

**DEVELOPMENT OF SLEEP MONITORING SYSTEM TO OBSERVE THE
EFFECT OF AMBIENT CONDITION TOWARD THE QUALITY OF SLEEP**

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PROJEK SARJANA MUDA II

Tajuk Projek : Development of Sleep Monitoring System to Observe Effect
Of Ambient Condition toward the Quality of Sleep

Sesi Pengajian :

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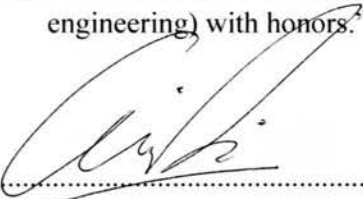
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Specially dedicated to

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ABSTRACT

Getting enough sleep at the right times can help in improving quality of life and protect mental and physical health. The aim of this project is to develop the end user prototyping for sleep monitoring system, measuring the body condition and room ambient by using BLUNO embedded system and window apps for user interface. Important parameter such as ambience parameter, body condition parameter and video based monitoring system are integrated into one system. BLUNO is used to acquire the sensor readings and transfer data obtained to Window Store apps via Bluetooth connection. For ambience monitoring, light intensity is monitored based on darkness level judging by the bare eye. Value of humidity is categorized as dry, moderate and moist while value of thermometer is categorized as very hot, hot, moderate, cold and very cold. The value of heart rate and body temperature can be obtained from pulse sensor and thermistor respectively. Body movement of the user is determined by using accelerometer which will give the value of 3-axis (X, Y and Z) digital acceleration data. The data display on the Window Store apps is validated by comparing it with the data measured manually. The captured data are log into MySQL database. Time is also been recorded into table. Through the experiments, the suitable ambient condition for getting better sleep is cold environment, moderate light intensity and lower light intensity.

ABSTRACT

Mendapat tidur yang cukup pada masa yang tepat boleh membantu dalam meningkatkan kualiti hidup dan melindungi kesihatan mental dan fizikal. Tujuan projek ini adalah untuk memghasilkan satu sistem pemantauan tidur untuk mengukur keadaan badan dan persekitaran bilik dengan menggunakan BLUNO sistem terbenam dan aplikasi Window untuk menunjukkan bacaan sensor. Parameter suasana, keadaan parameter badan dan sistem pemantauan berasaskan video disepadukan ke dalam satu sistem. BLUNO digunakan untuk memperoleh bacaan sensor dan memindahkan data yang diperolehi kepada aplikasi Window Store melalui sambungan Bluetooth. Untuk memantau suasana, keamatan cahaya dipantau berdasarkan tahap kegelapan penghakiman oleh mata telanjang. Nilai kelembapan dikategorikan sebagai kering, sederhana dan lembap manakala nilai termometer dikategorikan sebagai sangat panas, panas, sederhana, sejuk dan sangat sejuk. Nilai kadar jantung dan suhu badan boleh diperolehi daripada sensor nadi dan termistor masing-masing. pergerakan badan pengguna ditentukan dengan menggunakan pecutan yang akan memberi nilai 3-paksi (X, Y dan Z) data pecutan digital. Paparan data pada aplikasi Window Store disahkan dengan membandingkannya dengan data diukur secara manual. Data yang dirakam sedang log masuk ke pangkalan data MySQL. Masa juga telah direkodkan ke dalam jadual. Melalui eksperimen, keadaan bilik yang sesuai untuk mendapat tidur yang lebih baik adalah persekitaran sejuk, keamatan cahaya sederhana dan keamatan cahaya rendah.

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LIST OF ABBREVIATIONS

EMG	Electromyography
EEG	Electrogram
REM	Rapid Eye Movement
NREM	Non- Rapid Eye Movement
EDR	ECG-Derived Respiration
MT	Movement Time
ME	Movement Events
SWS	Slow-Wave Sleep
BLE	Bluetooth Low Energy
LDR	Light Dependent Resistor
DHT 22	Digital Humidity And Temperature Sensor
IDE	Integrated Development Environment
Window App	Window Application
DOF	Degree Of Freedom
IMU	Inertial-Measure Unit

US	United State
EU	European Union
SDB	Sleep Disorders Breathing
NF	Neurofeedback
API	Application Programming Interface
RH	Relative Humidity
GND	Ground
SCL	Serial Clock
SDA	Serial Data
LiPo	Lithium Polymer
IOT	Internet Of Things

CHAPTER 1

INTRODUCTION

This chapter will discuss the background of this project. Problem statement, objective and scope will be explained in this section. Structure of report will explain deeply in this chapter as well.

1.1 Project Background

Sleep is type of brain activity and a state of rest for human. It is necessary and important as most of the people spend more than five hours a day on this activity. Quantity of sleep will affect the performance of next day either working or studying. Bad quality of sleep also make someone mood become bad for whole day [1].

