

BORANG PENGESAHAN STATUS TESIS*

AUTOMATIC MEASUREMENT OF FUEL LEVEL FOR PETROL STATION
JUDUL : USING A PING ULTRASONIC SENSOR AND KALMAN FILTER

SESI PENGAJIAN : 2011 / 2012

Saya NURUL NADIRAH BINTI MOHAMAD KHAIRI

mengaku membenarkan tesis Projek Sarjana Muda ini disimpan di Perpustakaan Fakulti Teknologi Maklumat dan Komunikasi dengan syarat-syarat kegunaan seperti berikut:

1. Tesis dan projek adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan Fakulti Teknologi Maklumat dan Komunikasi dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan Fakulti Teknologi Maklumat dan Komunikasi dibenarkan membuat salinan tesis 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

(TANDATANGAN PENULIS)

Alamat tetap: 85, JLN KANCUNG LAUT
28/20, TAMAN ALAM MEGAH,
404000, SHAH LAM, SELANGOR.

Tarikh: 30 - AUG - 2012

(TANDATANGAN PENYELIA)

DR ABdul SAMAD b. SHIBAHATULLAH
Nama Penyelia

Tarikh: 30 - AUG - 2012

CATATAN: * Tesis dimaksudkan sebagai Laporan Projek Sarjana Muda (PSM).
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa.

**AUTOMATIC MEASUREMENT OF FUEL LEVEL FOR PETROL STATION
USING A PING ULTRASONIC SENSOR AND KALMAN FILTER**

NURUL NADIRAH BINTI MOHAMAD KHAIRI

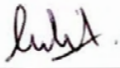
**This report is submitted in partial fulfilment of the requirements for the
Bachelor of Computer Science (Artificial Intelligence)**

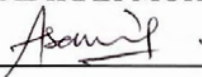
**FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2012**

DECLARATION

I hereby declare that this project report entitled
**AUTOMATIC MEASUREMENT OF FUEL LEVEL FOR PETROL STATION
USING A PING ULTRASONIC SENSOR AND KALMAN FILTER**

is written by me and is my own effort and that no part has been plagiarized
without citations.

STUDENT :  Date: 31-AUG-2012
(NURUL NADIRAH MOHD KHAIRI)

SUPERVISOR :  Date: 31-AUG-2012
(ABDUL SAMAD SHIBGHATULLAH)

DEDICATION

I dedicate this project report affectionately to the following:

My Parents, Mr. Mohd Khairi bin Daud and Mrs. Hasmah binti Salleh, who passed on a love of reading and respect for education.

My Auntie, Mrs. Haniah binti Salleh, who gave a lot of inspiration for this project.

My Siblings, Miss Nurul Kharima binti Mohd Khairi, Miss Fatin Amirah binti Mohd Khairi, Mr. Muhammad Haikal bin Mohd Khairi and Mr. Muhammad Huzair bin Mohd Khairi, who impressed me with their love.

My academic advisor, Miss Nuzulha Khilwani binti Ibrahim, who always gave her energy while I am in bad condition.

My lecturer, Dr Abdul Samad bin Hasan Basari, who gave his support and idea.

My Supervisor, Dr Abdul Samad bin Shibghatullah, without whose caring support it would not have been possible.

I also dedicate this project to myself as honest and patient in solving all problems that occur. The idea for this project I gained while working at a petrol station in Petaling Jaya. I use this idea from the workshop one to this degree project in the hope that this project will be continued so that it can be used in all petrol stations around the world.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious and the Most Merciful

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. Special appreciation goes to my supervisor, Dr Abdul Samad bin Shibghatullah, for his supervision and constant support. His invaluable help of constructive comments and suggestions throughout the experimental and thesis works have contributed to the success of this project. Not forgotten, my appreciation to my academic advisor, Miss Nuzulha Khilwani binti Ibrahim for her support and knowledge regarding this topic.

I would like to express my appreciation to the Head of Industrial Computing Department, Dr Abdul Samad bin Hasan Basari for his support and help towards my undergraduate affairs. My acknowledgement also goes to all the technicians and office staffs of Faculty of Information Technology and Communication for their co-operations.

