower layers while the higher layers are kept confidential by respective vehicle makers.

Event Data Recorder

BOSCH Crash Data Retrieval Kit is used in extracting data from Event Data Recorders that may be captured focusing in the airbag control modules of the vehicle[5]. The data is downloaded in code, and the crash data retrieval software converts the code into a readable graphical form.

[5] also mentioned that vehicles unsupported by BOSCH CDR Kit can still be investigated by accessing persistent memory in Electronic Control Modules that is available in each system (node) of a vehicle. Although the data might not be accessible in a centralised unit like the EDR, ECMs may be able to provide information to investigators.

Conclusion

In this article, a brief overview of CAN Bus and EDR is given. Investigating these two components may provide a better understanding on obtaining a vehicle's information.

CAN Bus is among the most widely used protocol in a vehicle communication system. Its implementation can be studied by reverse engineering or knowing the manufacturer's specific encoding. Reverse engineering can be done using a number of tools such as a CAN Bus data logger. The EDR is a device that is triggered when a crash occurred. The BOSCH CDR Kit is not manufacturer specific tool that is able to capture EDR data.

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Multi-feature Fusion Method for Perpetrator Bare Footprint Identification

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Abstract

This paper presents a multi-feature fusion method for high accuracy identification of bare footprint. The approach is fusing the shape and pressure features with different weights.

Background

Footprint is the mark left on the supporting object by plantar pressure while people are walking. Footprints can be used not only to distinguish different acting subjects, but also to reflect the gender, height, slimness of figure, age and other physiological characteristics, as well as behavior characteristics including walking posture and walking habits. Features like contour pressure of 2D bare footprint can reflect the physiological and behavior habit of the acting subject, meanwhile such feature has good uniqueness and stability under the same circumstance of other types of features. Bare footprint identification is to identify the class of a tested footprint by first extracting the features of the tested bare footprint and then comparing it with known bare footprints in the query database.

In recent years, researchers at home and abroad have done researches on 2D bare footprints. Kennedy [1] used 38 feature variables to describe a bare foot, including lengths from the heel to the tips of the five toes, the core of the heel and toes, the sole region, heel region, etc.. Lei Hang et al.[2] used 41 shape coefficients to establish a footprint-to-person identification model based on Bayesian decision theory and conducted experiments on ink rubbed footprints. In our early work[3], geometrical shape spectrum and pressure radial gradient map was used as two types of features to describe bare footprints in the two separate aspects of shape and pressure and our approach achieved outstanding identification results.

This study aims at improving the fusion method of geometrical shape spectrum and pressure radial gradient features based on the work of [3].

Data set

The data set used in this paper is MUR2RV2 which was formed by bare footprint image with pressure information, acquired by the suspect footprint collecting equipment[4] from Dalian Everspry Sci & Tech Co., Ltd. The principle of light reflection was used to record pressure information of the sole: the greater the pressure is, the larger the grayscale value of corresponding pixel becomes. The MUR2RV1 data set used in [3] contains 480 subjects, while the MUR2RV2 data set used in this paper contains 1,115 subjects between the ages of 17 to 60, with each subject providing 4 left or right foot images, a total of 4,460 images. With more subjects, it is possible to further test the distinctness of the features in personal identification as well as the robustness of the whole identification algorithm.

Feature fusion based footprint identification algorithm

The algorithm flowchart of this paper is presented in Figure 1. The preprocessing approach is the same as [3]. First, the maximum connected region of the hallux (the big toe), the sole region and heel region are found, and thus the scope of footprints is determined. Then, the footprints are divided into the sole region and the heel region, and the directions of the two regions are normalized according to the main direction of the heel region. While the preprocessing is finished, the features of the images in the database are extracted, selected and fused offline. As for the pending images, the process of feature extraction is performed online. Furthermore, feature selection and feature fusion are conducted using the same feature selection model and feature fusion model, and a feature vector is produced at the end of the process. Finally, the class of the footprint is identified by feature comparison.

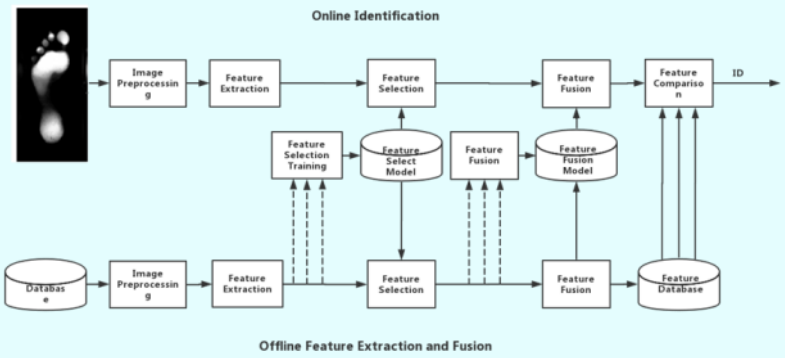

Figure 1. Algorithm flowchart

Feature extraction

Geometrical shape spectrum representation

During the examination of bare footprints, the shape information of bare footprints such as the shape of toes, plantar front edge, plantar back edge, plantar inner edge, plantar outer edge, shape of heel region, etc. are frequently used. Therefore, the method of Geometrical Shape Spectrum Representation (GSSR) is used to extract bare footprint to represent the shape characteristics of the footprints

In Figure 2, the grayscale center of the forefoot is calculated and then using it as the origin to establish a pole coordinate system. Extract the contour of the forefoot of footprint so the geometrical shape of the forefoot can be represented by the sum of the distances between each contour point and the grayscale center within a certain range of angle, as following

$$\rho_F(\theta) = \sum_{arctan(y_i'/x_i') \in [\theta-\Delta\theta, \theta+\Delta\theta)} \sqrt{(x_i - x_F)^2 + (y_i - y_F)^2} \quad (1)$$

Here (x_i, y_i) is the coordinate of the contour point, (x_F, y_F) is the grayscale center, (x_i', y_i') is the relative coordinate of (x_i, y_i)regarding the grayscale center, θ is the current polar angle, $\Delta\theta$ is the sampling interval of polar angle.

In order to remove the impact of noise in the footprint image, one dimensional median filter operation is performed on ρ_F the result is noted as ρ_{MF}. To reduce the influence on the feature formed by minor variations of sizes between footprints taken at different time, the feature ρ_{MF} is normalized, which is as follows

$$\boldsymbol{\rho}^{*}_{\mathrm{MF}}(\theta) = \frac{\boldsymbol{\rho}_{\mathrm{MF}}(\theta) - \bar{\boldsymbol{\rho}}_{\mathrm{MF}}}{\sigma(\boldsymbol{\rho}_{\mathrm{MF}})} \quad (2)$$

Here $\bar{\rho}_{MF}$ represents the mean value of all ρ_{MF} in the image, $\sigma(\rho_{MF})$ represents the variance of all ρ_{MF}. To grant the feature with translation and rotational invariance, Fourier transformation is performed on the normalized feature. The calculated modulus value is used as the geometrical shape spectrum representation (GSSR) as

$$G_F(\Theta) = \left|\sum_\theta \rho^*_{MF}(\theta) e^{-j\theta\Theta}\right| \quad (3)$$

Similarly, we can acquire the GSSR feature $G_H(\Theta)$ of the heel region of the footprint. Concatenating the GSSR features of sole part and heel part gives the GSSR feature of the corresponding footprint image.

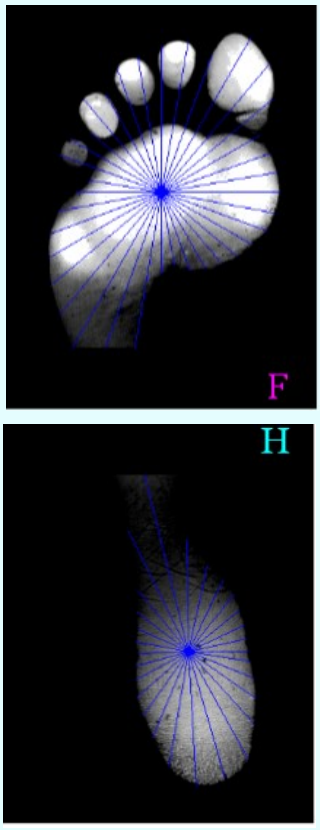

Figure 2. GSSR feature schematic of a footprint

Image pressure radial gradient map

There are 26 pieces of bones, 33 joints, and more than 100 pieces of muscles and tendons of human's foot, which are different among different persons[6]. Correspondingly these differences are reflected as different pressure patterns on footprints[7]. In order to characterize the footprint pressure patterns, we proposed the Pressure Radial Gradient Map (PRGM) [3]. While GSSR mainly describes the shape characteristics of a footprint, PRGM describes the pressure distribution characteristics on the footprint. For a single footprint image, to calculate the PRGM feature of the sole part and heel part separately and then concatenate them give the PRGM feature of the whole footprint.

