Faculty of Information and Communication Technology

HYBRID NEURAL NETWORK IN MEDICOLEGAL DEGREE OF INJURY DETERMINATION BASED ON VISUM ET REPERTUM

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Doctor of Philosophy

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A thesis submitted
in fulfillment of the requirements for the degree of Doctor of Philosophy

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this thesis entitled “Hybrid Neural Network in Medicolegal Degree of Injury Determination Based on Visum Et Repertum” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : Mohammad Hadyan Wardhana

Date : 6 January 2023

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

Signature : ……..……

Supervisor Name : Professor Dr. Abd Samad bin Hasan Basari

Date : 6 January 2023

DEDICATION

This research is dedicated to the almighty Allah SWT for giving me a good health and strength to finish this research without sense of desperation.

Special dedicated to my beloved family, Mr. Professor Dr. Zulkarnaini Saleh M.Si., Mrs. Darmalina S. Sos., Mr. Mohd Dwira Wardhani, S.KG., Mrs. Mega Purnamasari. M.IKOM, Ms. Alisha Azkayra Wardhana for providing support and encourangement for my journey.

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ABSTRACT

Essentially, determination model for degree of injury is crucial for refining diagnostic and increasing accuracy of the Forensic and Medicolegal services. Existing models are deemed difficult in identifying the critical features. These are due to the model having insufficient of critical features analysis that cause the inconsistency decision to determine degree of injury among the medical practitioners. The issue become more complex because the dataset consists of incomplete data and outliers class problem that can affects the sampling bias. The purpose of this study is to identify the characteristics and terms, develop and evaluate the Hybrid Neural Network Model (HNNM) for determining degree of injury based on Visum et Repertum (VeR) data. The VeR data consist of 289 patients' record. The HNNM is expected to determine either the persecution victim having a minor, moderate, or serious injury which inclusively mention in Indonesian Penal Code. HNNM is developed based on the case studies at three hospitals in Pekanbaru comprise three main phases which are pre-processing, development, and performance analysis. Pre-processing phase overcomes the issue of incomplete data by performing data cleansing and data normalization. The development phase begins with utilizing Analytical Hierarchical Process (AHP) to validate the ranking for each of weight on the critical features from the experts' opinion. Then, the selection of the critical features is chosen via Neural Network (NN) as classification algorithm and Genetic Algorithm (GA) as an optimization technique. The selected critical features are applied during the dataset training stages to improve the accuracy and reduce error of the HNNM. GA is aimed to increase the accuracy and minimize the error in the learning stages of NN. The development phase accomplished with testing stages by employing VeR dataset. The performance analysis shows the HNNM produced 98.85% accuracy level and Root Mean Square Error (RMSE) value at 0.077. In the validation stage, the questionnaires are answered by the Subject Matter Expert (SME) groups which consist of feature, implementation, and viability aspect of HNNM. Result from the questionnaires concluded that the agreement level of SMEs reaches up to 80%. Thus, the features of the HNNM are implementable and highly acceptable by the practitioner. For the future research, the HNNM need to increase the accuracy by improving the input features including lifestyle, habit, and job.

