

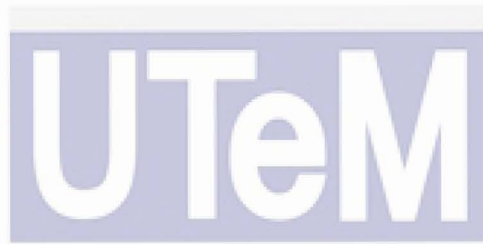
**REAL TIME PREDICTIVE ANALYTICS AND ACTIONABLE INSIGHTS
FOR WATER INTAKE ON WEARABLE DEVICE**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REAL TIME PREDICTIVE ANALYTICS AND ACTIONABLE INSIGHTS
FOR WATER INTAKE ON WEARABLE DEVICE**

HOW CHUN SIONG



This report is submitted in partial fulfillment of the requirements for the Bachelor of
Computer Science (Artificial Intelligence)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

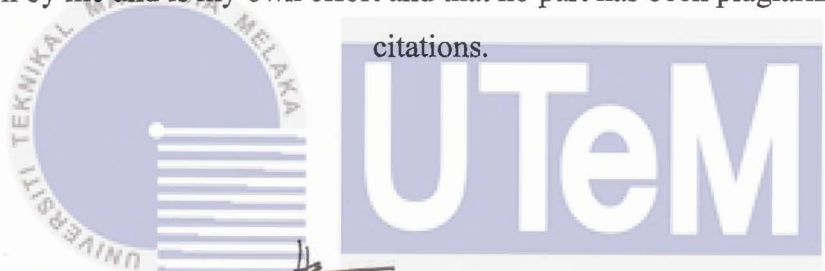
FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I hereby declare that this project report entitled
**REAL TIME PREDICTIVE ANALYTICS AND ACTIONABLE INSIGHTS
FOR WATER INTAKE ON WEARABLE DEVICE**

is written by me and is my own effort and that no part has been plagiarized without citations.



STUDENT : _____ Date: 27 AUGUST 2017

اويونر سي تي تيك نيك ماليسيا ملاك
(HOW CHUN SIONG)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

I hereby that I have read this project report and found this project report is sufficient
in

terms of the scope and quality for the award of

Bachelor of Computer Science (Artificial Intelligence) with Honours

SUPERVISOR: _____

[Signature]
(DR. CHOO YUN HUOY)

Date: 28 August 2017

DEDICATION

I dedicate my final year project report to my family, lecturers of the Department of Intelligent Computing and Analytic and also my friends. I would also like to show my gratitude to my project supervisor, Assoc. Prof. Choo Yun Huoy, for helping and guiding me throughout the project timeline. I would like to show my deepest gratitude to my parents for being supportive in many aspects while completing this project. My family members have been very encouraging while giving constructive ideas for this project. Finally, I would like to dedicate this project to all my friends who helped me regarding this project.

اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ACKNOWLEDGEMENT

I would like to show my gratitude to the following respected people in helping me to complete this project. Firstly, I would like to show my gratitude to my project supervisor, Assoc. Prof. Choo Yun Huoy and my project evaluator Dr. Abdul Syukor Mohamad Jaya who have given me constructive comments, guidance and support throughout this project. Next, I would like to thank my parents for being supportive in many aspects to finish this project successfully. I would like to thank my course mates for helping me to test and solve the technical and logical issues regarding my system.

اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ABSTRACT

Now a day, many people will try to use wearable device to track their fitness and health performance. In the market, there are many brands of the fitness band but majority of them do not provide any intelligence features inside like actionable insight or suggestion to user especially in suggestion for water requirement. Water requirement is based on respiratory water loss, urine loss, insensible water loss, metabolic water production and fecal loss. The total water requirement is sum of respiratory water loss, urine loss, insensible water loss and fecal loss, then minus metabolic water production. The wearable device will send the real time data into database and it will analyze to give suitable actionable insight like cup of water intake and dehydration level to user. There are three objectives of this project which are to develop a real time module that can give predictive analytics for volume of water requirement, to generate actionable insight from predictive analytics, and to let user monitoring the water intake requirement for whole day. The technologies that used to develop system are python and hypertext markup language(HTML). The Fuzzy model will be used in predicting water requirement. First stage is to collect user detail data like weight, height, gender and age to generate fuzzy membership functions of total water requirement. Second stage is collect the data required for model like heart rate, surrounding temperature and activity status from wearable device. After that, input the data into fuzzy model that can produce water requirement per second. Then, this system able to give suitable actionable insight to user based on previous analytic. The user detail data will be used in updating model automatically once user updates detail to system. The test strategies that use to test the system after implementation is black box testing. As a result, fuzzy model is performed well in thus system and the objectives are fulfilled. Besides that, the system contribute to the industri area like wearable device company. For further improvement, more research on AI technique has to be made so that the suitable technique is used for this system.

ABSTRAK

Pada zaman kini, ramai orang akan cuba menggunakan peranti yang boleh pakai untuk menjejaki prestasi kecergasan dan kesihatan mereka. Di pasaran, terdapat banyak jenama jalur kecergasan tetapi kebanyakan daripadanya mereka tidak menyediakan sebarang ciri-ciri perisikan seperti cadangan yang boleh diambil tindakan kepada pengguna terutamanya dalam cadangan untuk keperluan air. Keperluan air didasarkan pada kehilangan air pernafasan, kehilangan air kencing, kehilangan air nirakal, pengeluaran air metabolik dan kehilangan najis. Keperluan air total adalah jumlah kehilangan air pernafasan, kehilangan air kencing, kehilangan air nirakal dan kehilangan najis, kemudian menurunkan pengeluaran air metabolik. Peranti yang boleh dipakai akan menghantar data masa nyata ke dalam pangkalan data dan ia akan menganalisis untuk memberikan cadangan yang sesuai seperti pengambilan air cawan dan tahap dehidrasi kepada pengguna. Terdapat tiga objektif projek ini iaitu untuk membangunkan sistem masa nyata yang boleh memberikan analitik ramalan seperti jumlah keperluan air, untuk menghasilkan cadangan yang boleh diambil dari analisis ramalan, dan membiarkan pengguna memantau keperluan pengambilan air sepanjang hari. Teknologi yang digunakan untuk membangunkan sistem adalah python dan bahasa hypertext markup (HTML). Model Fuzzy akan digunakan dalam meramal keperluan air. Tahap pertama adalah untuk mengumpul data terperinci pengguna seperti berat, ketinggian, jantina dan umur untuk menghasilkan keahlian Fuzzy model berkaitan dengan keperluan air seharian. Tahap kedua adalah mengumpul data yang diperlukan untuk model seperti kadar denyutan, suhu sekitar dan status aktiviti dari peranti yang boleh pakai. Selepas itu, masukkan data ke dalam Fuzzy model yang boleh menghasilkan keperluan air sesaat. Kemudian, sistem ini dapat memberikan cadangan yang sesuai kepada pengguna berdasarkan analitik sebelumnya. Data terperinci pengguna akan digunakan dalam mengemas kini model secara automatik sebaik sahaja kemas kini pengguna terperinci ke sistem. Strategi ujian yang digunakan untuk menguji sistem selepas pelaksanaan adalah ujian kotak hitam. Sebagai hasilnya, Fuzzy model dilaksanakan dengan baik dalam sistem itu dan objektifnya dipenuhi. Selain itu, sistem menyumbang kepada kawasan industri seperti syarikat peranti yang boleh pakai. Untuk penambahbaikan selanjutnya, lebih banyak kajian mengenai teknik AI perlu dibuat supaya teknik yang sesuai digunakan untuk sistem ini.