Sincere thanks to all my friends especially Syareena, Athirah, Atiqah, Nur Izzati, Rashid, Imtiaz, Khairunnisa, Siti Fairuz, Zatul Alwani, Surya, Syazlin Amira and others for their kindness and moral support during my study. Thanks for the friendship and memories.

Last but not least, my deepest gratitude goes to my beloved parents; Mr. Mohd Khairi bin Daud and Mrs. Hasmah binti Salleh and also to my siblings for their endless love, prayers and encouragement. To those who indirectly contributed in this project, your kindness means a lot to me. Thank you very much.

Nurul Nadirah Mohd Khairi, August 2012

ABSTRACT

The objective of this project is to develop a more accurate way to measure the level in the fuel tank at petrol station and to improve the distance measuring technique to be easier and saving time. The level should be displayed for the petrol station so that the staff will be aware if the fuel level is too low. PING Ultrasonic distance sensor is a hardware component that will measure the amount of fuel in a tank. This device is separates into the two kinds, the transmitter and the receiver. This PING Ultrasonic distance sensor detects a reflected wave from the object after sending out an ultrasonic pulse. This about that can be measured by standing just at one place which means no need to measure for along the distance. By measuring the time which returns after emitting a sound wave, a distance to the object is measured. This project gives the improvement on reading technique compare by measure the distance manually. Basically, this project is separate into three main parts. The first one is to finds and designing the hardware that required and related to the project, the second part is to construct and develop the hardware together with testing and troubleshooting. Then the third is designing and develop the software part and combine together with the entire of hardware component developed. The micro controller, P8X32A-Q44 is use as interfacing to the output display. The fuel level estimated with a Kalman Filter method that uses fuel consumption and level measurement results in good performance. A more stable level estimate is achieved and a negative elevation of the estimate most of the time, as a result of fuel use. A more stable level estimate is achieved and negative elevations of the estimate most of the time. With this device it believes gives the improvement on reading technique. It also can reduce employee's health hazard and global warming effect caused by the emission of hazardous and dangerous gases from oil tank during dipping process.

ABSTRAK

Objektif projek ini adalah untuk membangunkan satu cara yang lebih tepat untuk mengukur tahap takat minyak dalam tangki di Stesen minyak dan memperbaiki teknik jarak pengukur untuk menjadi lebih mudah dan menjimatkan masa. Tahap takat minyak akan dipaparkan di stesen minyak supaya kakitangan boleh mengetahui jika tahap takat minyak adalah terlalu rendah. Alat pengesan PING adalah satu komponen perkakasan untuk mengukur jumlah takat minyak dalam tangki. Alat ini dipisahkan kepada dua jenis, pemancar dan penerima. Alat pengesan PING akan mengesan gelombang yang terpantul dari objek selepas menghantar denyut ultrasonik. Alat ini boleh diukur dengan hanya berdiri di satu tempat yang bermakna tidak perlu mengukur sepanjang jarak. Dengan mengukur masa yang kembali selepas mengeluarkan gelombang bunyi, jarak objek diukur. Projek ini memberikan peningkatan pada teknik bacaan berbanding dengan ukuran jarak manual. Pada asasnya, projek ini dapat dibahagikan kepada tiga bahagian utama. Yang pertama adalah untuk mencari dan mereka bentuk perkakasan yang diperlukan dan yang berkaitan dengan projek, bahagian kedua ialah untuk membina dan membangunkan perkakasan bersama-sama dengan ujian dan troubleshooting. Kemudian ketiga adalah merancang dan membangunkan bahagian perisian dan menggabungkan bersama-sama dengan keseluruhan komponen perkakasan yang dibangunkan. Pengawal mikro, P8X32A-Q44 digunakan sebagai pengantaramukaan untuk paparan keluaran. Tahap takat minyak yang dianggarkan dengan kaedah Penapis Kalman yang menggunakan bahan api dan keputusan pengukuran tahap prestasi yang baik. Anggaran tahap yang lebih stabil dicapai dan ketinggian negatif anggaran itu kebanyakan masa, akibat penggunaan bahan api. Tahap yang lebih stabil anggaran dicapai dan ketinggian negatif anggaran itu. Dengan alat ini, ia dipercayai dapat memberikan peningkatan pada teknik membaca. Ia juga boleh mengurangkan bahaya kepada kesihatan pekerja dan kesan pemanasan global yang disebabkan oleh pelepasan gas berbahaya dari tangki minyak semasa proses pencelupan.

