UNIVERSITI PUTRA MALAYSIA

METHOD OF EVENT RECONSTRUCTION IN DIGITAL INVESTIGATION AND ITS VISUALIZATION

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FSKTM 2011 2
METHOD OF EVENT RECONSTRUCTION IN DIGITAL INVESTIGATION
AND ITS VISUALIZATION

By

MOHD TAUFIK ABDULLAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

January 2011
I would like to dedicate my work to my beloved wife; Wan Sakiah Wan Oman, my sons; Muhammad Syamsi, Abdul Muhaimin, and Muhammad Afifuddin, my daughter; Nur Wahidah and Ajlaa Bazilah and my family.
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Chairman : Associate Professor Ramlan Mahmod, PhD
Faculty : Computer Science and Information Technology

A reconstruction of sequences of events that leads to a suspicious incident is an important phase in digital forensics investigation. Event reconstruction answers the question concerning the existence of digital object within computer at any particular time either triggered by an event or an effect of an event. Various event reconstruction techniques are used for representing the sequence of event that caused presence of the digital objects.

The reconstruction of events in digital investigations is fairly complicated. Unaided reasoning is usually insufficient to comprehensively analyze the sequence of events to identify suspect, apprehend the guilty and defend the innocent. Most present techniques lacks of thoroughness, relevancy, and user friendliness. A development of a sound technique which could reduce the possibility of reasoning errors and hence increases the effectiveness of the analysis is crucial.
This research defines a new method of event reconstruction which associates the capability to handle infinite set of incident scenarios, determine the relevancy of witness statements, and visualize all possibilities of incident scenarios. This study proposed a new method for representing the functionality of system under investigation as well as evidential statements. Some previous works only represent the functionality of the system under investigation as Finite State Machine (FSM). In the proposed method, the functionality of the system under investigation is represented as FSM whereby witness statement is represented as regular expression. An algorithm is developed to derive a Deterministic Finite Automaton (DFA) that accepts computations of FSM that represent the functionality of system under investigation. Similarly, the regular expression is transformed into another DFA using standard algorithms. Finally, the two DFAs are intersected to produce another DFA known as Diagram of Digital Event Reconstruction and Analysis (DDERA).

Having both the functionality of system under investigation and evidential statement represented as DFAs, the event reconstruction is reduced to the problem of automata intersection. The proposed method of event reconstruction in this research has an ability to represent infinite sets of incident scenarios. Therefore, it is capable of handling problematic even transition graphs with loops. Moreover, it allows relevancy checking among given statements themselves as well as against the representation of the functionality of system under investigation. Visualization of all possible scenarios of incident in graphical manner facilitates efficient insight gaining into digital evidence. Above all, the whole research formalizes and automates digital forensic analysis into a new horizon.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KAEDAH PEMBINAAN SEMULA URUTAN PERISTIWA DALAM PENYIASATAN DIGITAL DAN PENGAMBARANNYA

Oleh

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Januari 2011

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Pembinaan semula urutan peristiwa yang memberi petunjuk ke arah sesuatu kejadian yang mencurigakan adalah satu fasa yang mustahak di dalam penyiasatan forensiks digital. Pembinaan semula akan menjawab persoalan berkenaan dengan kewujudan objek digital di dalam komputer pada suatu masa tertentu sama ada dicetuskan oleh suatu peristiwa atau kesan daripada suatu peristiwa. Pelbagai teknik pembinaan semula peristiwa yang digunakan untuk mewakilkan urutan peristiwa yang menyebabkan satu objek digital wujud.

Membina semula peristiwa dalam penyiasatan digital agak rumit. Penaakulan tanpa bantuan biasanya tidak mencukupi untuk mengupas secara menyeluruh urutan peristiwa tersebut untuk mengenal pasti orang yang disyaki, memahami orang yang bersalah dan membela orang yang tidak bersalah. Kebanyakan teknik yang ada kurang kesempurnaan, kerelevanan dan ramah pengguna. Pembinaan satu teknik
yang kuku yang dapat mengurangkan kebarangkalian kesilapan penaaikan dan seterusnya meningkatkan keberkesanan analisis adalah sangat penting.

Penyelidikan ini mentakrifkan satu kaedah baharu pembinaan semula peristiwa yang menggabungkan keupayaan untuk mengendalikan set senario kejadian tak terhingga, menentukan kerelevanan kenyataan saksi dan dapat menggambarkan segala kemungkinan senario kejadian.


Memiliki kedua-dua fungsian sistem yang sedang disiasat dan kenyataan keterangan yang digambarkan sebagai automata berketentuan terhingga, pembinaan semula peristiwa diturunkan ke masalah persilangan automat. Kaedah pembinaan semula peristiwa yang dicadangkan di dalam penyelidikan ini berkemampuan untuk
I could not have completed this research work without endless guidance, help, blessings and motivation from Allah the Almighty. I also extend my sincere gratitude to a number of people, who deserve special thanks. Foremost of all, I would like to express my deep and sincere gratitude to my supervisory committee, Associate Professor Dr Ramlan Mahmod, Professor Dr Abdul Azim Abd. Ghani, and Professor Dr Abdullah Mohd Zain for their guidance, support, constructive advice, insight, and helpful suggestions throughout the year. A special thank goes also to Dr Pavel Gladyshev at the Department of Computer Science, University College Dublin for his valuable suggestions and insight regarding my project and for his comments in relation to several drafts. I also extend my special thank to Mr. Mohamad Afendee Mohamed for his help and comments.

Finally, I would like to express my deepest gratitude for the constant support, understanding, sacrifice, patience and love that I received from my beloved wife, sons and daughters, without which this thesis would not have been possible.
I certify that an Examination Committee has met on 25 January 2011 to conduct the final examination of Mohd Taufik b Abdullah on his degree thesis entitled “Method of Event Reconstruction in Digital Investigation and Its Visualization” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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Date:
DECLARATION

I declare that the thesis is my own work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MOHD TAUFIK ABDULLAH

Date: 25 January 2011
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