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**PATIENT STATUS MONITORING FOR SMART
HOME HEALTHCARE**

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Bachelor of Engineering

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PATIENT STATUS MONITORING FOR SMARTHOME HEALTHCARE

VIVIAN PING THOMAS

A dissertation submitted in partial fulfilment
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Final Year Project Report

Masters

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ABSTRACT

The purpose of this project is to create a patient status monitoring system for smart home healthcare. The suggested setup monitors the patient's vital signs and activity levels using wireless sensors and Wi-Fi technologies. The system gathers information from a variety of sensors, including heart rate, concentration of oxygen level and body temperature. The acquired data is subsequently sent to a cloud server for analysis and processing. The analyzed data are used to deliver real-time information on the patient's health state to caregiver and medical experts, which enables immediate actions and medical attention. The system is designed to be easily integrated into the existing smart home infrastructure and is intended to improve the quality of life and health outcomes of the patient's population in urban areas. All the objectives have been accomplished. Due to a significant inaccuracy, the outcome is, nevertheless, not very precise. The average percentage of inaccuracy for LM 35 was determined to be 4.43%. Meanwhile for MAX30102, which can detect concentration of oxygen level and heart rate have a percentage error of 0.6% and 9.7%.

ABSTRAK

Tujuan projek ini dijalankan adalah untuk mewujudkan sistem pemantauan status pesakit untuk penjagaan kesihatan rumah pintar. Persediaan yang dicadangkan mampu memantau tanda-tanda awal dan tahap aktiviti pesakit menggunakan alat ukur tanpa wayar dan teknologi Wi-Fi. Sistem ini mengumpulkan maklumat daripada pelbagai alat ukur, termasuk kadar denyutan jantung, kepekatan paras oksigen dan suhu badan. Data yang diperoleh kemudiannya dihantar ke 'cloud server' untuk dianalisis dan diproses. Data yang dianalisis akan digunakan untuk menyampaikan maklumat terkini keadaan kesihatan pesakit kepada penjaga dan pakar perubatan, yang membolehkan tindakan segera dan rawatan perubatan dibuat dengan pantas. Sistem ini direka bentuk untuk disepadukan dengan mudah ke dalam infrastruktur rumah pintar sedia ada dan bertujuan untuk meningkatkan kualiti hidup dan tahap kesihatan pesakit di kawasan bandar. Semua objektif yang ditetapkan untuk projek ini telah tercapai. Oleh kerana sedikit ralat, hasilnya, bagaimanapun, tidak begitu tepat. Purata peratusan ralat untuk LM 35 ditentukan ialah 4.43%. Manakala bagi MAX30102, yang boleh mengesan kepekatan paras oksigen dan kadar denyutan jantung mempunyai peratusan ralat 0.6% dan 9.7%.

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LIST OF ABBREVIATION

IoT	: Internet of Things
CCTV	: Closed-Circuit Television
3G	: Third Generation
4G	: Fourth Generation
PC	: Personal Computer
LoRa	: Long Range
LoRaWAN	: Long Range Wide Area Network
IC	: Integrated Chip

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter is dedicating a comprehensive chapter to the background, problem statement, research aims and objectives, significance of the study, and thesis outline, which establishes a strong foundation for the entire research. It contextualizes the study, positions it within the existing knowledge landscape, and provides a clear roadmap for the subsequent chapters. This chapter plays a crucial role in engaging the readers and capturing their interest, setting the stage for a rigorous and insightful research journey.

1.2 Research background

Before the invention of closed-circuit television (CCTV), people often need security or a man in charge to regularly monitor the surrounding of the property to ensure everyone's safety. These days, smart monitoring systems are being used literally everywhere. Through the use of the Internet and third generation (3G) or fourth generation (4G) cellular networks, smart monitoring enables users to watch videos from any location. It also has a number of features designed to improve life quality and safety [1]. Figure 1.1 shows a smart monitoring system. Smart monitoring systems are linked together using various technologies to facilitate data gathering, communication, and analysis. Smart monitoring systems provide a network of sensors and devices that can quickly collect and transfer data to a central monitoring system or cloud architecture by using different connection which enable real-time monitoring, data analysis, and decision-making based on the data obtained are made accessible by this connectivity.



Figure 1.1: Smart monitoring system [1]

Based on [2], the author asserts that the introduction of the Internet of Things (IoT) technology could be utilized to create the smart monitoring and dependable controlling system over the full sub-station equipment that is highly required with the rise of the internet and computational era. Besides, [3] states that the term "Internet of Things" (IoT) refers to a network of physical items, or "things," that have sensors, software, and other technologies integrated into them in order to communicate and exchange data with other devices and systems through the internet. These gadgets include anything from common domestic items to high-tech industrial gear. Today, there are more than 7 billion linked IoT devices, and according to analysts, there will be 10 billion by 2020 and 22 billion by 2025 [4].

