



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF INTELLIGENT NEONATAL
MONITORING SYSTEM BASED ON MULTI-SENSORS**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

by

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TECHNOLOGY

2019

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Development of Intelligent Neonatal Monitoring System Based on Multi-Sensors

Sesi Pengajian: 2019

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I hereby, declared this report entitled Development of Intelligent Neonatal Monitoring System Based on Multi-Sensors is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Tujuan projek ini adalah untuk membangunkan Sistem Pemantauan Neonatal Pintar berdasarkan Multi-Sensor. Di Unit Rawatan Rapi Neonatal (NICU), terdapat bayi-bayi pramatang dan bayi-bayi yang sakit yang memerlukan rawatan tambahan dari doktor, jururawat serta bekalan perubatan. Pertubuhan Kesihatan Sedunia (WHO) mendefinisikan neonat sebagai bayi baru lahir yang berusia 28 hari. Pada usia kritikal ini, mereka mempunyai kemungkinan kematian yang tinggi akibat komplikasi. Sindrom Kematian Bayi Mendadak (SIDS) adalah kejadian yang wujud di kalangan bayi di bawah umur satu tahun. Untuk mengelakkan episod ini, neonat perlu sentiasa dipantau oleh doktor dan jururawat. Oleh itu, sistem pemantauan neonatal yang bijak seharusnya menjadi penyelesaian yang baik untuk membantu mereka memerhatikan neonat dengan kerap. Sistem ini menghantar parameter fisiologi neonat seperti suhu badan dan kadar denyutan jantung ke “Internet of Things” (IoT) yang dipanggil “ThingSpeak”. Suhu badan dan kadar denyutan jantung akan dikesan oleh sensor suhu LM35 dan sensor nadi. Parameter fisiologi dihantar ke IoT melalui ESP8266 Wi-Fi Perisai. IoT membantu doktor dan jururawat untuk dihubungkan dengan data neonat dan membantu memantau neonat pada bila-bila masa melalui internet. Ia juga akan memberikan masa sebenar parameter fisiologi neonate dengan cara memantau parameter bersama dengan nilai dengan masa dan tarikh. Buzer akan berbunyi bip jika suhu badan atau denyutan jantung yang diukur tidak berada dalam julat normal. Peratusan perbezaan antara sensor suhu LM35 dan termometer digital adalah kurang daripada 3% manakala kadar jantung boleh berubah mengikut aktiviti fizikal. Sistem ini pasti akan memberikan kecekapan dan kebolehpercayaan yang akan memainkan peranan penting untuk penjagaan yang lebih baik.

ABSTRACT

The purpose of the project is to develop an Intelligent Neonatal Monitoring System based on Multi-Sensors. In the Neonatal Intensive Care Unit (NICU), there are premature babies and other ill babies who need extra care from the doctors, nurses as well as medical supplies. World Health Organization (WHO) defines neonate as a newborn baby who is 28 days of age. At this critical age, they have a high possibility of death due to complication. Sudden Infant Death Syndrome (SIDS) is an incident exists among infants below the age of one year. In order to avoid this episode occurred, neonates need to be continuously monitored by the doctors and nurses. Therefore, an intelligent neonatal monitoring system should be a good solution in order to help them to observe neonates frequently. This system transmits the physiological parameters of the neonate such as body temperature and heart rate to the Internet of Things (IoT) called ThingSpeak. The body temperature and the heart rate will be detected by LM35 temperature sensor and pulse sensor respectively. The physiological parameters are sent to the IoT via ESP8266 Wi-Fi Shield. IoT helps the doctors and nurses to be connected with the neonate's data and it is helpful in monitoring the neonates at any time through the internet. It also will give the real-time physiological condition of the neonates by monitoring the parameters along with the values with the time and date. The buzzer will go beep if the measured body temperature or heart rate is not within the normal range. The percentage difference between LM35 temperature sensor and digital thermometer is less than 3% while the heart rate can be vary according to the physical activity. This develops system will definitely providing efficiency and reliability which will play a vital role for better care.

DEDICATION

To my beloved mother and father who always there for me

Mohd Shair and Yati Yunus

To my siblings

Muhammad Khairi Akif

Nur Dania Aqilah

To my lecturer and supervisor, for their guidance and encouragement

Dr. Suhaila Binti Mohd Najib

To my friends, for their unconditionally support

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deepest grateful appreciation to all wonderful people have continuously giving me support, advices, knowledge, understanding and contribution towards the successful completion of this Final Year Project. In particular, I wish to express my sincere appreciation to my supervisor, Professor Dr. Suhaila binti Mohd Najib for encouragement, guidance, critics, advices, suggestion and motivation on developing this project. Without her assistance and involvement in every step throughout the process, this paper would have never been accomplished. I would like to thank you very much for your support and understanding over these past four years. Finally, I would like to express my sincerest gratitude and deepest thankfulness to my parent for their love, support and encouragement that they had given to me.