The PRGM feature of the sole part image $\mathrm{I}(\mathrm{x},\mathrm{y})$ is defined as follows. Take the grayscale center of the sole part as origin, build T isometric concentric circles in a circular region with radius of R and separate this region into N parts along the circumference and form a template like the one shown in Figure 3. R is 1/2 of the length of the diagonal of the minimum enclosing rectangle of the foreground pixels in the image. Write r_i as the i_{th} concentric circle where $\mathrm{i} = 1,2,\ldots,\mathrm{T}$, θ_k is the k_{th} direction where $\mathrm{k} = 1,2,\ldots,\mathrm{N}$. $\mathrm{M}(\theta_k, r_i)$ represents the sum of pressure in the sector region between the positive x axis and the half-line of the k_{th} direction in the i_{th} concentric circle. The sum of pressure is represented by the sum of grayscale value of all pixels in the region as

$$\mathrm{M}(\theta_k, r_i) = \sum_{y/x \le tan\theta_k} \sum_{x^2+y^2 \le r_i^2} I(x - x_F, y - y_F) \tag{4}$$

where (x_F, y_F) is the grayscale center of the image, (x, y) is a point in the sector region, the difference between neighbouring sector parts along the axis is

$$\mathbf{M}_\theta(\theta_k, r_i) = \frac{\mathbf{M}(\theta_k, r_i) - \mathbf{M}(\theta_{k-1}, r_i)}{\theta_k - \theta_{k-1}} \tag{5}$$

calculate the derivation of the difference on r gives the PRGM feature of the sole part as

$$\mathbf{P}_\mathrm{F}(\theta_k, r_i) = \frac{\mathbf{M}_\theta(\theta_k, r_i) - \mathbf{M}_\theta(\theta_k, r_{i-1})}{r_i - r_{i-1}} \tag{6}$$

Similarly, we can acquire the PRGM feature of the heel part $P_H(\theta_k, r_i)$. Then the PRGM feature of the whole footprint is $\mathrm{P} = [P_F^*, P_H^*]$, where P_F^* and P_H^* are the vector form of $P_F(\theta_k, r_i)$ and $P_H(\theta_k, r_i)$.

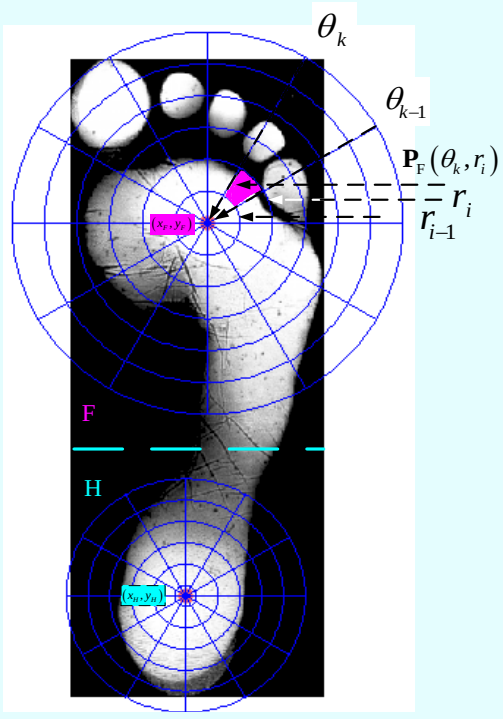

Figure 3. Footprint PRGM feature schematic

Feature fusion

GSSR and PRGM features describe the footprint in the aspect of shape and pressure separately. Based on the observation of inter and intra class feature differences within the database, this paper assigns different weights to GSSR and PRGM, fusing them to form the features used in the identification phase.

Separability criterion

To achieve accurate classification, the inter class dispersion in the feature space is expected to be as large as possible while the intra class dispersion to be as small as possible. Taking GSSR as an example, the separability criterion can be calculated as follows.

The feature separability J_G is defined as:

$$J_G = tr(\mathbf{S}_w^{-1}\mathbf{S}_b) \tag{7}$$

where S_b is inter class dispersion, S_w is intra class dispersion, so

$$\boldsymbol{S}_{\mathrm{b}} = \frac{1}{N}\sum_{l=1}^{C} R_l\left(\overline{\boldsymbol{Z}}_l - \overline{\boldsymbol{Z}}\right)\left(\overline{\boldsymbol{Z}}_l - \overline{\boldsymbol{Z}}\right)^{\mathrm{T}}, \boldsymbol{S}_{\mathrm{w}} = \frac{1}{N}\sum_{l=1}^{C}\sum_{j=1}^{R_l}\left(\boldsymbol{Z}_{lj} - \overline{\boldsymbol{Z}}_l\right)\left(\boldsymbol{Z}_{lj} - \overline{\boldsymbol{Z}}_l\right)^{\mathrm{T}} \tag{8}$$

The number of features of the l_{th} class is $R_l\,(l = 1, 2..., C)$, and $N = \sum_{l=1}^{C} R_l$. $\overline{\boldsymbol{Z}}_l$ is the mean value of the features of the l_{th} class, $\overline{\boldsymbol{Z}}$ is the mean of all features, $\boldsymbol{Z}_{lj}$ is the j_{th} feature vector of the l_{th} class. Again in the feature space, large inter class distance and small intra class distance are good for classification. A large J_G indicates strong separability in the GSSR feature space.

Correlation criterion

In information theory, mutual information is an essential basic concept[8]. It refers to the correlation between two sets of incidents. Introducing mutual information into feature fusion, and then the mutual information between feature and class reflects the relevance between class and feature. The greater the mutual information is, the higher the relevance between feature and class is. The equation to calculate mutual information MI_G is as follows.

$$MI(\mathbf{G}, c_i) = \log\frac{p(\mathbf{G}, c_i)}{p(\mathbf{G}) \times p(c_i)} = \log\frac{p(\mathbf{G}|c_i)}{p(\mathbf{G})}$$

$$MI_G(\mathbf{G}) = \sum_{i=1}^{m} MI(\mathbf{G}, c_i) \tag{9}$$

where $p(\mathbf{G}|c_i)$ is the probability of the presence of a footprint with feature $\mathbf{G}$ but belong to class c_i. $p(\mathbf{G})$ represents the probability that feature $\mathbf{G}$ appears in the database. $p(c_i)$ is the probability that the footprint in the database belongs to class c_i. A high probability of feature $\mathbf{G}$ appears in class c_i, but the probabilities of other classes are low means that feature $\mathbf{G}$ and class c_i has high relevance.

Feature fusion

First, calculating the feature separability criterion of GSSR as J_G and J_P for PRGM as well as the mutual information MI_G for GSSR and MI_P for PRGM. Then computing the ratio between J_G and J_P as well as the ratio between MI'_G and MI'_P in the following manner.

$$\begin{aligned} J'_G &= J_G/(J_G + J_P) \\ J'_P &= J_P/(J_G + J_P) \\ MI'_G &= MI_G/(MI_G + MI_P) \\ MI'_P &= MI_P/(MI_G + MI_P) \end{aligned} \tag{10}$$

Second, using weights to fuse the separability criterion and correlation criterion for GSSR and PRGM separability to gain the confidence of GSSR as α_G and β_P the confidence of PRGM as following the equations in (11).

$$\alpha_G = \alpha J'_G + (1-\alpha) MI'_G$$
$$\beta_P = \alpha J'_P + (1-\alpha) MI'_P \quad (11)$$

where α is the manually set weight based on separate observations of the properties of GSSR and PRGM. The value of α is set to 0.45 in the work of this paper.

