

**ANALYZE AN IOT MULTI-SENSOR MONITORING SYSTEM  
USING CAN-BUS NETWORK FOR ENABLING RAPID IOT  
PROTOTYPING**

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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SYSTEM USING CAN-BUS NETWORK FOR ENABLING  
RAPID IOT PROTOTYPING**

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**This report is submitted in partial fulfilment of the requirements  
for the degree of Bachelor of Electronic Engineering with Honours**



**Faculty of Electronic and Computer Engineering  
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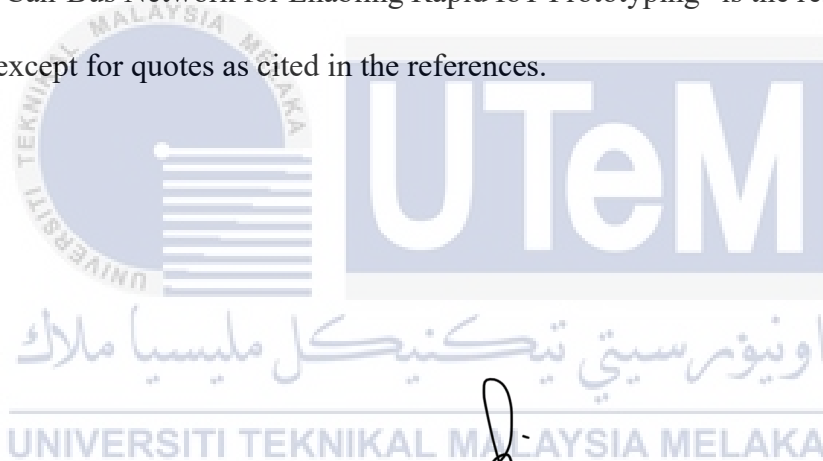
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## APPROVAL

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## DEDICATION

This thesis is dedicated to those who have helped me throughout this project and supported me throughout my education.



## ABSTRACT

Internet of Things (IoT) is widely used and are creating new opportunities for developing innovative application by leveraging on existing and new technologies. Multiple devices are becoming interconnected on developing IoT application. CAN-bus (Controller Area Network) is one of the options used for networking IoT devices. In the fast-changing IoT world, a prototype is a strategic perspective for executing an IoT proof-of-concept (PoC). However, IoT prototyping is a complex activity for inexperienced developers who have the idea to develop IoT prototype system but do not have electronic background or lack of engineering skills to develop IoT prototype rapidly. Besides that, building a full-fledged product or system required a high cost just to evaluate and test new idea and designs. Addressing that, this project focuses on designing an IoT multi-sensor monitoring system that allows anyone to easily assemble the system independently without an extensive understanding of IoT and electronic concepts. R-IoT allows the user to combine a low-power system on chip Wi-Fi microcontrollers for example ESP32 with an accelerometer, vibration or environmental sensor that is temperature, humidity, light, noise, air pressure, and air quality sensor depending on the prototype's requirements. Hence, R-IoT helps reduce development time and enables rapid proof-of-concept for IoT applications.

## ABSTRAK

*Internet of Things (IoT) digunakan secara meluas dan mencipta peluang baharu untuk membangunkan aplikasi inovatif dengan memanfaatkan teknologi sedia ada dan baharu. Pelbagai peranti dihubungkan dalam membangunkan aplikasi IoT. CAN-bus (Rangkaian Kawasan Pengawal) ialah salah satu pilihan yang digunakan untuk rangkaian peranti IoT. Dalam dunia IoT yang kian meluas, prototaip ialah inisiatif strategik untuk melaksanakan konsep bukti (PoC) IoT. Walau bagaimanapun, prototaip IoT ialah aktiviti yang rumit untuk pembangun yang tidak berpengalaman yang mempunyai idea untuk membangunkan sistem prototaip IoT tetapi tidak mempunyai latar belakang elektronik atau kekurangan kemahiran kejuruteraan untuk membangunkan prototaip IoT dengan pantas. Selain itu, membina produk atau sistem sepenuhnya memerlukan kos yang tinggi hanya untuk menilai dan menguji idea dan reka bentuk baharu tersebut. Untuk menangani masalah ini, projek ini memberi tumpuan dalam mereka bentuk sistem pemantauan yang mempunyai berbagai sensor IoT yang membolehkan sesiapa sahaja memasang sistem secara bebas tanpa pemahaman yang meluas tentang konsep IoT dan elektronik. R-IoT membolehkan pengguna menggabungkan sistem berkuasa rendah pada mikropengawal Wi-Fi cip contohnya ESP32 dengan penderia pecutan, getaran atau persekitaran iaitu suhu,*