HIBRID RANGKAIAN NEURAL DALAM PENENTUAN DARJAH KECEDERAAN MEDICOLEGAL BERDASARKAN KEPADA VISUM ET REPERTUM

ABSTRAK

Pada asasnya, model penentuan untuk darjah kecederaan adalah penting untuk memperhalusi diagnostik dan meningkatkan ketepatan perkhidmatan Forensik dan Medikolegal. Model sedia ada dianggap sukar dalam mengenal pasti ciri-ciri kritikal. Ini disebabkan oleh model yang tidak mempunyai analisis ciri-ciri kritikal yang menyebabkan keputusan tidak konsisten dalam menentukan darjah kecederaan di kalangan pengamal perubatan. Isu ini menjadi lebih rumit kerana set data terdiri daripada data tidak lengkap dan masalah data terasing yang dapat mempengaruhi bias pensampelan. Tujuan kajian ini adalah untuk mengenal pasti ciri-ciri dan istilah, membangun dan mengesahkan model rangkaian neural hibrid (HNNM) untuk menentukan darjah kecederaan berdasarkan data Visum et Repertum (VeR). Data VeR terdiri daripada 289 rekod pesakit. HNNM dijangka dapat menentukan sama ada mangsa penganiayaan yang mengalami kecederaan kecil, sederhana atau serius yang secara keseluruhan disebutkan dalam Kanun Keseksaan Indonesia. HNNM yang dibangunkan adalah berdasarkan kajian kes di tiga hospital di Pekanbaru yang terdiri daripada tiga fasa utama iaitu pra-pemprosesan, pemodelan, dan analisis prestasi. Fasa pra-pemprosesan dapat mengatasi isu data yang tidak lengkap dengan melakukan pembersihan data dan penormalan data. Fasa pembangunan bermula dengan menggunakan Proses Hierarki Analitik (AHP) untuk mengesahkan kedudukan untuk setiap pemberat pada ciri-ciri kritikal dari pendapat pakar. Kemudian, pemilihan ciri-ciri kritikal dipilih melalui Rangkaian Neural (NN) sebagai algoritma klasifikasi dan Algoritma Genetik (GA) sebagai teknik pengoptimuman. Ciri-ciri kritikal yang dipilih diterapkan semasa peringkat latihan set data untuk meningkatkan ketepatan dan mengurangkan ralat HNNM. GA bertujuan untuk meningkatkan ketepatan dan meminimumkan kesilapan dalam tahap pembelajaran NN. Fasa pembangunan dicapai dengan tahap ujian dengan menggunakan set data VeR. Analisis prestasi menunjukkan HNNM menghasilkan paras ketepatan 98.85% dan nilai Ralat Punca Min Kuasa Dua (RMSE) pada 0.077. Dalam peringkat pengesahan, soal selidik dijawab oleh Pakar Bidang (SME) yang terdiri daripada ciri-ciri, pelaksanaan dan aspek daya maju HNNM. Hasil dari soal selidik menyimpulkan bahawa paras kesepakatan SMEs mencapai 80%. Oleh itu, ciri-ciri HNNM boleh dilaksanakan dan boleh diterima oleh pengamal. Untuk kajian masa depan, HNNM perlu meningkatkan ketepatan dengan meningkatkan ciri-ciri input termasuk gaya hidup, tabiat dan pekerjaan.

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LIST OF ABBREVIATIONS

A	-	Age
AHP	-	Analytical Hierarchy Process
AB	-	Abrasion
AI		Artificial Intelligence
AIS	-	Abbreviated Injury Scale
AIVR	-	Artificial Intelligent Virtual Reality
AP	-	Anatomic Profile
APACHE	-	Acute Physiology and Chronic Health Evaluation
ASCOT	-	A Severity Characterization of Trauma
AUC	-	Area Under Curve
BL	-	Blunt Injury
BL	-	Bleeding
CO	-	Contusion
CRTs	-	Coded Revise Trauma Score
CW	-	Chop Wound
DL	-	Deep Learning
DRISS	-	Drug-Rock Injury Severity Score
DT	-	Decision Tree
ES	-	Expert System
ESI	-	Emergency Severity Index
F	-	Fracture
FIS	-	Fuzzy Inference System
FL	-	Fuzzy Logic
GA	-	Genetic Algorithm
GAP	-	Glasgow Coma Scale, Age, and Systolic Blood Pressure
GCS	-	Glasgow Comma Scale
HARM	-	Harborview Assessment for Risk of Mortality
HNNM	-	Hybrid Neural Network Model
ICD	-	International Classification of Disease, Ninth Revision
ICISS	-	International Classification of Disease-base ISS
IID	-	Intelligent Injury Determination Model
ISS	-	Injury Severity Score