TABLE OF CONTENTS

	PAGE
DECLARATION	iv
APPROVAL	v
ABSTRAK	vi
ABSTRACT	vii
DEDICATION	viii
ACKNOWLEDGEMENTS	ix
TABLE OF CONTENTS	x
LIST OF TABLES	xv
LIST OF FIGURES	xvi
LIST OF APPENDICES	xix
LIST OF ABBREVIATIONS	xx
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Project Background	1
1.3 Problem Statement	3
1.4 Objective	4
1.5 Scopes of Work	4

1.6	Project Significance	4
CHAPTER 2 LITERATURE REVIEW		6
2.1	Introduction	6
2.2	Overview of Neonatal Monitoring System	6
2.3	Past Related Research on Health Monitoring System	8
2.3.1	Development of Wireless Monitoring System for Neonatal Intensive Care Unit	8
2.3.2	Patient Monitoring System Using Raspberry Pi	9
2.3.3	Infant Monitoring System Using Multiple Sensors	11
2.3.4	Intelligent Baby Monitoring System	12
2.3.5	Baby Incubator Using Microcontroller & GSM	14
2.3.6	Advanced Baby Monitor	15
2.3.7	Android Based Embedded Baby Monitoring and Controlling	17
2.3.8	A Prototype of Child Monitoring System Using Motion and Authentication with Raspberry Pi	18
2.3.9	Raspberry Pi Based Patient Health Status Observing Method Using Internet of Things	19
2.3.10	Sudden Infant Death Monitoring Using Smart Wearable System	21
2.3.11	GSM Based Baby Incubator	23

2.3.12	Real Time Monitoring of Human Body Vital Signs using Bluetooth and WLAN	25
2.3.13	Baby Health Monitoring System using Wireless and Remote Access Technology	28
2.4	Comparison of Health Monitoring System	31
2.5	Summary	36
CHAPTER 3 METHODOLOGY		37
3.0	Introduction	37
3.1	Project Development Process	37
3.2	Project Flowchart	39
3.3	Hardware Development	40
3.3.1	Arduino Uno	41
3.3.2	ESP8266 Wi-Fi Shield	43
3.3.3	LM35 Temperature Sensor	43
3.3.4	Pulse Sensor	45
3.3.5	Piezo Buzzer	46
3.4	Software Development	48
3.4.1	Arduino IDE	48
3.5	IoT Cloud	49
3.5.1	ThingSpeak	49

3.6	3-Dimensional Design	51
3.7	Summary	52
CHAPTER 4 RESULT AND DISCUSSION		53
4.1	Introduction	53
4.2	Project Development	53
4.3	Operation of Neonate Monitor	54
4.3.1	Hardware Operation	54
4.3.2	Internet of Things (IoT) Operation	57
4.4	Project Analysis	59
4.4.1	LM 35 Temperature Testing	59
4.4.2	Pulse Sensor Testing	63
4.4.3	Testing for Wi-Fi Connectivity	65
4.4.4	Cloud Analysis	67
4.5	Cost Analysis	69
4.6	Summary	69
CHAPTER 5 CONCLUSION & FUTURE WORK		71
5.1	Introduction	71
5.2	Conclusion	71
5.3	Recommendation for Future Work	72

5.4	Project Potential	73
	REFERENCES	74
	APPENDIX	78

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1:	Comparison of Health Monitoring System	31
Table 3.1:	Specification of Arduino Uno	42
Table 3.2:	Pin Description of LM35	45
Table 3.3:	Specification of Piezo Buzzer	47
Table 4.1:	Normal temperature of neonates	59
Table 4.2:	Temperature Measurement Comparison	60
Table 4.3:	Mean and Standard Deviation	63
Table 4.4:	Normal Heart Rates based on Age	64
Table 4.5:	Heart Rate Measurement	64
Table 4.6:	The Results on the Distance and Signal Status	66
Table 4.7:	Hardware Cost	69

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1:	The Neonatal Intensive Care Unit (NICU) Environment	2
Figure 1.2:	The Monitor Screen in NICU	2
Figure 2.1:	Block Diagram of the System	9
Figure 2.2:	Architectural Diagram	10
Figure 2.3:	Dataflow Diagram	11
Figure 2.4:	Block Diagram of the System	12
Figure 2.5:	Block Diagram of the System	13
Figure 2.6:	Block Diagram of Baby Incubator using GSM	15
Figure 2.7:	Architecture of Baby Monitoring System	16
Figure 2.8:	Block Diagram of Embedded Baby Monitoring and	18
Figure 2.9:	Block Diagram of Child Monitoring System	19
Figure 2.10:	Architecture for Patient Monitoring System using Raspberry Pi	21
Figure 2.11:	System's Architecture	22
Figure 2.12:	System Flowchart	23
Figure 2.13:	Block Diagram of the System	25
Figure 2.14:	System Architecture of the Proposed Approach	27
Figure 2.15:	Work flow of the Proposed Approach	28