TABLE OF CONTENTS

CHAPTER	SUBJECT	PAGE
	DECLARATION	II
	DEDICATION	III
	ACKNOWLEDGEMENTS	IV
	ABSTRACT	V
	ABSTRAK	VI
	LIST OF TABLES	XII
	LIST OF FIGURES	XIII
	LIST OF ABBREVIATIONS	XV
CHAPTER I	INTRODUCTION	
	ERROR! BOOKMARK NOT DEFINED.	
1.1	Overview	1
1.2	Problem Statements	2
1.3	Objective	4
1.4	Scopes	4
1.4.1	Approach used in this project	4
1.4.2	The project involved	5
1.5	Project Significance	5
1.6	Expected Output	6
1.7	Conclusion	6
CHAPTER II	LITERATURE REVIEW AND PROJECT METHODOLOGY	 7
2.1	Range, accuracy and error	7

2.2 Ultrasonic Technology	8
2.3 Sound propagation	10
2.4 Ultrasonic Sensor	10
2.5 The P8X32A-Q44 Microcontroller	12
2.5.1 Features:	12
2.5.2 Pin Assignments:	13
2.5.3 Key Specifications:	14
2.6 PING Ultrasonic Distance Sensor	14
2.6.1 PING Ultrasonic sensor features	14
2.6.2 PING Ultrasonic sensor dimension	15
2.6.3 PING Ultrasonic sensor Pin definition	16
2.6.4 PING Ultrasonic sensor Servo Cable and Port Cautions	17
2.7 Communication Protocol	18
2.8 Spin Language in Propeller Tool Version 1.2.7	19
2.9.1 The Spin Language Reference is divided into three sections:	19
2.10 Microsoft Visual Studio 2010	20
2.11 Calculation and Estimation of fuel level	22
2.11.1 Tank model	22
2.11.2 Kalman Filter Method	23
2.12 Project Methodology	25
2.12.1 Work Plan	25
2.13 Project Milestones	27
2.14 Conclusion	28
CHAPTER III	29
ANALYSIS	29
3.1 Introduction	29
3.2 Analysis of Manual Dipping Process and Fuel Level Estimation for Petrol Station using a Kalman Filter from aspect reading taken (mm³).	30
3.3 Analysis of Manual Dipping Process and Fuel Level Estimation for Petrol Station using a Kalman Filter from aspect Time taken (s).	30
3.4 Conclusion	31
CHAPTER IV	32
DESIGN	32

4.1 Introduction	32
4.2 Flow Chart	34
4.2.1 Flow Chart for PIC	34
4.2.2 Flow Chart for PC	35
4.3 Data Flow Diagram of AMF	36
4.4 Project Design	37
4.5 Project Element	42
4.6 Programming Language	43
4.7 Software	43
4.8 Conclusion	43
CHAPTER V	44
IMPLEMENTATION	44
5.1 Introduction	44
5.2 Software or/and Hardware Development Environment Setup	45
5.3 Software or/and Hardware Configuration Management	45
5.3.1 Hardware Configuration Environments Setup	45
5.3.2 Software Configuration Environments Setup	46
5.3.3 Firmware Configuration Environments Setup	47
5.3.4 Version Control Procedure	48
5.4 Implementation Status	50
5.5 Conclusion	53
CHAPTER VI	54
TESTING	54
6.1 Introductions	54
6.2 Test Plan	54
6.2.1 Test Organization	55
6.2.2 Test Environment	56
6.2.3 Test Schedule	57
6.3 Test Strategy	58
6.3.1 Testing Approach of the software development cycle	59
6.3.2 Classes of Tests	60
6.4 Test Implementation	62
6.4.1 Test Description	62

6.4.2 Test Data	65
6.5 Test Result and Analysis	65
6.6 Conclusion	67
CHAPTER VII	68
CONCLUSION	68
7.1 Introduction	68
7.2 Observation on Strengths and Weaknesses	69
7.2.1 The Strengths	69
7.2.2 The Weaknesses	69
7.3 Further Improvement	69
REFERENCES	70
BIBLIOGRAPHY	72
APPENDICES	73

