UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CROSSWIND DETECTION FOR DIRECTION AND SPEED MONITORING SYSTEM AT HIGHWAY

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electronics Engineering Technology (Industrial Electronic) with Honours.

by

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I hereby, declared this report entitled “Crosswind Detection for Direction and Speed Monitoring System at Highway” is the results of my own research except as cited in the references.

Signature : **……..……**

Name : **AHMAD THARMIZI BIN MD SUKHAIMI**

Date : **19 DECEMBER 2015**

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Industrial Electronic) with Honours. The member of the supervisory is as follow:

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Supervisor's Name	**:**	**SHAHRIZAL BIN SAAT**
Date	**:**	**19 DECEMBER 2015**

ABSTRACT

In becoming a developed country, Malaysian government had built infrastructure, including new highway for easy commute. The travelling time has been shortened as the road is wider and convenience. However, some deficiencies that have to be faced by the drivers such as an accident occur connected with the crosswind. From Malaysian Institute of Road Safety Research (MIROS) in review report 2009, crosswind represented only 0.5% of the total accident cases. The effect of the crosswind is one of the most critical problems connected to the vehicle safety and stability. Conventional windsock is no longer effective in present time to avoid accident happen. Therefore, the general purpose of the Crosswind Detection Monitoring System at Highway is to measure and monitor the speed and direction of crosswind from time to time. An aerovane is a device used to measure wind speed and wind direction. Wind speed is measured using aerovane is more accurate because it measures wind speed parallel to the wind direction. Besides, with the creation of this system, it can give awareness to highway user in the crosswind area with LCD displays the speed and direction of winds and reduce possibility accident in the crosswind area on the highway.

ABSTRAK

Dalam menjadi sebuah negara membangun, kerajaan Malaysia teah membina infrastruktur termasuk lebuh raya baru untuk kemudahan berulang alik. Masa perjalanan manjadi bertambah singkat, kerana keadaan lebuhraya yang lebih lebar dan selesa. Walau bagaimanapun, terdapat juga beberapa kelemahan yang perlu ditanggung oleh pengguna lebuhraya, salah satu daripadanya adalah faktor kemalangan berlaku dikaitkan dengan angin lintang. Dari Institut Keselamatan Jalan Raya Malaysia (MIROS) dalam kajian laporan 2009, angin lintang mewakili hanya 0.5% daripada jumlah kes kemalangan. Kesan angin lintang adalah salah satu masalah yang paling kritikal berhubung dengan keselamatan kenderaan dan kestabilan. Penggunaan kain angin tidak lagi berkesan pada abad sekarang untuk mengelakkan kemalangan berlaku. Oleh itu, tujuan umum Sistem Pemantauan Pengesanan Angin Lintang di Lebuhraya adalah untuk mengukur dan memantau kelajuan dan arah angin lintang dari semasa ke semasa. Kincir angin adalah alat yang digunakan untuk mengukur kelajuan angin dan arah angin. Kelajuan angin diukur menggunakan kincir angin adalah lebih tepat kerana ia mengukur kelajuan angin selari dengan arah angin. Selain itu, dengan penciptaan sistem ini, ia boleh memberi kesedaran kepada pengguna jalan raya di kawasan angin lintang dengan paparan LCD kelajuan dan arah angin dan dapat mengurangkan kemalangan kemungkinan di kawasan angin lintang di lebuh raya.

DEDICATIONS

In the name of ALLAH the Most Gracious the Merciful Thousands of appreciation to ALLAH for giving me strength, strong, ideas and knowledge that helps me to finish this project.

For my beloved parents, my dear lecturers especially Mr. Shahrizal bin Saat as my supervisor and all my friends. May ALLAH bless all of you as for giving me the motivation and support to do with this project. I am nowhere near who I am now.

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CHAPTER 1
INTRODUCTION

1.0 Introduction

A Weather measurement tools are essential for humans, which is used to determine the actual and forecast weather, and wind is one of the elements of weather that can be measured. It is a known fact that the wind really affects our daily lives. Good and even bad situations can be caused by wind. The wind brings rain from one place to another cool down the heat, and in some windy area, the wind can be used to generate electricity. However, it can also be disastrous, such as heavy rain is very dangerous for people driving on the highway, and not to mention, storms and hurricanes that are capable of producing large-scale disaster. With advances in technology nowadays, measuring weather especially wind, is made easily and accurately performed because it can improve the quality of our lives.