Numerous business chances provided by IoT enable businesses to create fresh company plans and frameworks to carry out the idea. The realization of effective and productive research prospects for academics and researchers working in cross -disciplinary subjects, in addition to business potential [5]. Thus, it unites business studies, engineering expertise, science, and the humanities under one roof. Additionally, IoT creates a "smart" environment in which everything is easily available and takes less time and effort. Figure 1.2 shows the IoT based smart application. Smart IoT applications may be found in a variety of fields, including industrial operations, energy management, environmental monitoring, infrastructure monitoring, healthcare, and home automation. They provide benefits such as greater operating efficiency, predictive maintenance, increased safety, optimised resource utilisation, and cost savings by enabling proactive decision-making based on real-time data and analytics.



Figure 1.2: IoT based smart applications [6]

Today, it has become extremely significant to continuously produce high-quality support in people's daily environments. As a result, many organizations and businesses have been interested in the potential of IoT applications in the creation of new networks of intercommunicating items in customers' daily lives. The IoT-based system makes it possible for objects to be sensed or controlled remotely across the existing network infrastructure, opening up opportunities for a more direct integration of the physical world into computer-based systems and bringing about improvements in efficiency, accuracy, and cost-effectiveness with the added benefit of requiring the least amount of human involvement.

1.3 Problem Statement

According to prior study, researchers simply use one or two sensors to monitor their patient. This could lead to poor communication or inaccurate data would be sent to the doctor or caregiver. Sometimes, doctors misinterpret condition of their patient if only using CCTV as inputs as it only can detect actions, sound, and facial expression. This will cause misguidance that perhaps means making poor judgements or steering the medical condition to wrong direction and leads to conflicts between the doctors and caregiver. Besides, in previous research, they only use few sensors such as temperature sensor and heart rate sensor to measure the patient conditions and link up the server via Wi-Fi module or LoRa technology [7-11]. This might lead to inaccurate information about the patient's condition and the people who live at rural area cannot implement this method due to poor internet connection and unstable cellular signal. Thus, the main objective of this project is to

combine the features from the research study to design a smarter and more effective equipment to monitor patient's condition and health.

1.4 Research aims and objectives

The primary aim of this research is to construct a robust and user-friendly smarthome healthcare system, specifically designed for patients, which can be conveniently monitored by both caregivers and doctors. By integrating the LM 35 Temperature sensor and the MAX 30102 Pulse oximeter and heart rate sensor, this system intends to provide comprehensive health monitoring capabilities. To achieve this, the research will focus on the following specific objectives:

- i. Designing a smart home healthcare system by integrating the LM 35 Temperature sensor and the MAX 30102 Pulse oximeter and heart rate sensor.
- ii. Developing a user-friendly interface using Blynk, specifically designed to monitor the patient's condition.
- iii. Assessing the effectiveness of the proposed system.

This research project is dedicated to enhancing the performance of smart home healthcare by developing a simple yet efficient system. By integrating temperature and vital signs monitoring sensors and utilizing the Blynk interface, caregivers and doctors will be empowered with real-time health data and a user-friendly platform for effective patient monitoring. The evaluation of the proposed system will contribute to its continuous improvement, ultimately benefiting patients, caregivers, and the healthcare community.

1.5 Scope of project

The research project aims to develop a prototype system that utilizes sensors to measure the concentration of oxygen level, body temperature, and heart rate in order to monitor the condition of patients. This innovative system offers a comprehensive approach to healthcare monitoring by integrating sensor technology, real-time data transmission through CCTV, mobile notifications via Blynk, and efficient data storage in the cloud or micro-SD card.

The prototype system utilizes specialized sensors capable of accurately measuring the concentration of oxygen level, body temperature, and heart rate. These sensors are designed to provide precise and reliable data, enabling continuous monitoring of patients' vital signs. By capturing real-time data, the system ensures that any changes or

abnormalities in these vital signs can be promptly detected. To facilitate real-time monitoring, the system incorporates CCTV technology. Through strategically placed cameras, caregivers can observe patients in real-time, allowing for enhanced supervision and immediate response in case of emergencies or critical situations. This visual monitoring capability provides an additional layer of safety and enables caregivers to assess patients' overall condition more effectively.