TABLE OF CONTENTS

CHAPTER	SUBJECT	PAGE
	DECLARATION	i
	DEDICATION	ii
	ACKNOWLEDGEMENTS	iii
	ABSTRACT	iv
	ABSTRAK	v
	TABLE OF CONTENTS	vi
	LIST OF TABLES	xi
	LIST OF DIAGRAMS	xiii
CHAPTER I	INTRODUCTION	
	1.1 Introduction	1
	1.2 Problem Statements	2
	1.3 Objective	3
	1.4 Scopes and Limitation	3
	1.5 Project Significance	4
	1.6 Expected Output	4
	1.7 Summary	4
CHAPTER II	LITERATURE REVIEW AND PROJECT METHODOLOGY	
	2.1 Introduction	5
	2.2 Domain knowledge of intelligence module in MyDWS	6

2.2.1	Water in human body	6
2.2.2	Source of Water loss	7
2.2.2.1	Respiratory loss	8
2.2.2.2	Urinary loss	8
2.2.3.3	Fecal water loss	9
2.2.3.4	Insensible water loss	9
2.2.1.2	Metabolic production	9
2.2.3	Factors affecting water intake	10
2.2.3.1	Temperature	11
2.2.3.2	Activity intensity	12
2.2.4	Fuzzy model	12
2.2.4.1	Fuzzification	13
2.2.4.2	Rule evaluation, aggregation and defuzzification	13
2.2.5	Data of wearable device retrieve from third party	14
2.2.5	Existing System	15
2.2.6	Technique	16
2.3	Project Methodology	17
2.4	Project Requirement	19
2.4.1	Software Requirements	19
2.4.2	Hardware Requirements	20
2.4.3	Other Requirement	20
2.5	Project Schedule and Milestones	20
2.6	Summary	24

CHAPTER III ANALYSIS

3.1	Introduction	25
3.2	Problem Analysis	26
3.2.1	Flowchart of the MyDWS system	28
3.2.1.1	Main function	28
3.2.1.2	Calculate respiratory water loss sub function	29
3.2.1.3	Urine loss sub function	31
3.2.1.4	Calculate insensible water loss sub function	32
3.2.1.5	Metabolic water production sub function	32
3.2.1.6	Find values of membership function of water requirement sub function	33
3.2.2	Flowchart of the MyDWS web	35

3.2.2.1	Main function	35
3.2.2.2	Homepage	36
3.2.2.3	Sign in page	37
3.2.2.4	Forgot password page	38
3.2.2.5	Sign up page	39
3.2.2.6	UserHome page	40
3.2.2.7	Data process page	41
3.2.2.8	Update detail page	42
3.2.2.9	Log off function	43
3.3	Requirement Analysis	43
3.3.1	Data Requirement	43
3.3.2	Functional Requirement	45
3.3.2.1	MyDWS system Use Case Diagram	45
3.3.2.2	MyDWS web Use Case Diagram	46
3.3.2.3	Data Flow Diagram(DFD)	47
3.3.2.4	User Case Description	48
3.3.3	Non-Functional Requirement	54
3.3.4	Other Requirement	55
3.4	Summary	56
CHAPTER IV DESIGN		
4.1	Introduction	57
4.2	System architecture	58
4.3	User Interface Design	58
4.3.1	MyDWS system GUI	58
4.3.2	MyDWS web Homepage	59
4.3.3	MyDWS web Sign in page	59
4.3.4	MyDWS web Forgot password page	60
4.3.5	MyDWS web Change password page	61
4.3.6	MyDWS web Sign up page	61
4.3.7	MyDWS web userHome page	62
4.3.8	MyDWS web Data process page	62
4.3.9	MyDWS web Update detail page	63
4.3.10	Navigation Design	64
4.3.11	Input Design	65
4.3.12	Technical Design	69
4.3.12.1	Mamdani Fuzzy Model in Urine Loss	69