For a single bare footprint, taking the sole part as an example, the sole feature is acquired by fusing GSSR and PRGM based on the confidences as $\mathbf{F} = [\alpha_G \mathbf{G}, \beta_P \mathbf{P}]$.

Similarity Computation

Features of the footprint images in the database are acquired after the feature fusion process and are stored in the feature library. In the identification process, the features of the test footprint are acquired by the same feature fusion process. The identification process then proceeds with similarity based on the cosine distance between features.

Results and analysis

To investigate the effectiveness of the proposed feature fusion algorithm, footprint identification experiments were conducted on MUR2RV2 and the results were compared with the approach of [3].

MUR2RV2 is divided into two subsets: test set and database. The definition is as follow: (1) Test set is formed by taking one footprint image from each of the 1115 classes in MUR2RV2. (2) Database is formed by the matching pairs of the test set, which are the rest 3 footprint images in each class of the 1115 classes in MUR2RV2.

The evaluation criteria for the classification algorithm is the Correct Recognition Rate (CRR), defined as the ratio of correctly classified sample among all test samples.

Method	CRR
GSSR	60.40%
PRGM	88.07%
IJCB	90.39%
Ours	**92.91%**

Table 1 Algorithm Results

Based on the test data introduced in 4.1, identification experiments were conducted using GSSR, PRGM, IJCB and our approach and the CRR results of these algorithms are shown in Table 1. It can be seen that after the number of subjects increased from 480 to 1115, the CRRs of the algorithms have dropped. However, the CRR of our approach is still 2.5% higher than the others' on the same data set.

Conclusion

This paper presents a method that fuses shape feature and pressure feature of a 2D bare footprint based on the study of both dispersion aspect and correlation aspect of intra and inter class situations. Test results shows that on a data set with more subjects we have achieved a higher CRR then the IJCB approach of our early work.

The proposed algorithm complements the vacancy of bare foot identification in the domestic footprint identification works at present by realizing the aim of case consolidation and increasing case-solving efficiency.

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Case Study

New Trends in Improvised Explosive Devices in Sri Lanka

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Ten years since 2009 the end of Sri Lanka brutal civil war against terrorism, country experienced another wave of atrocities against innocent civilians in April 21, 2019 Easter Sunday. The type of improvised explosive devices (IED) had been used in Easter Sunday attacks was somewhat peculiar to the devices employ in the country and they are not even similar to the devices manipulated by LTTE. Thereafter a new trend of homemade IED has been emerging and investigators have recovered evidence in post blast investigation of similar explosions.

In May 2020, an explosion has occurred close to a police post at Northern Province injuring the right foot of a police officer. Scene investigation recovered some fragments of a metal plate, metal balls, nail head, poly-vinyl-chloride (PVC), barbed wire, distorted 9 volts battery and electrical wire. Subsequent laboratory analysis for post blast residues revealed potassium nitrate, sulphur and aluminium powder on the debris. Examination of the uniform and the shoes worn by the officer indicates silver colour stains on the lower area of the trouser and bottom of the shoes. Further, stains were of the same explosive mixture of potassium nitrate, sulphur and aluminium powder.

Reconstruction of the fragments of PVC and metal plates was made easy with the ragged edges and silver stains pattern on them. Jigsaw physical fits revealed two cylindrical containers, a metal pipe with 55 mm diameter and a PVC pipe with 90 mm diameter. The smaller metal pipe packed with the explosive mixture had been within the larger PVC pipe. The space between the two pipes was filled with the shrapnel.

The next step was to identify the means of initiation and the firing mechanism. Since the main charge was low explosive, high explosive firing train with a detonator is ruled out. Since low explosives are activated by heat or spark, the most probable means of activation should be an explosive train with a safety fuse. Parts of a 9 volts battery and pieces of electrical wires further indicate a firing mechanism comprising an electrical circuit.

According to the victim's statement explosion occurred the moment when he steps on it with right foot and the right foot received the blast injuring the lower foot. Obviously, it had initiated by the pressure of the foot. Nail head part separated from the nail of the trigger that was the switch of the electrical circuit. Foot pressure had driven the nail so placed on top of the device, closing the circuit and firing the device.

Few days later similar incident occurred at the same area. A home-made device assembled inside a doll. A person carrying the doll in a traveling bag has received only minor injuries. Crime scene revealed 9 volts battery connected with a multi-strand electrical wire, small piece of 1.044 wire connected with nichrome wire, metal stones, wooden and rubbery material and plastic parts belongs to a doll contaminated with ash colour residues. The ash colour residues on post blast debris were identified as potassium nitrate, sulphur and aluminium powder.

About a week later, unexploded IED was found in a small town in Jaffna District. It was appeared as a plastic switch box fixed with one gang switch. It was deactivated by bomb disposal squad and the debris were consisted of metal balls, 9 volts battery, silver colour explosive mixture having same chemical components as previous and piece of single strand 1.044 wire connected with nichrome wire.

In the month of July severely injured person was hospitalized due to an explosion in a bed room of a newly built house at Pallai police area in Northern Province. Several number of metal balls, plastic pieces, pieces of 9 volts battery and burnt polythene pieces were collected at the crime scene. The wall of the bedroom was stained with blackish smoke and silver colour powdery deposit indicating small fire following the explosion. No crater or superficial damages appeared on the cement floor of the room and blast damages on both hands and body of the victim pointed out that device was exploded close to his hand. Potassium nitrate, sulphur and aluminium powder was identified in all post blast debris.

Additionally, water soaked partially burnt garments (sarong and shirt) were recovered. Although the garments were water soaked at the time of recovering, similar chemicals were identified on them. In addition red colour stains were observed on the garments as well as on floor and on the wall of the bed room. Finally DNA analysis established that the reddish stains were human blood and that of the victim.

Moreover, few lengths of 90 mm diameter PVC pipes, 55 mm diameter metal containers, metal balls, MP make 9 volts batteries, multi-strand earthed neutral wire, 1.044 wire pieces and rubbery material were recovered from the premises by showing that device was exploded inside the 'Home of IED'.

In summary homemade IED has been made with commonly available material and a low explosive mixture with an electrical firing mechanism connected with heat generating system.

A Study on Brake Fluid Color, Identification of its Main Compound and Quantitative Determination of Water Contamination by Kinematic Viscosity

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Abstract

Analysis of brake fluids starts with the identification of ethylene glycol the major constituent and followed by the determination of water content. Water contamination effects brake fluids hydrophilicity and viscosity properties thus altering the brake system efficiency. A total of ten samples were collected from fatal accident case scenes and analyzed by gas chromatography and compared with a known unused commercial brake fluid. The measurement of water content in brake fluid samples were performed by kinematic viscosity. Out of ten samples analyzed, four had water content of more than 3% which indicates a decrease in viscosity thus effecting the efficiency of the vehicles braking system.

Introduction

The Criminalistics Division has received numerous road accident cases over the last 3 years. Even though the first collision impact analysis can be determined, the identification of the root cause of accidents is still a challenge. In addition to human negligence, the vehicle's mechanical condition especially the brake system should be taken into account. Brake fluids are normally used in the hydraulic brake system as a fluid that transfers force into pressure, which amplifies the braking force in motor vehicle hydraulic brake systems. Brake fluids must have unique characteristics and should meet certain quality standards for the braking system such as SAE (Society of Automotive Engineers) International or US DOT (Department of Transportation).

The most common brake fluids are *ethylene glycol* based, which are used today and they are marked as DOT 3 (light vehicles; motorcycle), DOT 4 (general vehicles) and DOT 5 (silicone base) which can be differentiated by the degree of wet boiling point. The minimum wet boiling points specified by the DOT standards are, DOT 3 (140°C), DOT 4 (155°C) and DOT 5 (180°C) [1]. Based on availability of samples, only DOT 4 brake fluid was used in this paper.

Generally, *glycol based* brake fluids are used for double close circuit systems. These brake fluids hydrophilic characteristics may mix with water and become diluted over time during driving[2]. Due to this characteristic, if the brake fluid has not been replaced for a long period of time, it may cause a severe decline in braking power. Figure 1 illustrates the hydrophilic characteristics of brake fluids. The (O-H) structures between *ethylene glycol* and water bond easily through hydrogen bonding and cause added moisture to *ethylene glycol* (and other high *glycol*), which changes the characteristics and contaminate the fluid system over time [3].

