

INDUSTRIAL MONITORING VIA TEXT MESSAGING WITH EMBEDDED PROGRAMMING

Ngo Boon Kiat

This report is submitted in partial fulfillment of the requirements for award of
Bachelor of Electronic Engineering (Computer Engineering) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2010



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Industrial Monitoring via Text Messaging with Embedded Programming
Sesi Pengajian : 2009/2010

Saya Ngo Boon Kiat mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan () :

SULIT*

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD*

(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

 (TANDATANGAN PENULIS)

 (COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: No 118, Lot 71, Abell Road,
 Off Padungan Road,
 93100 Kuching
 Sarawak.

Tarikh:

Tarikh:

“I hereby declare that this report is the result of my own work except for quotes as cited in the references.”

Signature : _____
Author : Ngo Boon Kiat
Date : _____

“I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of bachelor of Electronic Engineering (Computer Engineering) With Honours.”

Signature : _____
Supervisor's Name : Engr. Khairuddin bin Osman
Date : _____

*Dedicated to my beloved family
To my father and mother
To my respected lecturer/supervisor
And to all my coursemates
For their support, advice, patience and understanding.*

ACKNOWLEDGEMENT

First and foremost, I would like to express my deepest gratitude to my project supervisor, Engr Khairuddin bin Osman for his efforts, patience, guidance and critic in helping and guiding me throughout the course of my final year project.

My deepest appreciation to my industrial training supervisors, Mr. Thomas Oh Boon Hun and Mr. Wang Shu King for their support and encouragement in assisting me during my final year project. Without their support and help, this project would never have been completed in time.

Finally, my deepest thank to God for all the blessings and encouragement and without His guidance, realizing this project would be impossible.

Thank You.

ABSTRACT

This project will present the use of Embedded Programming in embedded language to perform industrial monitoring works remotely via text messaging service. Conventional industrial monitoring systems are tedious, inefficient and the at times integrity of the data is unreliable. The objective of this system is to monitor industrial processes specifically the fluid level which will measures the instantaneous fluid level parameter and respond by text messaging the exact value of the parameter to the user when being enquired by a privileged access user. In order to achieve the objective of this project, embedded programming is used to program the Nokia12i module device to perform arithmetic calculations and also to integrate it to establish a Global System for Mobile Communication (GSM) connection with the telecommunication network provider. This system ensures data integrity and efficiency of monitoring industrial processes in a more direct manner. This project will begin with a general introduction the project including the problem statements and objectives then moving on to the understanding of embedded java programming and text messaging as well as the principles of distances measuring using ultrasonic sensor. The development of the embedded program code and the circuit for fluid level measuring will be discussed as well. Finally, suggestions for future implementations and efficient remote monitoring works will be included.

ABSTRAK

Projek ini akan menjelaskan kegunaan Pengaturcaraan Terbenam untuk melakukan pemantauan proses industri secara kawalan jauh menerusi hantaran mesej teks dari telefon bimbit. Sistem pemantauan industri konvensional adalah membebankan, tidak cekap dan kadang-kadang integriti data tidak boleh dipercayai. Tujuan sistem ini adalah untuk memantau proses industri khususnya tahap cecair yang akan mengukur tahap cecair dalam parameter dan membalas dengan tepat nilai parameter tersebut dengan mesej teks bagi pengguna yang berhak. Untuk mencapai matlamat projek ini, pengaturcaraan terbenam adalah program yang digunakan untuk modul Nokia12i peranti untuk melakukan operasi kiraan dan juga untuk menyepadukan dengan sambungan Sistem Global untuk Komunikasi mudah alih (GSM) dengan rangkaian telekomunikasi yang sedia ada. Sistem ini menjamin integriti data dan kecekapan proses industri pemantauan secara langsung. Laporan ini akan bermula dengan pengenalan umum projek termasuk pernyataan masalah dan objektif dan juga pemahaman tentang pengaturcaraan terbenam dan teks mesej serta prinsip pengukuran jarak dengan menggunakan sensor ultrasonik. Di samping itu, kod program dalam pengaturcaraan terbenam dan litar skema untuk mengukur tahap bendalir akan termasuk dalam bab juga. Akhirnya, cadangan untuk implementasi masa depan dan pemantauan secara kawalan jauh akan disertakan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	PROJECT TITLE	i
	BORANG PENGESAHAN STATUS LAPORAN	ii
	DECLARATION	iii
	DEDICATION	v
	ACKNOWLEDGEMENT	vi
	ABSTRACT	vii
	ABSTRAK	viii
	TABLE OF CONTENTS	ix
	LIST OF TABLES	xiii
	LIST OF FIGURES	xiv
	LIST OF ABBREVIATIONS	xvi
	LIST OF APPENDICES	xvii
I	INTRODUCTION	
	1.0 Introduction	1
	1.1 Problem Statement	2
	1.2 Objective of Project	2
	1.3 Scopes of Project	3
	1.4 Report Outline	3
II	LITERATURE REVIEW	
	2.0 Introduction	5
	2.1 Embedded Systems	5