4.3.12.2 Mamdani Fuzzy Model in Total Water Requirement	70
4.3.13 Output Design	72
4.4 Database Design	73
4.4.1 Conceptual and Logical Database Design	73
4.4.2 Entity Relationship Diagram (ERD)	74
4.5 Detailed Design	74
4.5.1 Software Design	74
4.5.1.1 User clicks drink water button	75
4.5.1.2 Fuzzy model	75
4.5.1.3 User clicks data process button	75
4.5.1.4 User updates detail	76
4.5.1.5 Sign in	76
4.5.1.6 Sign up	76
4.5.2 Physical Database Design	76
4.6 Summary	77
CHAPTER V IMPLEMENTATION	
5.1 Introduction	79
5.2 Software Development Environment setup	79
5.3 Software Configuration Environment Setup	81
5.3.1 Configuration Environment Setup	81
5.3.1.1 MyDWS file path configuration	81
5.3.1.2 Database configuration	82
5.3.1.3 User sensor data source file configuration	89
5.3.2 Version Control Procedure	89
5.4 Implementation Status	90
5.5 Summary	93
CHAPTER VI TESTING	
6.1 Introduction	94
6.2 Test plan	94
6.2.1 Test organization	95
6.2.2 Test environment	95
6.2.3 Test schedule	95
6.3 Test strategy	95
6.3.1 Classes of tests	96
6.4 Test Implementation	96

6.4.1 Test Description	96
6.4.2 Test Data	97
6.5 Test Result and Analysis	99
6.6 Summary	100
CHAPTER VII CONCLUSION	
7.1 Introduction	101
7.2 Observation on Weaknesses and Strengths	101
7.3 Propositions for Improvement	102
7.4 Project Contribution	103
7.5 Summary	103
REFERENCES	104
APPENDICES	107



LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	TBW as a Percentage of Body Weight by age	7
Table 2.2	Estimation of Minimum Daily Water Losses and Production	7
Table 2.3	Comparison with previous work on different dataset	16
Table 2.4	Project milestone	21
Table 2.5	Gantt Chart of PSM 1	22
Table 2.6	Gantt Chart of PSM 2	24
Table 3.1	Data dictionary for MyDWS	44
Table 3.2	Click drink water button Case Description	48
Table 3.3	Sign in use case Description	49
Table 3.4	Reset password use case Description	50
Table 3.5	Sign up use case Description	51
Table 3.6	Data process use case Description	52
Table 3.7	Update detail use case Description	53

Table 3.8	Log off use case Description	54
Table 3.9	Non-functional requirements	55
Table 4.1	Input Design for MyDWS main system GUI	65
Table 4.2	Input Design for Sign In page	66
Table 4.3	Input Design for Forgot password page	66
Table 4.4	Input Design for Change password page	66
Table 4.5	Input Design for Sign up page	67
Table 4.6	Input Design for Data process page	67
Table 4.7	Input Design for Update detail page	68
Table 4.8	Output Design of MyDWS	72
Table 4.9	Data dictionary for MyDWS	77
Table 5.1	Software required to setup the environment	80
Table 5.2	Python extra libraries required to setup the environment	80
Table 5.3	Version and description of MyDWS	90
Table 5.4	Implementation status of MyDWS	91
Table 6.1	Part of Sensor data in data.csv	98

LIST OF FIGURES

DIAGRAM	TITLE	PAGE
Figure 2.1	Metabolic water production relative to daily energy expenditure.	10
Figure 2.2	Approximate daily water requirements as a function of climatic temperature (Wet Bulb Globe Temperature, WBGT) and total energy expenditure (kcal)	11
Figure 2.3	Fuzzy membership function	13
Figure 2.4.	Example of fuzzy rule	13
Figure 2.5	Example aggregation and output	14
Figure 2.6	V model (SDLC)	17
Figure 3.1	MyDWS system of main function	28
Figure 3.2	Calculate respiratory water loss sub function	29
Figure 3.3	Urine loss sub function	31
Figure 3.4	Calculate insensible water loss sub function	32
Figure 3.5	Metabolic water production sub function	32

