

INTERNET OF WEARABLE THINGS-BASED
ON LORA AND WI-FI HEALTHCARE
MONITORING SYSTEM FOR MEDICAL
APPLICATIONS.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang Al-Sultan Abdullah or any other institutions.

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ABSTRAK

Internet Perkara (IoT) menghubungkan pelbagai peranti melalui Internet untuk mengumpul, menyimpan, bertukar dan memantau data. Dalam penjagaan kesihatan, IoT berpotensi untuk memberi kesan yang signifikan kepada kesejahteraan manusia. Khususnya, Internet of Wearable Things (IoWT) membolehkan peranti boleh pakai bertukar data dengan pelayan IoT berasaskan awan. Pemantauan berterusan parameter penting adalah penting untuk menguruskan penyakit kronik dengan berkesan. Walau bagaimanapun, terdapat keperluan untuk penambahbaikan dalam pemantauan penyakit jantung, terutamanya dalam kes hipertensi, serta meningkatkan komunikasi tanpa wayar untuk pemantauan jarak jauh, dengan tumpuan untuk menggunakan teknologi LoRa dan Wi-Fi. Selain itu, sistem penjagaan kesihatan IoT sedia ada yang menggunakan mikropengawal mempunyai had dari segi ketepatan data, kebolehpercayaan penghantaran dan mikropengawal terbenam. Tesis ini membentangkan reka bentuk dan pembangunan Internet Perkara Boleh Dipakai berasaskan Lora dan Sistem Pemantauan Penjagaan Kesihatan Wi-Fi (IoWT-LWHMS) untuk aplikasi perubatan, yang merangkumi pembangunan sistem penjagaan kesihatan berasaskan IoWT yang menggunakan unit penerima boleh pakai untuk jarak jauh. dan memantau keadaan kesihatan pesakit dengan mudah seperti Tekanan Darah (BP), Degupan Jantung (HR), dan Suhu Badan (BT) dalam masa nyata dan pembangunan rangkaian LoRa dan Wi-Fi untuk IoWT-LWHMS untuk menyokong sambungan jarak pendek dan sambungan jarak jauh, menggunakan mikropengawal FiPy dengan algoritma bersepadu untuk pemerolehan data dan kemaskini kepada platform IoT. Juga, menilai prestasi sistem yang dibangunkan dari segi ketepatan data, kebolehpercayaan komunikasi, penggunaan kuasa, dan kependaman masa dan mengesahkan keberkesanannya. Sistem yang dibangunkan mengikuti proses sebanyak lima peringkat iaitu: pengumpulan data, pemprosesan, penghantaran, penyimpanan dan visualisasi. Penderia boleh pakai mengumpul data pesakit, yang diproses oleh MCU FiPy. Data dihantar melalui rangkaian LoRaWAN dan Wi-Fi dan disimpan dalam awan untuk pemantauan jarak jauh melalui papan pemuka. Sistem ini menjalani ujian menyeluruh, menunjukkan bacaan yang stabil dan tepat untuk parameter penting. Rangkaian Wi-Fi dan LoRaWAN berprestasi dengan pasti, meliputi julat sehingga 1.5 km tanpa kehilangan data. Sistem ini beroperasi secara berterusan selama 13 jam pada bateri mudah alih dan mempamerkan masa tindak balas yang pantas sehingga 2 saat untuk penghantaran data ke awan. Dapat disimpulkan bahawa IoWT-LWHMS yang dibangunkan boleh dilaksanakan untuk memantau keadaan kesihatan pesakit (BP, HR, BT) dari jauh dan mudah dalam masa nyata menggunakan rangkaian LoRaWAN dan Wi-Fi dengan cekap dan berkesan.

ABSTRACT

The Internet of Things (IoT) connects various devices over the Internet to gather, store, exchange, and monitor data. In healthcare, IoT has the potential to significantly impact human well-being. Specifically, the Internet of Wearable Things (IoWT) enables wearable devices to exchange data with cloud-based IoT servers. Continuous monitoring of vital parameters is crucial for managing chronic diseases effectively. However, there is a need for improvement in heart disease monitoring, particularly in the case of hypertension, as well as enhancing wireless communication for remote monitoring, with a focus on utilizing LoRa and Wi-Fi technologies. Additionally, existing IoT healthcare systems using microcontrollers have limitations in terms of data accuracy, transmission reliability, and embedded microcontrollers. The thesis presents the design and development of an Internet of Wearable Things-based on Lora and Wi-Fi Healthcare Monitoring System (IoWT-LWHMS) for medical applications, which includes the development of an IoWT-based healthcare system utilizing wearable sensing units for remotely and conveniently monitoring patients' health conditions such as Blood Pressure (BP), Heart Rate (HR), and Body Temperature (BT) in real-time and development of a LoRa and Wi-Fi networks for IoWT-LWHMS to support short-and long-range connectivity using the FiPy microcontroller with an integrated algorithm for data acquisition and update to the IoT platform. Moreover, assessment of the system's performance, focusing on data accuracy, communication reliability, power consumption, and time latency has been conducted. The developed system follows a five-stage process: data gathering, processing, transmission, storage, and visualization. Wearable sensors collect patient data, which is processed by the FiPy MCU. The data is transmitted through LoRaWAN and Wi-Fi networks and stored in the cloud for remote monitoring via a dashboard. The system underwent thorough testing, showing stable and accurate readings for vital parameters. The Wi-Fi and LoRaWAN networks performed reliably, covering a range of up to 1.5 km with no data loss. The system operated continuously for 13 hours on a portable battery and exhibited fast response times of up to 2 seconds for data transmission to the cloud. It can be concluded that the developed IoWT-LWHMS could be implemented for remotely and conveniently monitoring patients' health conditions (BP, HR, BT) in real-time using LoRaWAN and Wi-Fi networks efficiently and effectively.

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