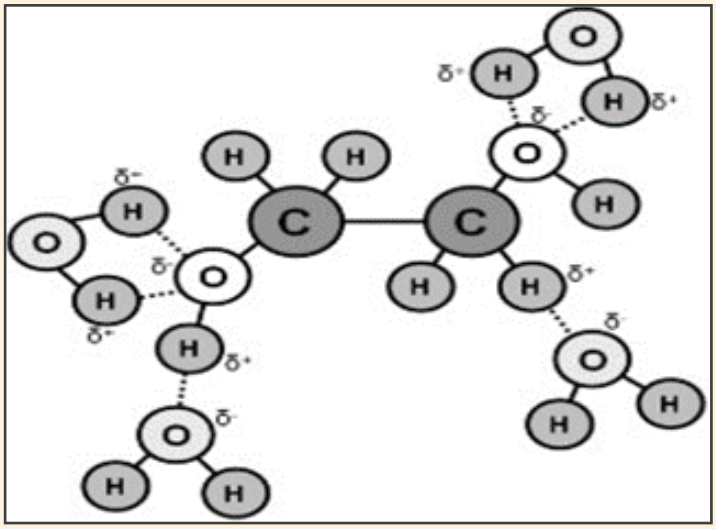

Figure 1: Illustration of ethylene glycol molecule absorbing and polymerizing the hydro molecules (water) through hydrogen bonding [3].

Poor viscosity of the brake fluids can result in much longer reaction time of the brake system in case of emergency. This fact can have far-reaching consequences as far as the operational safety of the vehicle is concerned. There are opinions that the water content must be limited as it increases the corrosiveness of brake fluids. Thus, previous researchers established that up to 1.5 % of water content in the brake fluids is in optimum, water content between 1.5% to 3 % is acceptable but must be changed soon and if it is over 3 %, the brake fluids must be changed immediately [4].

In this case study, apart from the negligence factor and driving above the speed limit in hilly areas, the percentage content of water in brake oil is also important in traffic accident investigation to determine the root cause as well as valuable information for risk assessment.

2 Materials and Methods

2.1 Sampling

A total of ten cases of road accidents resulting in deaths and serious injuries which occurred in the Klang Valley, Selangor, Malaysia since January to June 2020 were covered in this study. The main cause of these accident is due to failure to immediately stop the vehicle especially while down the hill road. The vehicles selection is also based on statement given by the witness and also from investigating officer. By using a clean syringe, 30 ml each of vehicle's brake fluid were filled into an amber glass bottles and being stored at room temperature upon analysis. The samples were taken from light vehicles involved, marked as K1 to K8 whereas K9 and K10 were taken from heavy vehicles trucks.

2.2 Identification Using Gas Chromatography Mass Spectrometer (GC-MS)

New DOT 4 commercial brake fluids were purchased from local stores as reference. While, used brake fluids were obtained from the selected accident vehicles by using a syringe and transferring it into an amber glass bottle. The color of all the samples were recorded and 1 ml of each sample were prepared in head space glass tube and heated at 90°C for 30 minutes. The vapor was injected in the Agilent gas chromatography mass spectrometer equipped with a HP 5ms Ultra Inert (15 m x 250 µm x 0.25 µm) column. Helium was used as the carrier gas at a 1.6 mL/min (set at 4°C) flow rate. The oven temperature was programmed as follows: 40°C for 2 min, then 25°C/min to 280°C and hold for 3 min.

2.3 Quantitative Determination of Water Contamination by Kinematic Viscosity

The viscosity – water standard calibration curve analysis was prepared by using unused commercial brake fluids which were diluted with deionized water to 0%, 2%, 3% and 5% respectively, meanwhile for samples 20 ml of each sample is used. The determination of the brake fluids kinematic viscosity for all the standard and samples were measured by Herzog Multi-Range Viscometer (HVM 472) at 100°C. After the calibration, the samples were analysed within viscosity range of 0.5 to 100 mm^2/s. The calibration results were printed and calibration curve was plotted by using Microsoft Excel Version 2002. The percentage of water contains in the all samples were calculated based on the linearity equation in the graph.

3 Results and Discussions

3.1 Description of Color

The color was recorded prior sampling. Based on observation (Table 1), the color of unused commercial brake fluids is lighter than used brake fluids. This may be due to contamination by grime and debris from the braking system and it might have absorbed some water which collectively contributes to color change[5]. Nevertheless, in this study, the functionality of the brake fluids could not be evaluated based on their color appearance only.

3.2 GC-MS analysis

Figure 2 shows the total ion chromatogram of the commercial brake fluid as a standard, while Figure 3 shows the total ion chromatogram of sample K2 as represents other samples. In the first chromatogram, it is possible to observe the presence of *diethylene glycol monoethyl ether* [CAS 111-90-0] at min 5.1, *triethylene glycol monobutyl ether* [CAS 143-22-6] at min 6.4 and *tetraethylene glycol monomethyl ether* [CAS 23783-42-8] at min 6.6.

The presence of the *diethylene glycol monoethyl ether* [CAS 111-90-0] compounds in all the sample chromatograms were typical for the brake fluids. Some samples contain additives such as *cyclohexanamine, n-cyclohexyl* [CAS 101-83-7] at min 6.2 which act as corrosion inhibitors [5].

Sample ID	Color
New Commercial Brake Fluid	Light yellow
K1	Yellow
K2	Red
K3	Yellow
K4	Dark yellow
K5	Dark Red
K6	Yellow
K7	Yellow
K8	Yellow
K9	Green
K10	Dark Brown