2.1.1	Embedded Computing	6
2.1.2	Embedded Architecture	7
2.2	Java™	8
2.2.1	Java is simple	8
2.2.2	Java is Platform Independent	9
2.2.3	Embedded Java	10
	2.2.3.1 About Embedded Java	11
	2.2.3.2 Embedded Java Platform Architecture	12
2.3	Remote monitoring (SMS)	13
2.3.1	Short Messaging Service	14
2.3.2	SMS Use Cases	14
	2.3.2.1 Consumer Application based on SMS	15
	2.3.2.1.1 Person-to-Person Messaging	15
	2.3.2.1.2 Information Services	16
	2.3.2.1.3 Voice Message and Fax Notification	17
	2.3.2.1.4 Internet Email Alerts	17
	2.3.2.1.5 Download Services	17
	2.3.2.1.6 Chat Applications	17
	2.3.2.1.7 Smart Messaging	18
	2.3.2.2 Corporate Application based on SMS	18
	2.3.2.2.1 Vehicle Positioning	18
	2.3.2.2.2 Remote Monitoring	18
2.4	Teltonik T-Box N12R	19
2.4.1	Nokia 12i	20
	2.4.1.1 Versatile	20
	2.4.1.2 Connectivity Support	21
	2.4.1.3 Reliable Application Development	21
	2.4.1.4 Other features	22
2.5	Principles of Ultrasonic Sensor	22
2.5.1	Effective use of Ultrasonic Sensor	22
2.5.2	Sound Velocity in the Atmosphere	22

III METHODOLOGY

3.0	Introduction	23
3.1	Wireless Messaging API	23
	3.1.1 Opening a connection	24
	3.1.2 Sending a message	25
	3.1.3 Receiving a message	26
	3.1.3.1 Using Wireless Messaging API specification	26
	3.1.3.2 Using the Embedded Terminal module	27
3.2	I/O Control API	28
	3.2.1 Using the I/O Control API	28
	3.2.2 Using the Embedded Terminal module	29
3.3	Compiling and Simulating the Java Imlet	30
3.4	Block Diagram	32

IV RESULTS AND ANALYSIS

4.0	Introduction	33
4.1	Receiving and Sending Text Messages	33
	4.1.1 Receiving Text Messages	33
	4.1.2 Sending Text Messages	35
4.2	Analog Voltage to Parameter Conversion	38
4.3	Power Failure Notification Alert	39
	4.3.1 Parameter Value Conversion	39
4.4	Embedded System Response Analysis	40
	4.4.1 Retrieval of Analysis Result of Process Duration	42
4.5	Accuracy Analysis	45
	4.5.1 Simulation Results	45
	4.5.2 Actual Practical Results	47
	4.5.3 Analysis of Simulation and Practical Results	48

V	CONCLUSION & FUTURE WORKS	
	5.0 Conclusion	51
	REFERENCES	53
	APPENDIX A	56
	APPENDIX B	57
	APPENDIX C	60

LIST OF TABLES

NO	TITLE	PAGE
4.1	Comparison for average differences of duration between program code with and without function call.	44
4.2	Correlation between analog voltage input with fluid level (simulation)	46
4.3	Correlation between analog voltage input with fluid level (practica)	47
4.4	Comparison between simulation and practical results	49

LIST OF FIGURES

NO	TITLE	PAGE
2.1	The same compiled program can be run on many different types of computer platforms.	8
2.2	Two JAVA-enabled devices: on the left, a lightweight configuration; on the right, a solution based on JAVA OS	13
2.3	Mobile device with external keyboard. Reproduced by permission of Alcatel	16
2.4	Teltonika T-Box N12R	19
2.5	Diagram of calculating the length L of the distance from the transmitted and received wave.	22
3.1	Connection protocol to be used	24
3.2	Trying and opening a connection through raised exception	24
3.3	Sending a message	25
3.4	Receiving a message	26
3.5	Using Embedded Terminal Module	27
3.6	Reference to Embedded Terminal Module	29
3.7	Building and Compiling the .JAVA file with Sun Java™ Wireless Toolkit	30
3.8	Simulating with the Nokia 12 IMP 1.0 Concept Simulator	30
3.9	The Nokia 12 Configurator	31
3.10	Loading the .jar file with the Nokia 12 Configurator	31
3.11	Proposed Project Block Diagram	32
4.1	Indicator to receiving text message	34
4.2	Receiving text message to trigger digital output	35
4.3	Setting text message payload text format	36
4.4	Trigger to sending text message	36
4.5	Triggered digital input no 5 on the Teltonika T-Box N12R	37