IW	-	Incised Wound
LA	-	Laceration
LOC	-	Level of Consciousness
LR	-	Logistic Regression
MAIS	-	Maximum Abbreviated Injury Scale
ML	-	Machine Learning
MTOS	-	Major Trauma Outcome Study
NB	-	Naïve Bayes
NISS	-	New Injury Severity Score
NN	-	Neural Network
NSP	-	National Sample Project
NTDB	-	National Trauma Data Bank
OID	-	Optimize Injury Determination Model
OIS	-	Organ Injury Scale
PATI	-	Penetrating Trauma Index
PE	-	Penetrating Injury
PEFR	-	Peak Expiratory Flow Rate
PGCS	-	Pediatric Glasgow Coma Scale
PI	-	Prognostic Index
PIW	-	Penetrating Incised Wound
POLRI	-	Kepolisian Negara Republik Indonesia
PS	-	Probability of Survival
PTS	-	Pediatric Trauma Score
Pulse Oximetry	-	SpO2
RMSE	-	Root Mean Square Error
ROC	-	Receiver Operator Curve
RR	-	Respiration Rate
RTS	-	Revise Trauma Score
S	-	Sex
SAPS	-	Simplified Acute Physiology Score
SBP	-	Systolic Blood Pressure
SRRs	-	Survival Risk Ratio
SVM	-	Support Vector Machine
T	-	Temperature
TARN Ps14	-	The Trauma Audit and Research Network
TBW	-	Type of Blunt Injury
TI	-	Trauma Index
TMPM	-	Trauma Mortality Prediction Model
TPW	-	Type of Penetrating Injury

TRISS	-	Trauma Score Injury Severity Score
TS	-	Trauma Score
UTeM	-	Universiti Teknikal Malaysia Melaka
VeR	-	Visum et Repertum
WCFI	-	Weighted Critical Feature of Injury Determination Model
WHO	-	World Health Organization

LIST OF SYMBOLS

$\chi 2$	-	Chi-Square
ƛ	-	Lambda
$\sum$	-	Sigma
e	-	Variance in predictive value of Neural Netwwork
α	-	Learning Rate
δ	-	Delta
μ	-	Momentum
$\Delta\varepsilon$	-	The maximum number of iterations to reach convergence

LIST OF PUBLICATIONS

1. Wardhana, M. H., Hasan Basari, A.S., Ibrahim, N.K., Wan Yaacob, W.Z., 2022. Novel Hybrid Trauma Injury Classification based on Trauma Revise Injury Severity Score (TRISS) and Visum et Repertum (VeR) Features. *International Journal of Engineering Trends and Technology*, 70(7), pp. 462–470.

2. Wardhana, M. H., Hasan Basari, A. S., Mohd Jaya, A. S., Afandi, D., 2019. A Hybrid Model using Artificial Neural Network and Genetic Algorithm for Degree of Injury Determination. *International Journal of Innovative Technology and Exploring Engineering*, 9(2), pp. 1357–1365.

3. Wardhana, M. H., Hussin, B., Hasan Basari, A. S., Afandi, D., 2018. Enhanced Degree of Injury Classification Model: Determination Critical Indicator and Criteria Degree of Injury from Visum et Repertum (Ver) in Pekanbaru, Indonesia. *Egyptian Journal of Forensic Sciences*, 8(1), pp. 1-10.

4. Wardhana, M. H., and Fatriah, S., 2018. Degree of Injury on Visum et Repertum. *Journal of Forensic & Genetic Science*, 1(1), pp. 7-8.