Table 1: New commercial brake fluid and ten samples color-comparison

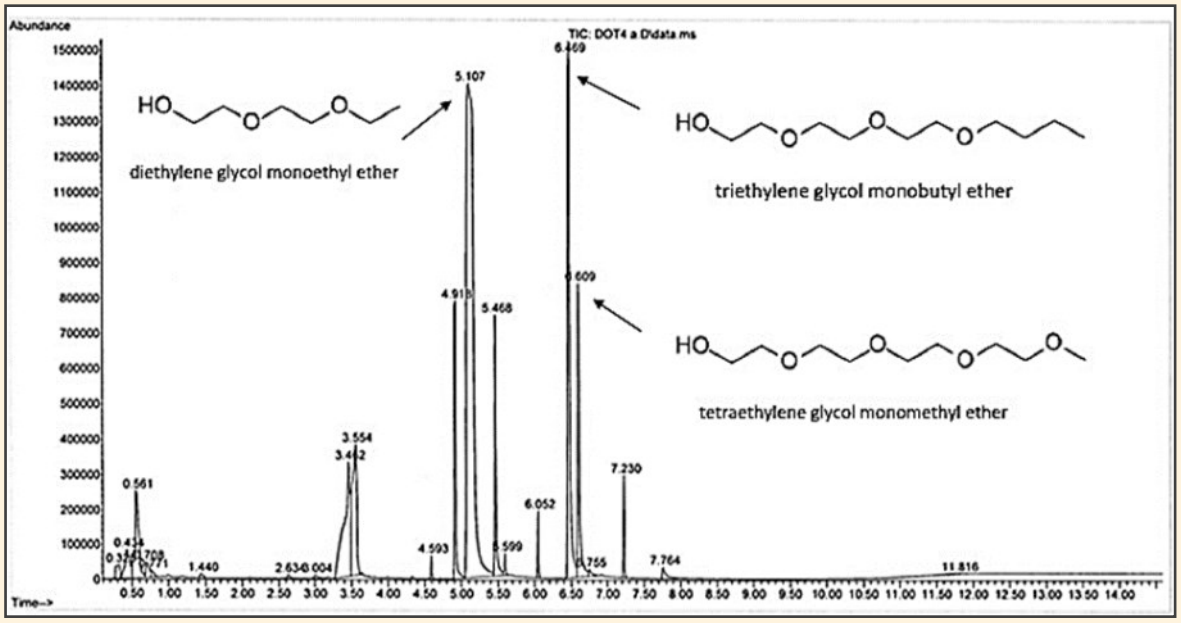

Figure 2: Total ion chromatogram of commercial brake fluids

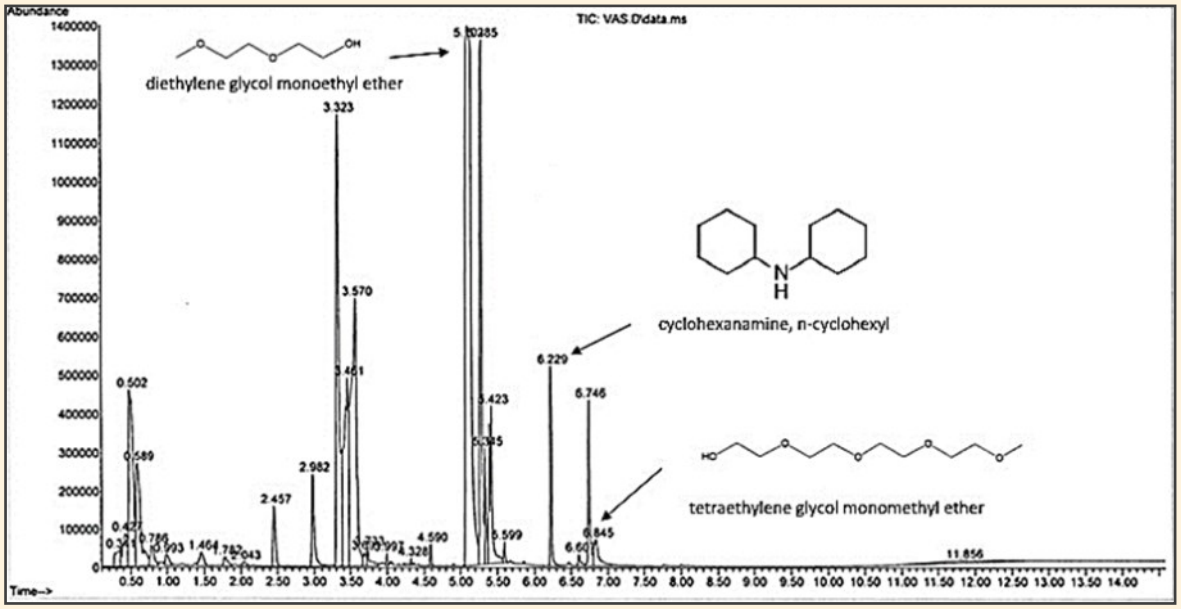

Figure 3: Total ion chromatogram of sample K2

3.3 Viscosity analysis

The results of dilution to 0%, 2%, 3% and 5% plotted to form a calibration curve of the brake fluid standard at 100°C and shown in Figure 4. The curve running through the values show that the brake fluids viscosity is inversely proportional to the percentage of water contamination in the brake fluid. Table 2 show the sample viscosity reading of all the samples measured by Herzog Multi-Range Viscometer (HVM 472). Summarized results show that six samples have less than 3% of water content which is ideal. The viscosity of remaining four samples is lower than 2.017 mm^2/s, which means that the water content is more than 3%, in this case studies two samples K9 and K10 recorded above 5% which is a critical value. The decrease in viscosity value is undesirable for the normal operation of braking system due to the adverse effects on the brake transmission, especially if the brake fluids temperature reaches 155°C[6] (when driving downhill or during abrupt intensive braking in high speed). Three samples K1, K2 and K6 have viscosity value above 0% this might be due higher viscosity of the particular commercial brake fluid used compared to the commercial brake fluid obtained for this study.

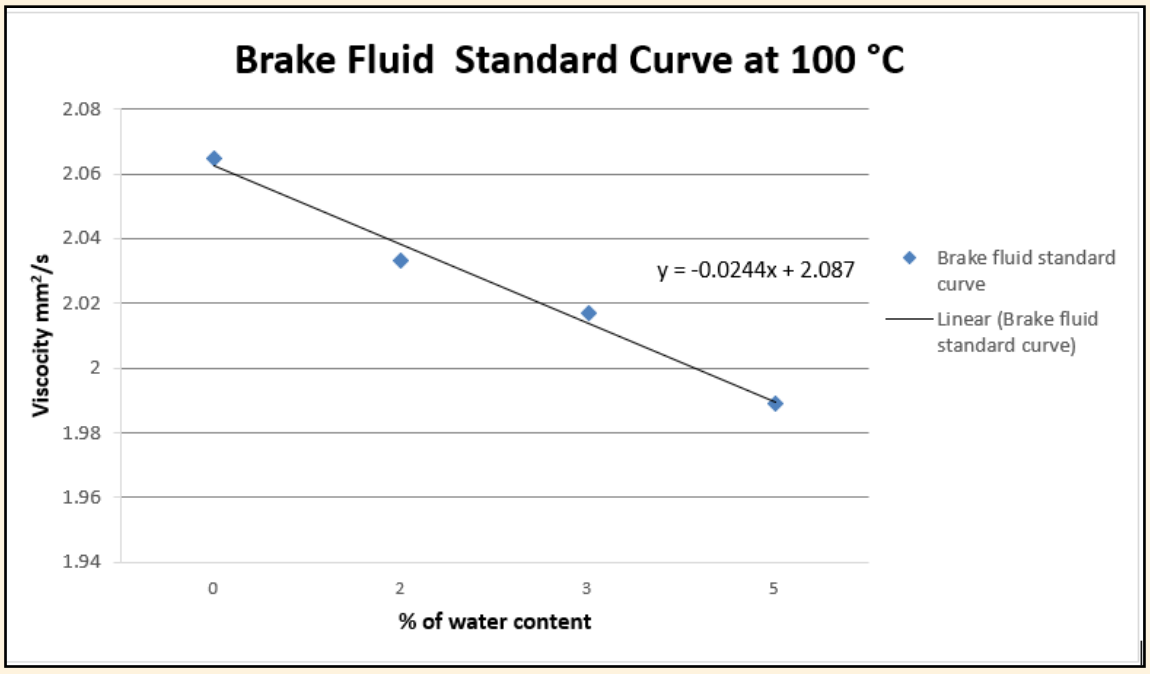

Figure 4: Calibration curve of the brake fluid standard

Sample ID	mm2/s	% of water
K1	2.150	<3
K2	2.090	<3
K3	2.052	<3
K4	1.997	>3
K5	2.044	<3
K6	2.130	<3
K7	1.970	>3
K8	2.029	<3
K9	1.740	>5
K10	1.936	>5

Table 2: Viscosity result of the samples

4 Conclusion

The headspace GC-MS method was used to identify the *ethylene glycol* as the main compound in brake fluids. Besides that, correlation between viscosity and brake fluid water content can be determined using the viscometer. This study has found with the rise in water content, the brake fluids viscosity decreases, resulting in dangerous effects on the normal functions of the brake system[7]. As this concerns road safety, the authors plan to expand the studies to various type of vehicles and larger sample size for viscosity analysis. However, by using advance analytical tools like portable refractometer[8] that limitation can be overcome but additional cost is quite challenging and to conduct the research is a major concern due to the current economic climate.

Acknowledgements

Special thanks to the Center of Analysis for Industry and Custom Tariff, Department of Chemistry Malaysia for contribution of viscosity test report.

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Detection of Delta-8-THC-COOH in Urine

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In recent years, the medical and recreational use of cannabis have been explored continuously and legalised in numerous countries. Many would be familiar with the main psychoactive cannabinoid, delta-9-tetrahydrocannabinol (delta-9-THC), but little attention has been paid to its double-bond isomer, delta-8-tetrahydrocannabinol (delta-8-THC) (Figure 1).