Figure 2.16:	Workflow Process of the System	30
Figure 3.1:	Block Diagram of Neonatal Monitoring System	38
Figure 3.2:	Schematic Diagram of the Project	39
Figure 3.3:	Flowchart of the Neonatal Monitoring System	40
Figure 3.4:	Arduino Uno	41
Figure 3.5:	Schematic Diagram of Arduino Uno	42
Figure 3.6:	ESP8266 Wi-Fi Shield	43
Figure 3.7:	LM35 Temperature Sensor	44
Figure 3.8:	Pulse Sensor	46
Figure 3.9:	Front Side and Back Side of Pulse Sensor	46
Figure 3.10:	Piezo Buzzer	47
Figure 3.11:	Arduino IDE in Windows OS	48
Figure 3.12:	ESP8266 Wi-Fi Library Code	49
Figure 3.13:	ThingSpeak Website	50
Figure 3.14:	Channel on ThingSpeak Platform	50
Figure 3.15:	API Keys	51
Figure 3.16:	Design Prototype Model	52
Figure 4.1:	Full Prototype of Intelligent Neonatal Monitoring System	54
Figure 4.2:	Testing of the Project on Neonate	55
Figure 4.3:	Implementation Circuit of the Project	56
Figure 4.4:	The Output of Temperature and Pulse Rate on Serial Monitor	57

Figure 4.5:	Channel Settings on ThingSpeak	57
Figure 4.6:	Write API Key	58
Figure 4.7:	Graph on ThingSpeak Website	58
Figure 4.8:	Export Data Excel	59
Figure 4.9:	Digital Thermometer	60
Figure 4.10:	The Graph of the Temperature against Number of Trial Every 5 Minutes	62
Figure 4.11:	The Graph of the Heart Rate against Number of Trial Every 5 Minutes	65
Figure 4.12:	The Values of Temperature and Heart Rate on Serial Monitor	67
Figure 4.13:	The Output of Temperature with Respect to Time	68
Figure 4.14:	The Output of Heart Rate with Respect to Time	68

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix 1	Gantt chart	78
Appendix 2	Program Code	79

LIST OF ABBREVIATIONS

ADC	Analog-to-Digital Converter
AT	Application Terminal
BPM	Beats Per Minute
ECG	Electrocardiogram
GPS	Global Positioning System
GSM	Global System for Mobile Communications
IDE	Integrated Development Environment
IoT	Internet of Things
LCD	Liquid Crystal Display
NICU	Neonatal Intensive Care Unit
PIC	Peripheral Interface Controller
PIR	Passive Infrared Sensor
PWM	Pulse Width Modulated
SCU	Signal Conditioning Unit
SIDS	Sudden Infant Death Syndrome
SMS	Short Messaging Service
USB	Universal Serial Bus
WBAN	Wireless Body Area Network

WHO	World Health Organization
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, the purpose of the project is described generally including problem statement, objective and scope. The problem statement is related to the current issues while the objective is the targets for this project in solving the problem arise. However, there will be a limitation in completing this project which is discussed in the chapter.

1.2 Project Background

In the Neonatal Intensive Care Unit (NICU), there are premature babies and other ill babies who need extra care from the doctors, nurses as well as medical supplies. World Health Organization (WHO) defines neonate as a newborn baby who is 28 days of age (Quinn *et al.*, 2016). At this critical age, they have a high possibility of death due to complication. Therefore, they need close and direct supervision from the doctors and nurses. Sudden Infant Death Syndrome (SIDS) and apnea are the incidents might happen to them. In order to avoid these episodes occurred, neonate needs to be continuously monitored in terms of body temperature and heart rate.



Figure 1.1: The Neonatal Intensive Care Unit (NICU) Environment

Figure 1.1 shows the neonatal care environment. All the sensors are connected by wires to a monitoring unit outside of the incubator. The display next to the incubator visualizes the vital sign signals and sensor's reading from these sensor used in NICU as shown in Figure 1.2. From these vital signs, it can identify the existence of medical problem because not all neonates have the same condition. So, the doctors and nurses must be presented near the neonates all the time to record all the sensors reading periodically and frequently.



Figure 1.2: The Monitor Screen in NICU

Therefore, this monitoring system should be a good solution in order to help them to observe the tiny neonate frequently. Arduino Uno has been chosen as the main controller in a proposed system. It will controller in a proposed system. Subsequently, the system will upload the monitored data to the private cloud called ThingSpeak, an Internet of Things (IoT) via ESP8266 WiFi Shield and it will gives the real time physiological condition of the neonates by monitoring the parameters along with the values with the time and date. This develops system will definitely providing efficiency and reliability which will play a vital role for better care.

1.3 Problem Statement

Sudden Infant Death Syndrome (SIDS) and apnea are the incidents that always happen among the neonates. SIDS is the sudden and unexplained death of an infant under 1 year of age (Blair *et al.*, 2006). Sometimes, babies are born with problems in the part of their brain that controls breathing, heart rate, blood pressure, temperature, and waking from sleep (Krous *et al.*, 2004). Hence, this develop system helps the doctors and nurses to monitor the physiological condition of neonates and alert them if there is any unstable health situation.

Babies who need special cares will be admitted into NICU for close supervising and monitoring by pediatric doctors and nurses. In a few situations, it becomes difficult for them to monitor the neonates because they need to be presented near the neonates all the time. They need to check the neonates' condition such as temperature and heart rate frequently and consistently. Using the neonatal monitoring system developed, all the sensor's reading can be updated and recorded automatically along with time and date.