CHAPTER 1

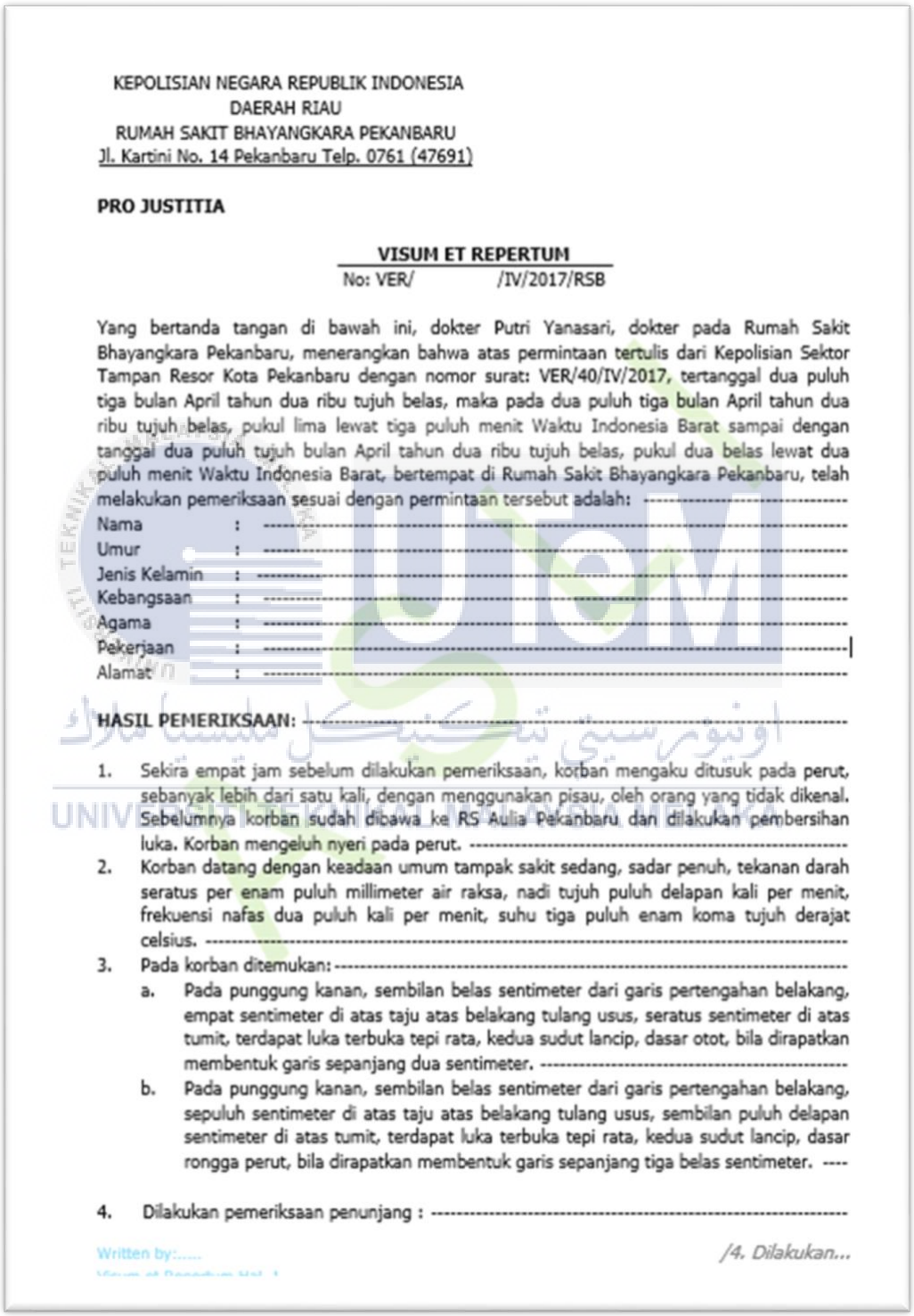
INTRODUCTION

1.1 Introduction

Trauma injury is a critical cause of disability, death and survival of a severe injured person depends on the specialized treatment delivered in a timely manner (Saleh et al., 2018). Determining the likelihood or probability of survival in trauma injuries is essential for the triage, research, and the priority of treatment (Rau et al., 2019). Trauma scoring system can be valuable for several situations. Probability of survival affected by various parameters include the extend location of the body injuries, type of the injuries, host factors such as gender, age, and pre-existing medical condition. The applicability of the parameters is used in medicolegal science which is related with the healthcare field. It is used to determine a variety of trauma experience from patients in clinical practices that written on Visum et Repertum (VeR) documents. The purpose of this process is to classify the result in terms of identify and analyze the type of treatment that could lead to further medication (Theodoraki et al., 2010). This process is also being used as valid evidence to enforce the law and justice during the pretrial hearing in court (Azhari et al., 2012); (Fatriah et al., 2017).