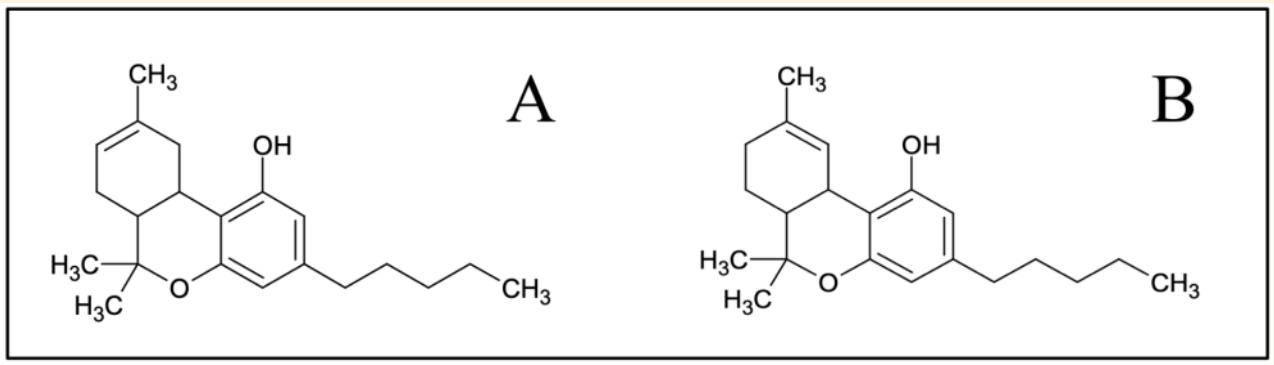

Figure 1 Chemical structures of A: delta-8-THC and B: delta-9-THC

Delta-8-THC is closely related to and is about two-third less potent than delta-9-THC[1]. In 1995, study was conducted by Dr Raphael Mechoulam in a Jerusalem children hospital, demonstrated the anti-emetic use of delta-8-THC during the cancer treatment of young children[2]. It also suggested that children may be treated with higher doses of delta 8-THC as they seem to be less susceptible to THC's anxiety-inducing effects[2]. With this breakthrough, interest in researching delta-8-THC as a potential therapeutic cannabinoid has developed over the years.

In Singapore, cannabis is one of the commonly abused drug besides methamphetamine and heroin, with delta-9-THC being the main cannabinoid found in the cannabis. Both delta-8-THC and delta-9-THC are listed as controlled drugs under the Misuse of Drugs Act (MDA).

Like many laboratories worldwide, the laboratory looks for 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid (delta-9-THC-COOH) in suspected cannabis abuser's urine for proof of cannabis consumption. In our laboratory, we received from the law enforcement agency one particular case of suspected cannabis abuse where the urine sample was screened positive for cannabinoids at approximately 854 ng/ml using Cobas c501 analyzer (KIMS). However, only 7 ng/ml of delta-9-THC-COOH was found in the confirmatory test using gas chromatography-mass spectrometer (GC-MS). The discrepancy between the screening and confirmation test results suggests other cannabinoid(s) could be present in the urine sample.

During the same period, an electronic cigarette containing brown viscous liquid was seized by the law enforcement agency and submitted to our drug testing laboratory for analysis (Figure 2). Upon analysis, the brown liquid was found to contain delta-8-THC and CBN (Figure 3).

Figure 2 Photo of an electronic cigarette containing brown viscous liquid (seized exhibit)

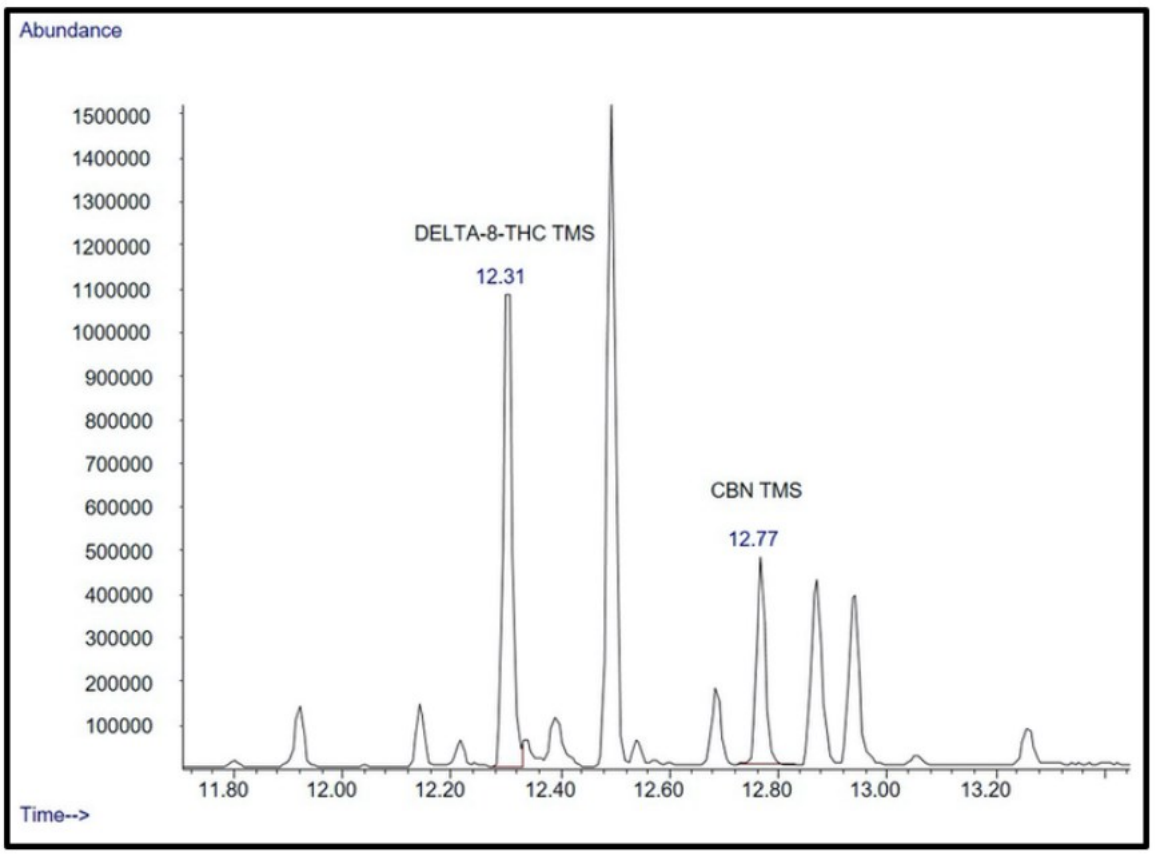

Figure 3 GC-MS total ion chromatogram (TIC) of the brown liquid sample

From the GC-MS SIM^2 chromatogram of the urine sample, an unknown peak was seen next to the delta-9 -THC-COOH peak (retention time of 5.267 min) in all three ions monitored (Figure 4). This unknown peak was eluted at a later retention time of 5.319 min and its intensity ratio for the three ions monitored were different from delta-9-THC-COOH reference standard.

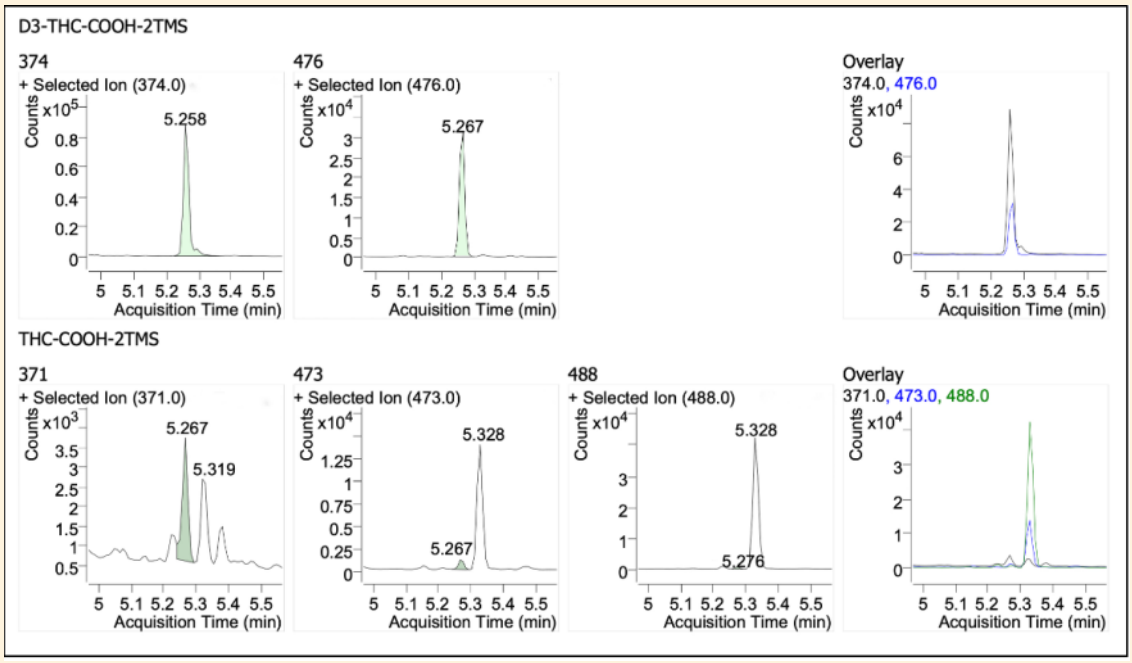

Figure 4 GC-MS SIM chromatogram of the urine sample of suspected cannabis abuse

To further investigate, the urine sample was analysed using a Thermo Scientific Q-Exactive Hybrid Quadrupole–Orbitrap mass spectrometer coupled with liquid chromatography (Orbitrap LC-MS) equipped with heated electrospray ionization source (HESI-II) and operated in the Full MS and data-dependent MS^2 (FS-ddMS^2) scanning mode. Without the presence of delta-8-THC-COOH reference standard, the identification of delta-8-THC-COOH in the sample was based on the accurate mass and the product ion spectra from the ddMS^2 scan (Figure 5).