Poor sleep state will cause a lot of sleep disorders. Insomnia, restless legs syndrome, narcolepsy are the familiar examples of sleep disorders. Among that, insomnia is the common and always happen to women and elderly and also the psychosocially disadvantaged people [2]. Busy and stressful life style is also one of the reasons to cause insomnia to someone. Besides that, there also other type of disorders such as sleep walking, nightmares and enuresis.

There are three fundamental measures to determine sleep stage which are muscle tone, gross brain wave and eye movement. Muscle tone normally is measure by using electromyography (EMG) method. In this method, electrodes are used to transfer the

electrical signals that cause muscles to contract [3]. Needle electrodes are placed into the muscle is used to record electrical activity. Another important measurement of EMG is then skin taped by using electrodes. This is used to determine the signal that are travelling between the points. Lastly, the signal will be translated into graphs or numerical values for a specialist to interpret.

Gross Brain wave is using electroencephalography technique which use to read scalp electrical activity that generated by brain structure. It is measure directly from the electrocardiogram which is the cortical surface of the brain. When using depth probes of the same technique, it is called as electrogram [4]. EEG is a very powerful tool in the neurology field as it can capture normal electrical activity of brain as well as abnormal activity.

When a people is sleeping, it can be categorized into two states which called as rapid eye movement (REM) and non-REM (NREM) [5]. Non-REM sleep consist of three phases which can be last from 5 to 15 minutes for each stage. Stage 1 is named as transition stage where it is the beginning of sleep [6]. When someone is in this stage, his or her eyes will move slowly, the muscle activity will be slowing down and the people can be awakened easily. During stage 2, the eyes movement will stop and the physical parameter like heart rate and body temperature will be decreased. During stage 3, he or she will be more difficult to be awaken. This stage called as deep stage. Dream sleep is the state of REM. During this stage, people fall asleep and dream is taking place. In this stage, heart rate and body temperature will be increased to supply the brain and body with a lot of energy [7].

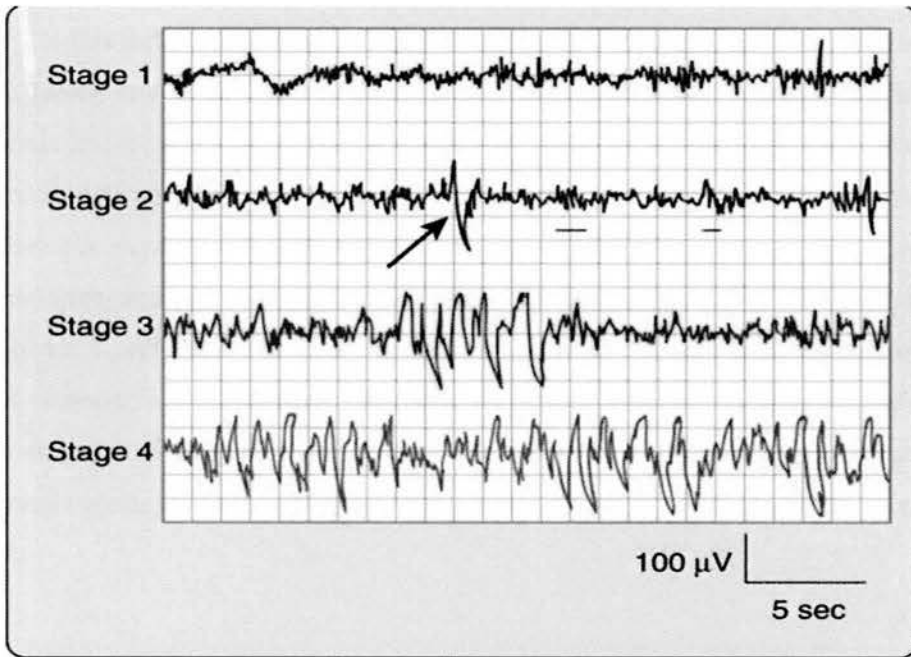


Figure 1.1: Brain activity signal when a people is in different stage of NREM [6]. The arrow showed that there is largest event in healthy human EEG (K-complex) during stage 2.

Physical condition in the room such as room temperature and humidity will influence people sleep in different ways. There were some studies that analysed the influence of both cold and warm temperature on the sleep stages [7, 8]. The study shows that environment with warm temperature help user to have a good sleep at night [8]. Besides that, humidity of the room also is an important issue. In the study done by Okamoto-Mizuno [8], it shows that the skin temperature was increased as well as wakefulness which cause by the hot-humid conditions. It reduced REM phase and slow-wave sleep. Other than room temperature and humidity, noise environment also cause people to not to have a good sleep in night [9]. This is proved in the study done by Pedersen in 2012 [9]. It states that there are some people who did not has a good sleep because of traffic noise during their night sleep. By determining the body condition such as heart rate, body temperature as well as body movement, a quality of sleep can be defined or perhaps estimated [10]. This is due to the body parameter will be changed based on stage of sleep.