The method of trauma scoring assessment can be categorized as physiological, anatomical and combination of both (Saleh et al., 2017). Medical practitioners begin with the medical diagnostic check-up, treat victims and issue medicolegal reports. The aim is to support the law enforcement process to an injured victims (Barek and Haque, 2013). Currently, the medical practitioners receive the request from the victims itself to issue the medical report and certificate which requires to begin the legal action against someone with an offense or crime (Barek and Haque, 2013). These procedures are conducted to both life

and death victims. Visum et Repertum (VeR) is one of the valid evidences that contains the result of forensic medical examinations to the victim. Figure 1.1 shows the form of Visum et Repertum (VeR).



KEPOLISIAN NEGARA REPUBLIK INDONESIA
DAERAH RIAU
RUMAH SAKIT BHAYANGKARA PEKANBARU
Jl. Kartini No. 14 Pekanbaru Telp. 0761 (47691)

PRO JUSTITIA

VISUM ET REPERTUM
No: VER/ /IV/2017/RSB

Yang bertanda tangan di bawah ini, dokter Putri Yanasari, dokter pada Rumah Sakit Bhayangkara Pekanbaru, menerangkan bahwa atas permintaan tertulis dari Kepolisian Sektor Tampan Resor Kota Pekanbaru dengan nomor surat: VER/40/IV/2017, tertanggal dua puluh tiga bulan April tahun dua ribu tujuh belas, maka pada dua puluh tiga bulan April tahun dua ribu tujuh belas, pukul lima lewat tiga puluh menit Waktu Indonesia Barat sampai dengan tanggal dua puluh tujuh bulan April tahun dua ribu tujuh belas, pukul dua belas lewat dua puluh menit Waktu Indonesia Barat, bertempat di Rumah Sakit Bhayangkara Pekanbaru, telah melakukan pemeriksaan sesuai dengan permintaan tersebut adalah: ----------

Nama : ----------
Umur : ----------
Jenis Kelamin : ----------
Kebangsaan : ----------
Agama : ----------
Pekerjaan : ----------
Alamat : ----------

HASIL PEMERIKSAAN: ----------

1. Sekira empat jam sebelum dilakukan pemeriksaan, korban mengaku ditusuk pada perut, sebanyak lebih dari satu kali, dengan menggunakan pisau, oleh orang yang tidak dikenal. Sebelumnya korban sudah dibawa ke RS Aulia Pekanbaru dan dilakukan pembersihan luka. Korban mengeluh nyeri pada perut. ----------
2. Korban datang dengan keadaan umum tampak sakit sedang, sadar penuh, tekanan darah seratus per enam puluh millimeter air raksa, nadi tujuh puluh delapan kali per menit, frekuensi nafas dua puluh kali per menit, suhu tiga puluh enam koma tujuh derajat celsius. ----------
3. Pada korban ditemukan: ----------
   a. Pada punggung kanan, sembilan belas sentimeter dari garis pertengahan belakang, empat sentimeter di atas taju atas belakang tulang usus, seratus sentimeter di atas tumit, terdapat luka terbuka tepi rata, kedua sudut lancip, dasar otot, bila dirapatkan membentuk garis sepanjang dua sentimeter. ----------
   b. Pada punggung kanan, sembilan belas sentimeter dari garis pertengahan belakang, sepuluh sentimeter di atas taju atas belakang tulang usus, sembilan puluh delapan sentimeter di atas tumit, terdapat luka terbuka tepi rata, kedua sudut lancip, dasar rongga perut, bila dirapatkan membentuk garis sepanjang tiga belas sentimeter. ----
4. Dilakukan pemeriksaan penunjang : ----------

Written by:.....
/4. Dilakukan...

Figure 1.1: Example of Visum et Repertum form