To streamline the communication and notification process, the system utilizes Blynk. The prototype system integrates Blynk into the system architecture, allowing for seamless notifications to be sent to caregivers and doctors. Caregivers receive notifications on their mobile devices, alerting them of any deviations from the normal range of vital signs. In the event of abnormal readings, Blynk automatically notifies the assigned doctor, ensuring that they are promptly informed to assess the patient's condition.

In cases where the sensor data indicates that the patient is in a stable condition, Blynk notifies the assigned caregiver, providing reassurance and reducing unnecessary concern. On the other hand, if the sensor data suggests a deteriorating or critical condition, Blynk promptly notifies the doctor, alerting them to assess the situation and intervene accordingly. This proactive approach enables doctors to prepare in advance, ensuring that they are fully equipped to address the patient's needs upon arrival. Simultaneously, the caregiver receives the notification from Blynk and promptly rushes to the patient's location, ready to provide immediate assistance and transportation to the hospital if required. Furthermore, the collected data from the sensors is securely stored either in the cloud or on a micro-SD card. This data storage mechanism ensures the availability and accessibility of patient information for analysis and further medical evaluation. Storing the data in the cloud provides the added benefit of easy remote access, enabling healthcare professionals to review patient data from anywhere at any time. This coordinated effort between the caregiver, doctor, and the prototype system ensures a timely response to any emergent situations, enhancing the overall patient safety and well-being.

1.6 Research significance

In this project, an application built with Blynk serve as a pivotal component to establish a seamless connection between the health monitoring system and the relevant stakeholders, including doctors and caregivers. Additionally, the EZVIZ application is utilized to provide real-time health data on the status of patients, enabling healthcare

professionals and caregivers to access vital information conveniently and promptly. The integration of the Blynk application into the system architecture enhances the overall functionality and accessibility of the health monitoring system. By leveraging Blynk's capabilities, the application acts as a central hub for managing patient data. Through this user-friendly interface, doctors and caregivers can conveniently access real-time health data, view trends, and monitor critical parameters.

The utilization of the EZVIZ app further amplifies the system's capabilities by facilitating the seamless transmission of health data to doctors and caregivers. This application allows for the secure and efficient transfer of real-time health information, enabling healthcare professionals to remotely monitor patients' conditions. The EZVIZ app serves as a valuable tool in ensuring that healthcare providers have access to timely and accurate data, empowering them to make informed decisions and provide necessary interventions promptly.

The smart home healthcare sensor employed in this project plays a vital role in collecting and analyzing data about patients' health patterns and behaviours. By continuously monitoring various physiological parameters, the sensor captures valuable insights into the patient's health status. This data can be analyzed to identify patterns, detect anomalies, and generate personalized healthcare recommendations. The availability of such comprehensive health data empowers healthcare professionals to develop tailored treatment plans based on each patient's unique needs. With access to accurate and real-time information, doctors can make informed decisions, prescribe appropriate interventions, and adjust treatment plans accordingly. This personalized approach improves patient outcomes and enhances the effectiveness of healthcare interventions.

Furthermore, the smart home healthcare system offers reassurance and peace of mind to caregivers, particularly in situations where they cannot be physically present at all times. With remote monitoring capabilities, caregivers can stay updated on the patient's health status, receive notifications about any concerning trends or irregularities, and respond promptly when necessary. This aspect of the system helps alleviate the burden and anxiety of caregiving, while ensuring that the patient receives continuous support and attention. In conclusion, the integration of the Blynk application and the EZVIZ application into the health monitoring system enhances its functionality and accessibility.

These applications facilitate the seamless transmission of real-time health data to doctors and caregivers, enabling timely interventions and informed decision-making. The smart home healthcare sensor plays a crucial role in capturing valuable health insights, which can be leveraged to provide personalized healthcare recommendations and tailored

treatment plans. Ultimately, this comprehensive system provides reassurance and peace of mind to caregivers, ensuring that patients receive continuous monitoring and assistance, even in their absence.

1.7 Thesis outlines

In this thesis report, there will be seven chapters which are Chapter 1: Introduction, Chapter 2: Literature Review, Chapter 3: Methodology, Chapter 4: hardware Development, Chapter 5: Software Development, Chapter 6: Result and Discussion and lastly Chapter 7: Conclusion.

The first chapter of the study provides a comprehensive discussion of the background, problem statement, research aims and objectives, significance of the study, and an outline of the thesis. This chapter serves as the foundation for the entire research, setting the stage for the subsequent chapters and showcasing the importance and relevance of the study.