*kelembapan, cahaya, bunyi, tekanan udara dan penderia kualiti udara bergantung pada keperluan prototaip. Oleh itu, R-IoT membantu mengurangkan masa pembangunan dan membolehkan pembuktian konsep pantas untuk aplikasi IoT.*



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## LIST OF SYMBOLS AND ABBREVIATIONS

BUS	:	Binary Unit System
CAN	:	Controller Area Network
CH	:	CAN-High
CL	:	CAN-Low
IoT	:	Internet of Things
LDR	:	Light Dependent Resistor
LOA	:	Limit of Agreement
UEQ	:	User Experience Questionnaire

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# CHAPTER 1

## INTRODUCTION



### 1.1 Project Background

Developing an IoT system requires a wide range of expertise and sometimes are difficult to be developed by inexperienced developers. Rapid prototyping has been filling this gap to allow developer to test their idea into proof-of-concept before developing a full-fledged system. R-IoT is a system that use CAN-bus network that was designed into 3D interlocking block that consist of main controller block and sensor block to enable IoT prototyping. R-IoT is a system that allow user to combine main block consist of microcontroller ESP32 with sensor block depending on the prototype's requirement. This system allows anyone to easily assemble the system independently without an extensive understanding of IoT and electronic circuit.

## 1.2 Problem Statement

Prototypes are often created to evaluate and test new idea and design rather than developing a completely develop product or system. The goal for prototyping is to incorporate only the core functionality and is built with inexpensive component to validate the feasibility of product design, clarify technical requirement and identify potential modification to ensure the design are fit for the design's purpose. However, (1) creating a prototype of IoT system is a complex task for developers that are not expert in IoT as it requires dealing with multi layered hardware and software infrastructure[1]. Apart from that, a (2) system usually takes years and are costly to move from conception to market and developers cannot afford a high cost just to evaluate a new design. Although a number of prototype tools are available to support IoT development, those tools are often bound to specific hardware and vendor-locked technologies[1]. Therefore, this project aims to analyze an IoT multi-sensor monitoring system using CAN-bus Network for enabling rapid IoT prototyping. This project breaks a complete electrical circuit that consist of sensor device into an interlocking block and allow developer to connect a group of sensors device using the CAN-bus without any constraint to enable the rapid IoT prototyping.

### 1.3 Objective

- i. To analyze CAN-bus Network for developing an IoT multi-sensor monitoring system.
- ii. To develop IoT data logger system and automation system.
- iii. To design a module for each CAN to develop a CAN Bus Network for IoT prototype system.



## 1.4 Scope of work

### 1) Hardware

- i. To design R-IoT 3D interlocking block module that can fit electronic component of the R-IoT system using 3D CAD software such as SolidWorks.
- ii. Print out the R-IoT 3D block module using 3D printer.

### 2) Software

- i. To program the connection of CAN-bus network to allow the connection of multiple sensors to the R-IoT system.
- ii. To program the ESP32 microcontroller and connect to Cayenne IoT dashboard.
- iii. To develop IoT data logger system that allow user to monitor the feasibility of the IoT prototyping with low-cost embedded device via Internet of Things (IoT) platform depending on the prototype's requirement.

### 3) End-User

- i. Everyone who have the idea to develop an IoT system and want to explore the possibilities whether the system is going to be useful without have to develop or design a circuit.

## 1.5 Thesis Outline

This thesis is contained of five chapters. The first chapter provides an introduction for this project to readers. This includes the background, problem statement, objectives and scope of work. Chapter 2 will discuss the overview and general knowledge about the Internet of Things, related work about the CAN Bus Network and rapid prototyping. In Chapter 3, project methodology and flow chart design to implement the process are further