4.6	The sent text message send out by the Teltonika T-BoxN1R received	37
4.7	Low input triggering to send out message	39
4.8	Representation of integer, period and decimal fraction	39
4.9	Representation of integer, period and decimal fraction	40
4.10	Processing Speed vs Programming Code	41
4.11	Digital output pin number 2 is ON	42
4.12	Digital output pin number 9 is ON along with pin number 2	43
4.13	Digital output pin number 2 is then OFF, completion of a cycle	43
4.14	Processing Speed vs Programming Code	45
4.15	Analog Voltage Input vs Fluid Level height for simulation results	46
4.16	Analog Voltage Input vs Fluid Level Height for practical results	48
4.17	Comparison between simulation and practical results	49

LIST OF ABBREVIATION

API	-	Application Programming Interface
CHAP	-	Challenge Handshake Authentication Protocol
CORBA	-	Common Object Request Broker Architecture
EDGE	-	Enhanced Data Rate for GSM Evolution
ET	-	Embedded Terminal
GPRS	-	General Packet Radio Services
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communication
HSCSD	-	High Speed Circuit-switched Data
ORB	-	Object Request Broker
SMS	-	Short Messaging Services
TCP/IP	-	Transmission Control Protocol/Internet Protocol
UDP/IP	-	User Datagram Protocol/Internet Protocol

LIST OF APPENDICES

NO	TITLE	PAGE
A	Imported JAVA library for IO Control API and ET module	55
B	JAVA source code for project	56
C	JAVA source code analysis 4.4 ii)	59

CHAPTER I

INTRODUCTION

1.0 Introduction

During the past decade, the world has seen the paradigm shift into mobile computing and communications. Much of the business and educational work is now heavily relying on the fast access to information and easy communication channels, irrespective of terrain and climate conditions. Remote Industrial Automation is the proof-of-concept for controlling electronic devices based on wireless messaging. Using the existing system, it is possible to monitor industrial processes remotely. Moreover, it can offer other services such as image scanning and status updates. All these features can be accessed via hand-held devices that are used for attending and making calls.

Having that said, text messaging has come a long way and adapted into a more powerful form of professional applications. In our case, remote monitoring. Messages can transport information about the state of remote devices. For instance, system administrators can be notified by a short message that a server is running low of resources or that a fault has been detected on a remote computer [1].

This project uses embedded JAVA programming to program a GSM module that will measure and monitor fluid levels in an industrial process. A user is able to interact or query the current status of the monitoring parameters via text messaging

and the module will respond with the current status of the monitored sensor. In this remote monitoring application, the embedded GSM module is programmed to constantly monitors the parameters of the system and is able to perform calculations to measure the analog state of the parameter and respond in text format understood by the user and at the same time also functions as an alert monitor and will send out a notification to a pre-programmed user's phone number whenever a fault has occurred.

1.1 Problem Statement

Monitoring on industrial waste water discharge had been implemented across the country since decades but is usually confine to site. Monitoring and controlling industrial process maybe a tedious task where a person must be employed on site in order to monitor an industrial process which is a waste of money and time should there be no problem on site. Environmental Quality Act, 1974 and the Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979 [3], requires all industries with known point source of waste water discharge to install, monitor and report flow measurement of wastewater discharges from an industrial outlet.

Such method of monitoring is a time-consuming task, inefficient, subjected to fraudulence and centralize monitoring is almost impossible at times due to the site locality and limited resources of personnel present. Higher officials are unable to acquire first hand data but rather have to go through numerous unreliable intermediate channels.

1.2 Objective of Project

The project was to designed and implemented with the purpose of industrial monitoring via text messaging with embedded programming. Thus the objectives as follows should be achieved.

- (a) To design and develop an industrial monitoring system with embedded programming using JAVA.

- (b) To be able to use JAVA to program the GSM module to convert analog voltage into parameter values.
- (c) To enable users to interact or query the GSM module through text messaging to query the current status of the monitored parameter.
- (d) To enable the GSM module to be programmed to automatically send out an alerting text message whenever a power failure or the monitored parameter is at fault.
- (e) To design a fluid level measuring detector circuit that produces an analog voltage in reference to the fluid level.

1.3 Scope of Project

The scope of work for this project in order to fulfill the objectives is as follows:

- (a) Programming in embedded JAVA language.
- (b) Using the Nokia 12 Configurator to simulate the programmed program code.
- (c) Using the Sun Java Wireless Toolkit 2.5.2 as the compiler for the JAVA program.
- (d) Computing measured analog voltage of the monitored parameter into values.
- (e) Constructing a fluid level monitoring circuit.