The second chapter, the literature review is discussed. The first part will be the overall overview of the chapter. Next, further information about smart home healthcare will be explained. Following that, further details about and previous works on related research, hardware and software used in the project were also introduced.

In chapter three, which is the methodology part, it is started with the overview of the chapter. Then, the research flowchart for the whole project and research flowchart for the system execution will be discussed. Next, the research approach will be detailed using block diagram design. This chapter also covers about the equipment and material used in the project.

In chapter four, hardware used in the project is introduced. The details of how the development of the system will also be discussed. Then, some information on body temperature, heart rate and concentration of oxygen level will be explained in detail in this chapter.

Chapter five of the project serves as a comprehensive introduction to the software utilized in the development of the system. This chapter not only highlights the specific software employed but also delves into the coding language utilized and provides a detailed explanation of how the coding is employed to execute the system. Each software tool is introduced, emphasizing its relevance and significance in the project.

Chapter six of the project delves into the crucial phase of result and discussion, where a comprehensive analysis of the obtained outcomes is presented. This chapter serves as a platform to provide a detailed explanation of the results, shedding light on the factors contributing to their occurrence.

Chapter seven of the project serves as a culmination of the study, focusing on the summary of the system employed and providing valuable insights and recommendations for future works related to the research topic. In this chapter, a comprehensive summary of the system employed throughout the study is presented. The system, which may encompass various components such as methodologies, techniques, algorithms, software, or hardware, is meticulously outlined to provide readers with a clear understanding of the research framework. The summary emphasizes the key features, advantages, and limitations of the system, providing a comprehensive overview of its implementation and functionality.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter provide an overview of the term patient, smart home healthcare and previous work on related research. Following that, the components required to prepare and create this project will be outlined and discussed in detail to ensure that the project runs smoothly and successfully.

2.2 Patient

A patient, in the medical sense, encompasses a broad range of individuals who are in various stages of receiving medical care, treatment, or attention from healthcare professionals [12]. This term carries significant significance and is deeply ingrained in the healthcare domain. However, the concept of a patient extends beyond the medical context and can encompass individuals experiencing challenging circumstances or enduring difficult times.

Within the realm of healthcare, the term "patient" specifically refers to an individual who seeks medical assistance, diagnosis, or treatment for an illness, injury, or health condition. Patients can present with a wide array of medical needs, ranging from routine check-ups and preventive care to complex surgical interventions and long-term management of chronic conditions. The healthcare system is designed to prioritize the wellbeing and recovery of patients, with healthcare professionals dedicating their expertise and efforts to provide the best possible care and support.

Patients play an active role in their healthcare journey, collaborating with healthcare professionals to make informed decisions about their treatment options and participating in the management of their own health. This partnership between patients and healthcare providers is crucial for delivering effective and patient-centered care. It involves open communication, mutual respect, and shared decision-making to ensure that the treatment aligns with the patient's preferences, values, and goals.

Understanding the multifaceted nature of the term "patient" allows us to appreciate the complexities and diverse experiences associated with seeking medical care and enduring difficult circumstances. Whether it pertains to receiving healthcare or facing life's challenges, the term "patient" encapsulates the strength and vulnerability of individuals, emphasizing the need for empathy, support, and personalized care in both medical and nonmedical contexts.

2.3 Smart home healthcare

Smart Home (SH) technology intends to assist individuals have a better quality of life and to enable the patient to live a comfortable life and independently. Care for outpatients, the elderly, and those with disabilities is the focus of smart home healthcare. In recent years, the concept of smart homes has gained significant popularity, offering a wide range of automated and interconnected systems.

With the aging population and an increasing demand for remote healthcare solutions, smart home healthcare systems provide a convenient and efficient way to monitor the health of individuals in the comfort of their own homes [13].

According to [14], remote patient monitoring has several advantages, including the ability to assess patients regularly, the prevention of illnesses from getting worse, a reduction in hospitalisation costs, and a reduction in the number of hospitalisations.

The ability to assess patients regularly allows remote patient health condition monitoring, enabling medical professionals to check vital signs, medication compliance, and overall well-being without requiring frequent hospital visits. Both the caregiver and the doctor must be fully aware of the patient's state to avoid illnesses. This prevention method can lower the risk of medical mistakes and enhance care coordination in general. At the same time, employing smart home healthcare can be cost-effective to many people as it might possibly save healthcare expenses by offering remote monitoring and preventative treatment, which would cut down on emergency rooms, hospital readmissions, and extended hospital stays.

When combined with biomedical devices, the usage of Smart Home components such as sensors, actuators, controllers, and devices enable user tracking and interaction and