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Time required for PING Ultrasonic Ultrasonic sensor pin process	18
2.2	Project Milestones	27
3.1	Standard deviation test between the AMF reading and manual dipping process reading	30
3.2	Time taken between the AMF and manual dipping process	30
4.1	Project Element of AMF	42
5.1	Hardware Environment Setup	46
5.2	Software Environment Setup	47
5.3	Firmware Environment Setup	48
5.4	Version Control Procedures for AMF	49
5.5	Implementation Status for Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter	51
6.1	Test Organization for Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter	55
6.2	Hardware and Firmware Configuration of Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter	56
6.3	Test Schedule for Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter	58

6.4	Software Testing Under Black-box and White-box Strategy	60
6.5	System Test for Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter	61
6.6	System Test Description for AMF	62
6.7	Test Result of AMF before correction	66
6.8	Test Result of AMF after correction	66

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Hysteresis, also known as backlash	8
2.2	Principle of Active Sonar	9
2.3	Basic arrangement for ultrasonic level measurement	11
2.4	PING Ultrasonic sensor dimension diagram	15
2.5	PING Ultrasonic sensor Standard connections	16
2.6	PING Ultrasonic sensor process diagram	16
2.7	PING Ultrasonic sensor servo cable and port diagram	17
2.8	PING Ultrasonic Ultrasonic sensor I/O pin waveform	18
2.9	Propeller Tool Version 1.2.7	19
2.10	Microsoft Visual Studio 2010	20
2.11	Visual Basic.NET Interface	21
2.12	Box schematics showing how the KF uses feedback of the difference between the estimated and measured value for the volume to control the state-space model	24
2.13	Model underlying the Kalman filter. Squares represent matrices. Ellipses represent multivariate normal distributions (with the mean and covariance matrix enclosed). Unenclosed values are vectors	25
2.14	Basic Project Procedure	26
4.1	PING Ultrasonic sensor process diagram	37
4.2	Ultrasonic Distance Sensor diagram (Front view)	37
4.3	Ultrasonic Distance Meter diagram (top view)	38
4.4	Ultrasonic Distance Meter diagram (right view)	38

4.5	Ultrasonic Distance Meter diagram (All view)	38
4.6	AMF Interface in Visual Basic.NET	39
4.7	AMF Interface in Visual Basic.NET	39
4.8	AMF Interface in Visual Basic.NET	40
4.9	AMF Interface in Visual Basic.NET	40
4.10	AMF Interface in Visual Basic.NET	41
4.11	AMF Interface in Visual Basic.NET	41
6.1	Black Box diagram	59

LIST OF ABBREVIATIONS

AMF – Automatic Measurement of Fuel Level for Petrol Station using a PING Ultrasonic sensor and Kalman Filter

KF – Kalman Filter

ICT – Information Communication and Technology

VB.NET – Visual Basic.NET

SONAR - SOund NAVigation and Ranging

UT – Unit Test

CHAPTER I

INTRODUCTION

Chapter introduction goes in this first paragraph. This chapter basically discusses the project overview, problem statements, objectives, scopes, project significance, expected output and the conclusion. The project overview section briefly introduces the situation / organisation upon which this project is based on. Problem statement section highlights the problems faced by the organisation / situation. Objectives section explains about the purpose this system is develop. Scopes section explains the approach used in this project. Project significance explains why this project is developed. Expected output section explains the hypothesis about the project and the conclusion.

1.1 Overview

All kinds of devices or equipments nowadays, begin with the basic design with the basic theory and then all the weakness followed by improvement step-by step. So this project also do right the same reason which the improvement will be applied to bring the advantages to the user when measuring the fuel level depending on several problems that had been identified. The problems occurs from the current manual process that one will be improvement soon is identified by covering some factors likes the functionality, reliability, and also safety besides covering on cost so that the aim of why this improvement is carry out will be achieve. Generally, this