1.4 Report Outline

This report consists of four chapters. The report begins with a general introductory for the project including problem statement, objective and scope of the project.

Chapter two will be the literature review where the concept and theoretical aspects are mentioned such as the understandings of embedded systems, the

versatility of the JAVA language in Embedded JAVA evolution and advancements of text messaging, better known as SMS (Short Messaging Services) as well as the specifications of the Teltonika T-BoxN12R which uses the Nokia 12i GSM Module. The principle of ultrasonic sensor for distance measuring would also be mentioned in this chapter as well.

Chapter three introduces the methodology for this project which involves programming source codes for sending and receiving text messages as well as the various programming syntax alternatives available for Module or API JAVA programming works. It also includes the schematics to be fabricated for an ultrasonic sensor used to measure the depth of the fluid being monitored.

Chapter four includes the results of the software works of this project through Embedded JAVA programming with available APIs in the Teltonika T-Box N12R to send and receive text messages.

Chapter five will be the conclusion for this project and future works that can be implemented with the Teltonika T-Box N12R device for improved remote monitoring works.

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

This chapter will describe the current trend of embedded system applications in the current market and its gradual popularity in terms of its architecture, and computing capabilities including JAVA and its demanding role in embedded systems with embedded JAVA. Also, the advent of short messaging service (SMS) and the role it plays in this system will be mentioned as well as a brief introductory explanation about the features of the Nokia12i and the Teltonika T-Box N12R.

2.1 Embedded Systems

In November 2005, Andrew David Moss [7] developed a program transformation tools in the analysis and compilation of programs for embedded systems to aid the programmer in understanding and controlling the effects towards software precision and timing and therefore reduces the complexity of the problem.

With the advent of system level integration (SLI)—the next level of integration beyond Very Large System Integration (VLSI)—and system-on-chip (SOC) capabilities, the computer industry's focus is shifting from personal to embedded computing. The opportunities, needs, and constraints of this emerging

trend will lead to significantly different computer architectures at both the system and processor levels as well as a rich diversity of off-the-shelf (OTS) and custom designs.

2.1.1 Embedded Computing

Driven by the accelerated pace of semiconductor integration during the past three decades, the computer industry has steadily moved from mainframes and minicomputers to workstations and PCs. In accordance with a corollary of Moore's law, computing power becomes half as expensive every 18 to 24 months. Over a decade, this reduces the cost by a factor of 30 to 100, making computing affordable to an exponentially larger number of users and dramatically changing the key applications of this computing power. [12] Manufacturers have for several years incorporated embedded computers in so-called smart products such as video games, DVD players, televisions, printers, scanners, cellular phones, and robotic vacuum cleaners. Using embedded computers in devices that previously relied on analog circuitry such as digital cameras, digital camcorders, digital personal recorders, Internet radios, and Internet telephones provides revolutionary performance and functionality that analog designs could not achieve. Any computer architecture must balance the latest technological opportunities with product, market, and application requirements that together determine three important features of embedded computing architecture: specialization, customization, and automation. Specialization increases the performance and reduces the manufacturing cost of embedded computer systems. Customization permits specialization when no adequately specialized OTS product is available. Automation reduces the design costs incurred by customization.

2.1.2 Embedded Architecture

The architecture of an embedded system is fairly significant and favourable in resolving challenges faced when dealing with new systems.

The most common of these challenges include:

- a) defining and capturing the design of a system
- b) cost limitations
- c) determining a system's integrity, such as reliability and safety
- d) working within the confines of available elemental functionality(i.e., processing power, memory, battery life, etc.)
- e) marketability and sellability
- f) deterministic requirements

In short, embedded systems architecture can be used to resolve these challenges early in a project. Without defining or knowing any of the internal implementation details, the architecture of an embedded device can be the first tool to be analyzed and used as a high-level blueprint defining the infrastructure of a design, possible design options, and design constraints. What makes the architectural approach so powerful is its ability to informally and quickly communicate a design to a variety of people with or without technical backgrounds, even acting as a foundation in planning the project or actually designing a device. Because it clearly outlines the requirements of the system, an architecture can act as a solid basis for analyzing and testing the quality of a device and its performance under various circumstances. Furthermore, if understood, created, and leveraged correctly, an architecture can be used to accurately estimate and reduce costs through its demonstration of the risks involved in implementing the various elements, allowing for the mitigation of these risks. Finally, the various structures of an architecture can then be leveraged for designing future products with similar characteristics, thus allowing design knowledge to be reused, and leading to a decrease of future design and development costs. [2]