Figure 3.6	Find values of membership function of water requirement sub function	33
Figure 3.7	MyDWS web main function	35
Figure 3.8	MyDWS web homepage	36
Figure 3.9	MyDWS web Sign in page	37
Figure 3.10	MyDWS web forgot password page	38
Figure 3.11	MyDWS web Sign up page	39
Figure 3.12	MyDWS web userHome page	40
Figure 3.13	MyDWS web Data process page	41
Figure 3.14	MyDWS web Update detail page	42
Figure 3.15	MyDWS web Log off function	43
Figure 3.16	Diagram of Requirement of the MyDWS	45
Figure 3.17	MyDWS system Use Case Diagram	45
Figure 3.18	MyDWS web Use Case Diagram	46
Figure 3.19	Data Flow Diagram (DFD)	47
Figure 4.1	System Architecture of MyDWS Model	58
Figure 4.2	MyDWS main system GUI	59
Figure 4.3	MyDWS web Homepage	59
Figure 4.4	MyDWS web Sign In page	60
Figure 4.5	MyDWS web Forgot password page	60
Figure 4.6	MyDWS web Change password page	61
Figure 4.7	MyDWS web Sign up page	61

Figure 4.8	MyDWS web userHome page	62
Figure 4.9	MyDWS web Data process page	62
Figure 4.10	MyDWS web Update detail page	63
Figure 4.11	Navigation Bar of MyDWS web	64
Figure 4.12	Navigation Bar of MyDWS system	65
Figure 4.13	Logical Database Design	73
Figure 4.14	ERD of MyDWS	74
Figure 4.15	DFD diagram	75
Figure 5.1	Deployment diagram of the environment architecture	81
Figure 5.2	Directory of MyDWS	82
Figure 5.3	Start Mysql workbench 6.3 CE	82
Figure 5.4	Create new connection	83
Figure 5.5	Create a new connection name mydws	83
Figure 5.6	New connection name mydws	84
Figure 5.7	Click database icon to create new scheme	84
Figure 5.8	Type name of scheme	85
Figure 5.9	Click “Apply” button	85
Figure 5.10	Click “Finish” button	86
Figure 5.11	Import data from file	86
Figure 5.12	Change the path of directory	87
Figure 5.13	Click “Start import” button	87
Figure 5.14	Database is imported successfully	88


Figure 5.15	Tables in scheme	88
Figure 5.16	User sensor data source file configuration	89
Figure 6.1	Testing result for water accumulate in MyDWS	99



CHAPTER I

INTRODUCTION

1.1 Introduction



Now a day, a lot of people will try to use wearable device to track their fitness and health performance. Since the people is busy in working and no much time to manage their health, so they might be success in their career with the sacrifice of healthy life. At the end of their life, they will spend more money and time to gain back their health, so it is not worth that to sacrifice one of the most important thing in their life which is health. Without a strong body to support you to pass through life, the glory that you gain is short.

One of the main problem of health is that the people are less in drinking enough of water per day. There are 4 type of water loss and one water production in human body. The water loss are urine water loss, respiratory water loss, fecal loss and insensible water loss. The water production in body is metabolic water production. However, in the market, there are many brands of the fitness band but majority of them do not provide any intelligence features inside like actionable insight or suggestion to user especially is about drinking water suggestion. It just state the data to user only but do not provide any useful information, so the user must understand

the domain knowledge. Furthermore, there is not much device that embedded intelligence module for user, so that user can easy get the information and data from device. Regarding the problem stated above, the system will provide a real time intelligence module for user, give the suitable actionable insight like dehydration and amount of water to be drank in different situation. This project will develop a model called *MyDWS*, the model will be continuous updated to well suited to the user because it will change the parameters in model after user update their latest personel detail into the module.