1.2 Problem Statement

In this full of modern technology trends, most of the people are busy for their work, study, family and so on. Most of them always suffer with same sleeping disorder such as insomnia and sleep walking. Sleep disorders are caused by the bad sleep habit like playing electronic devices before sleep and so on. There are a lot of methods to analyze the quality of sleep but most of them have a major limitation which can only be performed by trained professionals and only can monitor to one or two nights. Other than that, the room environment parameters like room temperature, humidity, light intensity and noise will affect someone's sleep quality. The body parameters will be changing during different sleep stages. In this study, heart rate, body temperature and body movement will be observed together with the surrounding environment purposely made for personal use at home.

1.3 Aim and Objective of the Research

The aim of this study is to develop the end user prototyping for sleep monitoring system which measures the room ambient and body condition by using Bluetooth Low Energy (BLE) embedded system.

The objectives of this study have been determined as follows:

- i. To combine the ambient monitoring system and body monitoring system to synchronize the sensor reading for Windows Application.
- ii. To analyze the body condition on the sleeping subject by manipulating the several environment conditions.
- iii. To design the suitable casing and mounting for the prototype for the circuit design.

1.4 Scope of Work

This study consists of two important parts which are hardware and software. For the hardware part, it includes two microcontrollers that work together with several sensors to analyze the quality of sleep. One of the microcontrollers is BLUNO

UNO with DHT 22 and Light Dependent Resistor (LDR) to measure the room environment which included room humidity, room temperature and light intensity. While the heart rate, body temperature and body movement are measured by using pulse sensor, thermistor and accelerometer which work together with BLUNO NANO.

For software part, Arduino IDE is used to program the BLUNO UNO and BLUNO NANO so that the sensor reading can be transferred to Window Apps via Bluetooth connection. Microsoft Visual Studio Basic 2015 is used to develop the Window Apps to display the sensor reading and record the video and audio of the person while sleeping. Sketch up is used to design the prototype for the circuit of ambient monitoring system.

To achieve the third objective, 3D printer is also used to print out the design of the ambient monitoring system casing. The body monitoring system is placed on a wearable stripe so that user can be wearing it on the chest to measure the rate of heart, body temperature and movement of sleep when in sleep.

1.5 Project Significance

According to the Sustainable Development Goal 2015, health monitoring system is important in determine healthy lives and promote well-being for public. Monitoring system is a long-term system so that sleep monitoring system can create more opportunity for innovation to bring better professionals, outcome and value. Sleep monitoring system able to transmit the information of ambient and body parameters when someone is sleeping. User can look forward the recorded information to monitor the sleep environment or change the sleeping habit. This can help in self-health transform and care by embracing the data and information gathered.

Nowadays, self-awareness on the important of health is increasing but people are always busy for their work and other things. Sleep monitoring system is one of the health care system which able to innovate healthcare delivery. It also can create more opportunity for innovation in future to deliver better outcome, professionals and values. It also can help in promote the important of monitoring heath and improve the quality of sleep.

1.6 Chapter Review

In Chapter 1, a short description had been prepared to introduce the general overview of the sleep monitoring system. Other than that, the problem statement that related to the issue and the problem that faced by public and previous student are discussed. Aim and objective of this project are listed out in this chapter too. This section shows the expected result that need to achieve in the end of this project. Then, the scope of work is explained in detail to show the limitation in this study. Project significant also had been discussed to show the impact on the stated problem statement.

Second chapter is a literature review. A lot of journal or article had been review as a reference for this study. Some related topic had been collected and make as a reference so that this project can be achieve the aim and objective to solve the issue and problem faced. The topic that will be reviewed includes sleep disorder, sleep monitoring system, ambient parameter contribution in quality of sleep, physiological changes during sleep stage and the method to determine quality of sleep. The related paper has been summarized in this section.

In Chapter three, the implementation of the project was discussed. Hardware, software and overall flowchart have been showed. All the connection between sensor and microcontroller shows clearly by using figure. The way of the system work start from the reading of sensor and to show it on Window App is also illustrated clearly.

All the experimental result is shown in chapter four. There is a small experiment carried out to test out the whole system. Data obtained from LDR sensor, DHT22, pulse sensor, thermistor and accelerometer will be recorded and shown on the design Window apps. The data shows in Window apps and Arduino IDE serial monitor is compared.

Chapter 5 conclude the whole study based on the result and discussion. A short recommendation toward future development is also have been discusses in this chapter.