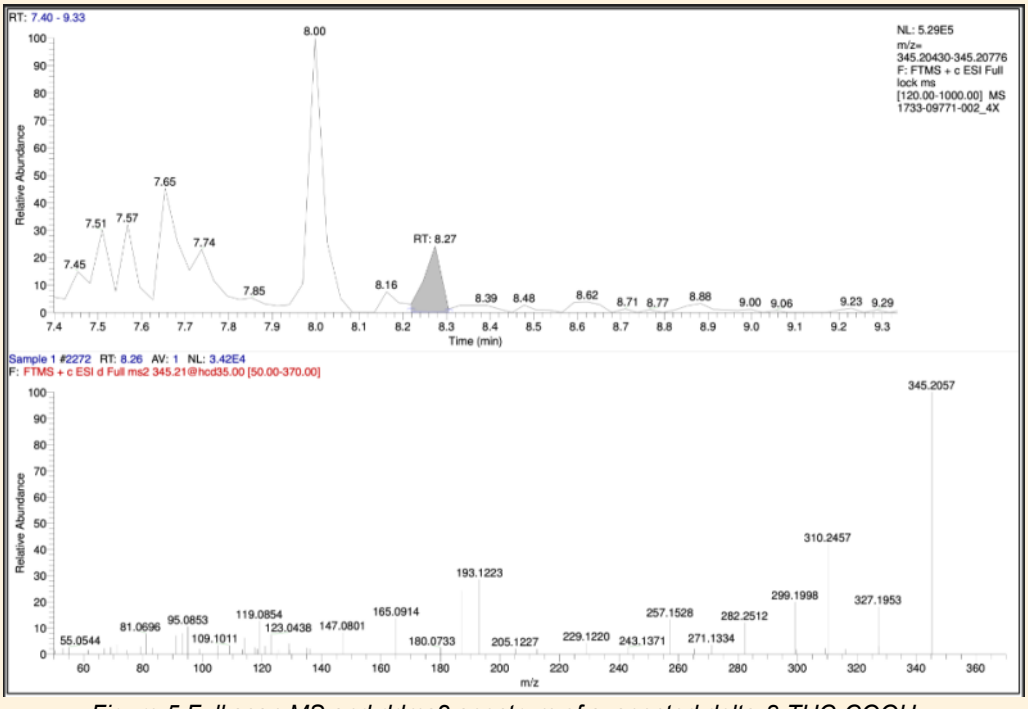

Figure 5 Full scan MS and ddms2 spectrum of suspected delta-8-THC-COOH in the urine sample

The reference material of delta-8-THC-COOH was subsequently purchased and analysed using GC-MS and Orbitrap LC-MS. From the GC-MS SIM and SCAN chromatograms, both delta-8-THC-COOH and delta-9-THC -COOH can be differentiated based on their retention times (a difference of about 0.06 min) and intensity ratio of the fragment ions (Figure 6 and 7).

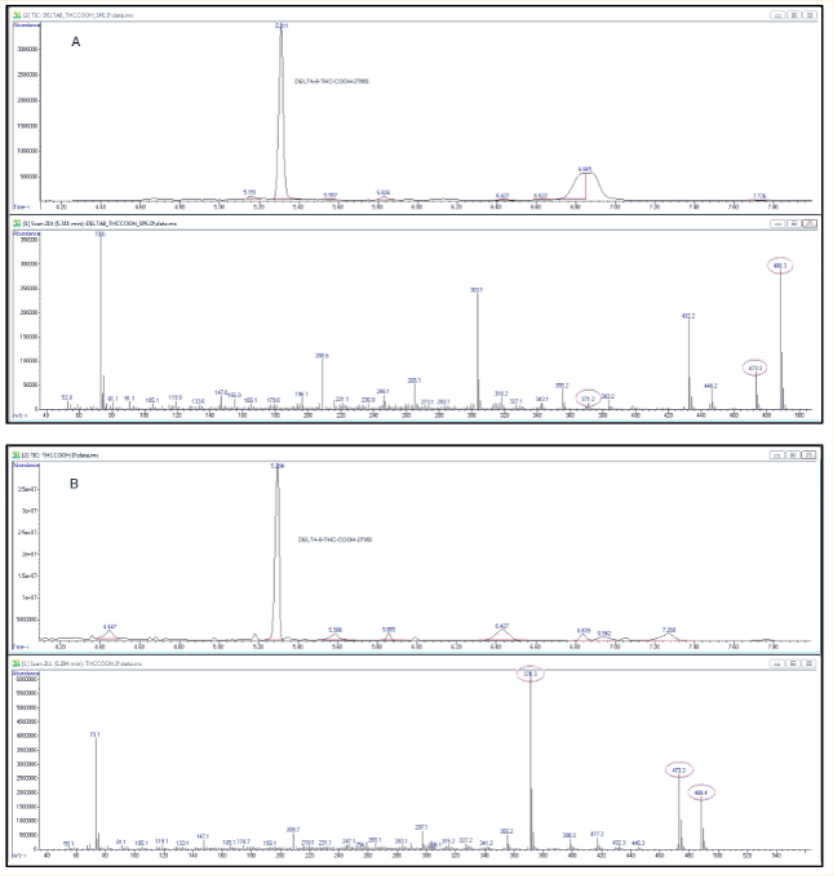

Figure 6 GC-MS total ion chromatograms and MS spectra of (A) delta-8-THC-COOH, and (B) delta-9-THC-COOH reference materials.

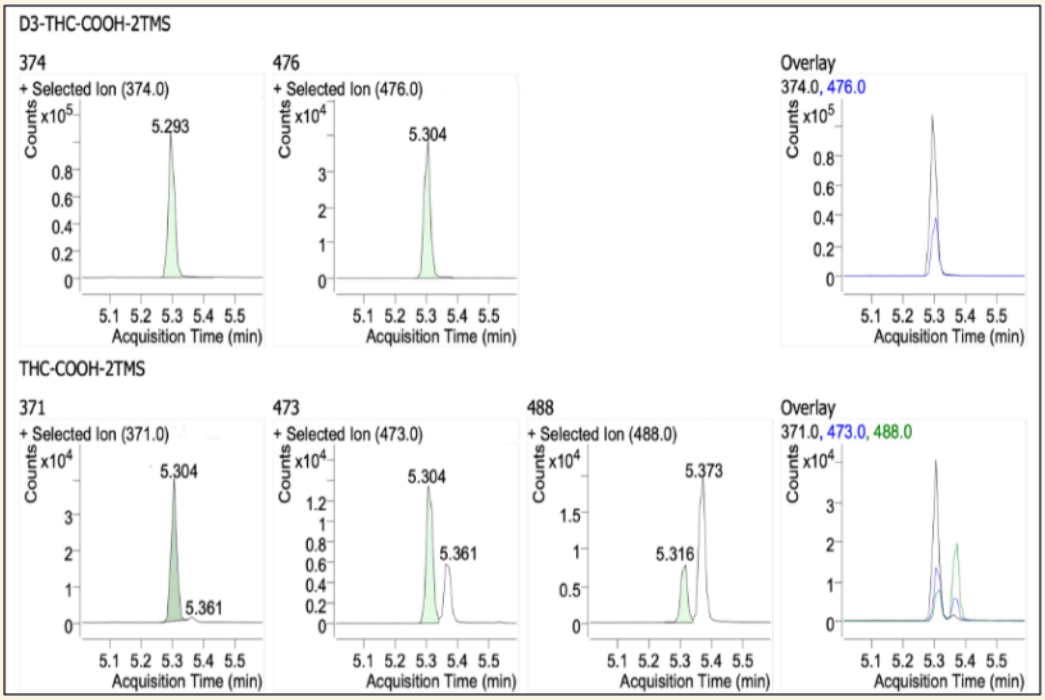

Figure 7 GC-MS SIM chromatogram of a mixture of delta-8-THC-COOH (5.361 min) and delta-9 -THC-COOH (5.304 min) reference materials, each spiked in a drug free urine at 200 ng/ml