project is developing due to improve the measurement technique become easier, more effective and reliable to the distance reading result through a device with ultrasonic deflection wave technology and the calculation with a Kalman Filter method . What the most important purpose of why this project is being carries out is the ultrasonic technology that used for this project is one of the medium on how the distance of fuel level in the tank will be measure. Basically this ultrasonic technology is came from and based on ultrasound and a common use of ultrasound is in range finding that perfectly related to the objectives of this project. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of the fluid. Up until now the accuracy of the fuel level measurement has not been of great importance. The purpose measuring the fuel level has been to present the information to the petrol station. Instead of accuracy the two most important things have been to avoid rapid changes in the fuel level displayed and the meter must indicate that the tank is empty when the fuel level is below a predefined level. This project investigates the possibilities of getting a more accurate fuel level estimation using the current hardware and Kalman Filter method. The goal is to accurately estimate the fuel level and compare it to the fuel level estimation method currently used Dipping Process.

1.2 Problem Statements

Petrol Station is a facility which sells fuel for motor vehicles. This is the place that people or also can call as a customer can get fuel for their motor vehicles. Customer will come to the petrol station every day. Although customer can get their fuel every time but sometimes the fuel in the tank can be finished and the staff of the petrol station need to tell customer that their station have no fuel anymore. This matter can make customer feel angry because they have to find the next station to get the fuel. This also can make customer have no confident to come to the station again. This matter is happen in Malaysia because; there have no system at a petrol station that will keep up the data after process of dipping automatically. The staffs need to write the data in the form and the form will be store in the file. Then, admin will check the data to send the data to the Shell Headquarters.

project is developing due to improve the measurement technique become easier, more effective and reliable to the distance reading result through a device with ultrasonic deflection wave technology and the calculation with a Kalman Filter method . What the most important purpose of why this project is being carries out is the ultrasonic technology that used for this project is one of the medium on how the distance of fuel level in the tank will be measure. Basically this ultrasonic technology is came from and based on ultrasound and a common use of ultrasound is in range finding that perfectly related to the objectives of this project. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of the fluid. Up until now the accuracy of the fuel level measurement has not been of great importance. The purpose measuring the fuel level has been to present the information to the petrol station. Instead of accuracy the two most important things have been to avoid rapid changes in the fuel level displayed and the meter must indicate that the tank is empty when the fuel level is below a predefined level. This project investigates the possibilities of getting a more accurate fuel level estimation using the current hardware and Kalman Filter method. The goal is to accurately estimate the fuel level and compare it to the fuel level estimation method currently used Dipping Process.

1.2 Problem Statements

Petrol Station is a facility which sells fuel for motor vehicles. This is the place that people or also can call as a customer can get fuel for their motor vehicles. Customer will come to the petrol station every day. Although customer can get their fuel every time but sometimes the fuel in the tank can be finished and the staff of the petrol station need to tell customer that their station have no fuel anymore. This matter can make customer feel angry because they have to find the next station to get the fuel. This also can make customer have no confident to come to the station again. This matter is happen in Malaysia because; there have no system at a petrol station that will keep up the data after process of dipping automatically. The staffs need to write the data in the form and the form will be store in the file. Then, admin will check the data to send the data to the Shell Headquarters.

The problem includes the difficulty faced by the admin to find the data in the file. It will take a time to check the data manually. Next problem is if the staffs take a wrong reading of fuel that left in the tanks the admin have to cover their losing if they order fuel exceed from the limit of the tanks. For a better management, the system will provide automatic system where the ultrasonic sensor that added in the tank will send the value of fuel that left in the tank to the system. The reading of the data is use by the system and the data will be calculated using a Kalman Filter. The system will keep up the data in the database and it will be easy for the admin to check the data. System also will calculate the total fuel volume in mm³. Next the system will show the tanker loading capacity and fuel level whether it is are high, medium, low or no fuel in the tank. Currently, staffs at petrol station use a stick in the tank to take a reading of fuel level left in the tank. Then, they insert the reading in a book to be recorded to the database manually. By this method, there are several problems that occur during measurement activity and could affect the result at the end. The lost of data also would be consider while handle this method. The most problems that identified for this project are

1. The non-accurate reading taken from distance measurement

- Know that the accuracy of the reading will be affected when the long distance had been taken. Typically by using the measurement stick, the user should take at least 3 time of reading result to have the average of result in order to have the accurate reading of distance measurement.