In addition, this module will incorporate with AI technique: mamdani fuzzy model. There is 4 phase in fuzzy model which is fuzzification, rule evaluation, rule aggregation and defuzzification. In fuzzification, the crisp data will be processed in membership function and produce fuzzy value. After that, the fuzzy values will be evaluated by rules and aggregated together. The aggregated fuzzy value will be change into crisp value in defuzzification phase.

1.2 Problem Statement

There is many brand of fitness band in the market but most of them are not provide any useful predictive analytic to user especially about the real time predictive analytic on water intake volume. Furthermore, the wearable device will show the raw data that get from device in graph but not every user able to understand the information that it wants to deliver to user. Hence, user probably will think that the money that they speed are wasted because it cannot give the desire output to user. For the amount of water intake is actually influence by the many factors like surrounding temperature, activity intensive level and health problem. In this case, people are hard to estimate the actual water intake in daily life based on different situation.

Here is the summary of the problem statements that happened and proves that it is important to having a water intake module:

i) **User hard to find a real time module that can give them useful predictive analytics volume of water requirement.**

There is a lot of real time module in the market but the real time module about volume of water intake is too less. Even there is the real time module about volume

of water intake, many of them cannot give user accurate and useful the predictive analytic.

ii) **User do not know the useful information from raw data that provide by wearable device**

Some of the wearable device will only show the data obtained from the sensor in graph only but do not do any suggestion to user, so user hard to know about the information that the wearable device want to deliver to user.

iii) **User do not know how much water intake requirement for real situation.**

In real life, there are many type of situation that face by human and it will affect the volume of water intake. For example, an inactive user suddenly do heavy exercise today in a hot temperature, so the water intake today will not be the same in the past.

1.3 Objective

This water intake module will propose with the following objectives:

- i) **To develop a real time module that can give predictive analytics for volume of water requirement.**
- ii) **To generate actionable insight from predictive analytics.**
- iii) **To let user monitoring the water intake requirement for whole day.**

1.4 Scopes and Limitation

There are some scope and limitation in this project which stated below:

Scope

The system is available for python language and window operating system only. Beside, that, we assume that the user always wear the device.

Limitation

The system is only available in English language only and MyDWS cannot be used to all wearable device. Other than that, we also assume that the dataset is accurate and true.

1.5 Project Significance

There is a lot of wearable device in the market, but most of them only give the suggestion or prediction to the user after the day as summary but not real time. MyDWS will give the user real time actionable insight in different situation that happen in real life. Furthermore, MyDWS is embedded artificial intelligence technique inside which is AI model, so it will calculate the water intake requirement in more human like way.

1.6 Expected Output

Since this system is an artificial intelligence module which included the fuzzy technique. So, MyDWS must able to will give actionable insight from predictive analytic that calculate from data. Users only need to update some detail like weight and height, then the module continuous updated to well suited to the user.

1.7 Summary

This chapter has made the introduction about the water intake system which is MyDWS. From that, reader will able to know how this system is going to implement. Purpose and the expected output are determined so that problem can be solved and the desired output can be achieved.

On the next chapter, literature review and project methodology will be discussed. For the literature review part, it will briefly explain about the previous research has done for similar about the health performance. In addition, it also will further discuss about the AI technique. For the methodology part, it will discuss about method and the technique that used to develop this system, platform to be used for it and how it implement inside system.

CHAPTER II

LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

This chapter will discuss about the literature review and methodology that used to develop a water intake suggestion system, MyDWS. The literature review part will summarize the past trend of the similar health performance module, identify the problem and knowledge in previous effort that done by the researchers. Therefore, the work of research needs to be done to help me investigate the potential weakness of the previous work and bringing the potential strength to solve some of the past works.

The remainder part of this chapter will further discuss about current trend of similar project to health performance, previous research that done by some researchers which has related to the MyDWS system, summary of the AI techniques used by researchers. Next, the project methodology will be discussed and finally the summarize of this chapter and explain the next activities in next chapter.