As for the Orbitrap LC-MS analysis of the urine sample, the product ion spectra from the ddMS^2 scan (Figure 5) match the delta-8-THC-COOH reference material (Figure 8). Based on the analyses, the unknown peak detected in the urine sample (Figure 4) was confirmed to be delta-8-THC-COOH. In summary, the detection of delta-8-THC-COOH in the suspected drug abuser's urine sample is consistent with the consumption of delta-8-THC. This case study has brought up awareness that it is necessary to include delta-8-THC-COOH in the detection method for cannabis abusers.

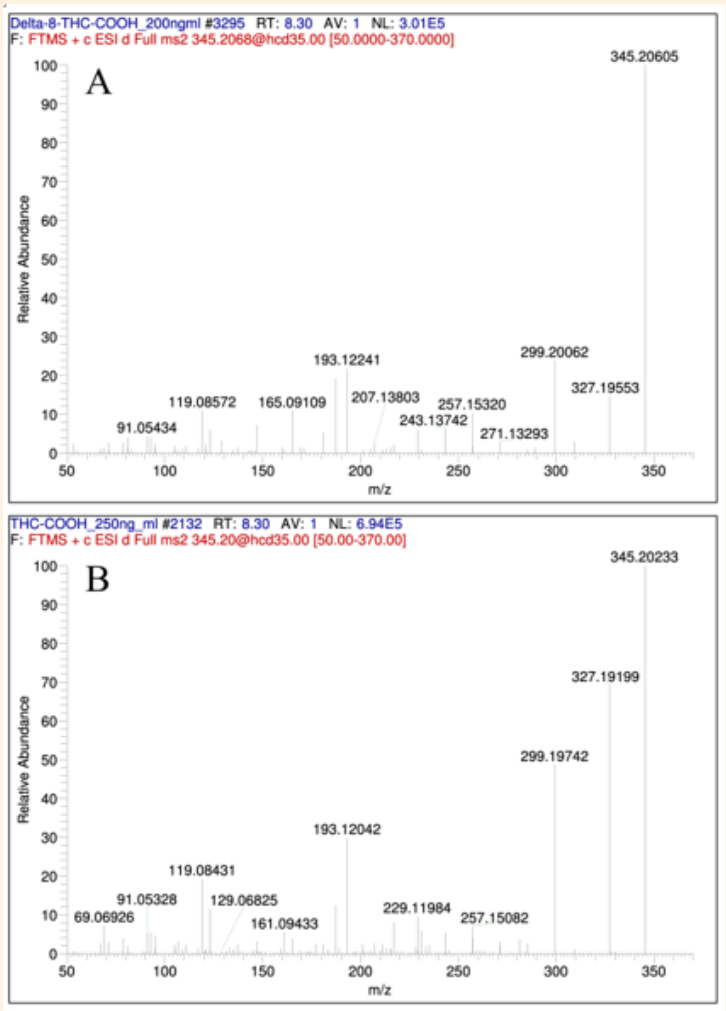

Figure 8 Orbitrap LC-MS ddms2 spectra of (A) delta--8-THC-COOH, and (B) delta-9-THC-COOH reference materials, each spiked in a drug free urine at 200 ng/ml

Acknowledgment

I would like to thank the Illicit Drugs Laboratory (Health Sciences Authority) for their contribution in providing information about the seized exhibit.

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AFSN Member Institutes

Country/Region	*No.*	*Name of Member Institute (as at December 2020)*
Bangladesh	1	National Forensic DNA Profiling Laboratory
Brunei Darussalam	2	Department of Scientific Services
India	3	Centre for DNA Fingerprinting and Diagnostics
	4	Directorate of Forensic Science, Himachal Pradesh
Indonesia	5	Department of Police Medicine of the Indonesian National Police
	6	Eijkman Institute for Molecular Biology
	7	Forensic Laboratory Centre of Indonesian National Police Headquarters
	8	Indonesian Association of Forensic Pathologist
	9	Laboratory of National Narcotics Board
	10	Master Program of Forensic Science, Postgraduate School, Universitas Airlangga
Lao PDR	11	Food and Drug Quality Control Center
Malaysia	12	CyberSecurity Malaysia
	13	Department of Chemistry
	14	Malaysian Communications and Multimedia Commission
	15	Royal Malaysia Police Forensic Laboratory
Mongolia	16	Mongolian National Institute of Forensic Science
People's Republic of China	17	Beijing Forensic Science Institute
	18	Forensic Science Center of Guangdong Provincial Public Security Department
	19	Forensic Science Division, Department of Fujian Provincial Public Security
	20	Guangzhou Forensic Science Institute
	21	Institute of Forensic Science, Ministry of Public Security
	22	Institute of Forensic Science, Dezhou Public Security Bureau
	23	Institute of Forensic Science, Hangzhou Public Security Department
	24	Institute of Forensic Science, Shandong Public Security Department
	25	Institute of Forensic Science, Suzhou Public Security Bureau
	26	Institute of Forensic Science, Tianjin Public Security Bureau
	27	The Institute of Evidence Law and Forensic Science, China University of Political Science and Law
	28	Forensic Science Division of the Government Laboratory, Hong Kong Special Administrative Region
	29	Forensic Science Department of Judiciary Police, Macau Special Administrative Region
Philippines	30	Laboratory Service, Philippine Drug Enforcement Agency
	31	National Bureau of Investigation
	32	National Reference Laboratory for Environmental and Occupational Health, Toxicology and Micronutrient Assay, East Avenue Medical Center, Department of Health
	33	Natural Sciences Research Institute, University of the Philippines Diliman Quezon City
	34	Philippine National Police
Republic of Kazakhstan	35	Forensic Examinations Centre of the Ministry of Justice

Country/Region	*No.*	*Name of Member Institute (as at December 2020)*
Republic of Korea	36	Daejeon Health Institute of Technology, Daejeon Health Sciences University
	37	Graduate School of Forensic Science, Soon Chun Hyang University
	38	Korea Coast Guard Research Institute
	39	National Digital Forensic Center of Supreme Prosecutors' Office
	40	National Forensic Service
	41	Scientific Investigation Center of Korean National Police Agency
	42	Scientific Investigation Laboratory, Ministry of National Defense
Singapore	43	Corrupt Practices Investigation Bureau
	44	Health Sciences Authority
	45	Ministry of Home Affairs
Sri Lanka	46	Government Analyst's Department
	47	National Dangerous Drugs Control Board
Thailand	48	Central Institute of Forensic Science
	49	Department of Forensic Medicine, Faculty of Medicine, Chulalongkorn University
	50	Department of Forensic Medicine, Faculty of Medicine, Siriraj Hospital, Mahidol University
	51	Department of Medical Sciences
	52	Department of Forensic Medicine, Thammasat University Hospital
	53	Faculty of Medicine, Chiang Mai University
	54	Human Genetics Unit, Department of Pathology, Faculty of Medicine, Ramathibodi Hospital
	55	Institute of Forensic Medicine, Police General Hospital, The Royal Thai Police
	56	Office of Narcotics Control Board
The Republic of the Union of Myanmar	57	Defence Services Medical Research Centre
Timor-Leste	58	POLÍCIA CIENTÍFICA DE INVESTIGAÇÃO CRIMINAL - LABORATÓRIO DE POLÍCIA CIENTÍFICA
Vietnam	59	Forensic Medicine Center of Ho Chi Minh City
	60	National Institute of Forensic Medicine
	61	Forensic Science Institute Vietnam