2. Time taken during the distance measurement process.

- Practically, when the reading is taken frequently to get the accurate result, the time that taken to carry out that result also will be affected. That mean measure the distance manually using measurement tape is quite wasting time and energy.

3. Safety of injury during handling the measurement devices/tools and

- When handling any devices or tools especially consist of mechanism compartment's tools, we most facing to the safety of injury.

4. Employee's health hazard

- The vapors of dangerous gases from the tank will affect the staff health.

1.3 Objective

Point of the whole flow of this project had been classified first to bring out the expected result successfully with considering the statement of the problems that already being identified for this project. So the following project objectives mannerly had been created to make sure the aim of this project will be achieve at in the end:

1. To build a distance meter using ultrasonic technique that can measure the fuel level.
2. To develop the fuel level calculation and estimation system using a Kalman Filter method.
3. To design a device to be implemented to the petrol station application.

1.4 Scopes

The ultrasonic sensor was designed for petrol station where the sensor will detect and measure the fuel level in the tank. The fuel level data will be sending automatically to the system. The detection will be calculated with a KF (Kalman filter) that uses level measurement results. Staff of the petrol station no need to do the dipping process that will take time to be inserting to the system.

1.4.1 Approach used in this project

1. Design and develop a method on how to measure the distance by using wave deflection technology (ultrasonic signal).
2. Process and develop the solution to calculate the measurement data to have the expected result.
3. Compare the result that how far the improvement have been done.

1.4.2 The project involved

1.4.2.1. Hardware

- The hardware development consists of the design, redesigns, testing and troubleshoots all the circuit involved.
- Build up the hardware for every stage of circuit.
- Assemble the component as well as reducing the cost.

1.4.2.2. Software

- The software part will base on the simulations and hardware itself for all the project parts on the PING Ultrasonic distance sensor.
- The Visual basic.NET is used to calculate the fuel level that left in the tank using a Kalman Filter method.

1.4.2.3. Firmware;

- This part consists of programming the software into the PIC microcontroller in hardware site and programming in the Visual Basic.NET. This combination of hardware and software should bring the expected result successfully that will measure the distance correctly compare to the real distance measurement.

1.5 Project Significance

The significance of this project is to reduce employee's health hazard and global warming effect caused by the emission of hazardous and dangerous gases from oil tank during dipping process. And also improve the distance measuring technique to be easier and saving time. This sensor will help in taking fuel level data in the tank without need to do a dipping process. This sensor and measurement system also will increase the time of transferring data to the system and to headquarters. Moreover, increase the accuracy of the estimation of fuel tank level.

1.6 Expected Output

The expected output for this project is a developed hardware device that can measure the fuel level in the tank based on the P8X32A-Q44 microcontroller and able to do the measurement by standing just one site of measurement range. The distance then will be calculated and estimated using a Kalman Filter method in Visual Basic. NET to get accurate reading.

1.7 Conclusion

As a conclusion, it is clearly explained that this project is develop to eliminate current manual dipping process that is not accurate and need more time to measure the fuel level that left in the tank. The Kalman Filter method is believe will give the accurate reading based on series of measurements observed over time.

CHAPTER II

LITERATURE REVIEW AND PROJECT METHODOLOGY

Chapter literature review and project methodology goes in this second paragraph. This chapter basically discusses the literature review and project methodology. The literature review in this chapter briefly explains the range, accuracy and error. And also explains the ultrasonic technology, sound propagation, ultrasonic sensor, The P8X32A-Q44 Microcontroller, PING Ultrasonic Sensor, Communication Protocol, Spin Language in Propeller Tool Version 1.2.7, Microsoft Visual Studio 2010, Calculation and Estimation of fuel level, Project Milestones and the conclusion.

2.1 Range, accuracy and error

The measuring distance, measuring interval and range are terms which describe the difference between the lower and upper limits that can be measured. The range ability or turndown is the ratio between the upper limit and lower limits where the specified accuracy can be obtained. The error is a measurement of the difference between the measured value and the true value. The accuracy is the maximum error which can occur between the process variable and the measured value when the transducer is operating under specified conditions. Errors can occur for several reasons such as calibration error, manufacturing tolerances and environmental effects