1.1 Background

The system is complete with rotary encoder and a breakout board rotary switch that converts the angular position or movement of the shaft for analog or digital code. The input to the system would be the speed and direction of winds. While the output of this system is the visual basic of the crosswind monitoring system and display local indication are located before the user enters the cross wind area. It is located in a control room for a highway management office. The GUI allows the use of icons or other visual indicators to interact with electronic devices than using only text through the command line. In Visual Basic, we are presented with a graphical user interface that allows to drag the visual elements like picture box, button, and the form and then creating an event and triggering of the elements. In this system, the visual basic to visual about the wind speed and wind direction.

1.2 Problem Statement

Nowadays the weather is unstable, to reduce an accident on the road to create something must be alert the drivers of the current speed and direction of crosswind on the highway. This project investigates the design criteria required for the cross wind detector to protect vehicles using the highway across the crosswind. It is important to all road users to suite their vehicle speed according by the current situation in ways to prevent overturning and side slip can cause an accident. The LCD display and monitoring system will indicate the speed and direction of wind to the user and plus center when user through the windy area.

1.3 Objectives

The objectives of this project are to:

i. To measure the speed and direction of the crosswind.
ii. To give awareness to highway user in the crosswind area with LCD displays the speed and direction of winds.
iii. To reduce possibility accident in the crosswind area on the highway.

1.4 Scope

i. Software: This system also used the Graphical User Interface (GUI) develop using Visual Studio 2010 (VB). Visual Basic is presented with a graphical user interface that allows to drag visual elements like windows, buttons, and forms and then create events and triggers for those elements.

ii. Hardware: This project developed the system using PIC 18F4550. A microcontroller PIC 18F4550 is used to count the number of pulses from the rotary encoder sensor and breakout board rotary switch sensor. From this count it calculates the wind speed and wind direction according to a mapping algorithm. The speed and direction of crosswind will be display using LCD 16x2 and USB to UART for interface the hardware with visual basic.

iii. Prototype: The Aero vane are precision instruments to measure wind speed and direction. The wind speed is detected by 11-bladed impeller mounted on a rotary shaft encoder. The pulse output with respect to the wind speed. Wind direction detected by breakout board rotary switch.

1.5 Project Significance

In this project, the main target users are drivers and motorcyclists use the highway. To measure the speed and direction of the crosswind, the rotary encoder and breakout board rotary switch as the main input to a PIC microcontroller. At the same time, this project and its research findings will be very useful as it will enable the road users to be aware of danger of crosswind. A lucrative LCD (Liquid Crystal Display) has been used to display the speed and the wind direction angle. The changes of the wind speeds were simultaneously measured and displayed on the LCD. Then, this project also interfaces with visual basic for the monitoring system. This system will provide information to the call center (PLUS) about the crosswind speed and crosswind direction. By the meanwhile, the recommended speeds of vehicles will be displayed which were suited with the current wind speeds. Suitable vehicle speed across the wind especially in high risks spots at highway is important in ways to

prevent undesired incident such as overturning and side slip. At the meantime, the number of accidents among the road users can be reduce.

1.6 Thesis Structure

There are five chapters in this thesis. Chapter 1 is this project introduction. Great idea and objectives can be found in this chapter. Problems involving while doing this project were also discussed. The scope and the report outline readable in this chapter.

This chapter 2 content gives the reader with pieces of information in implementing this project. Theory in PIC microcontroller, rotary encoder kits, breakout board rotary switch and others readable in this chapter.

Chapters 3 discussed the design and implementation of speed and direction of winds. Each part of circuit for designing this crosswinds sensor is shown in this chapter, such as a basic circuit for PIC 18F4550, implementing speed and direction sensor, and information for programming the microcontroller. Method of design and calculation in this project were discussed in details.

Chapter 4 describes the results and analysis of the project. Results and pictures of each part of the circuit shown in this chapter. Chapter 4 also includes details of the tests performed on the system.

Chapter 5 are the discussions and conclusions of this project. Future proposed can be read from this section, so that everyone who wants to use this project as a reference would know the limitations and potential.

References and appendixes are attached at the end of this thesis.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter discusses primarily on the research project, theory and recent development in crosswind detection for direction and speed monitoring system at highway. It includes an overview of the PIC kits SK40C and PIC18F4550, RE08A rotary encoder, BB-RS Breakout Board Rotary Switch, and the software used in this project.

2.1 Research Project

Research regarding accident and crosswind actually have done in past year ago. Based on the research from Korea University, the research of the title is “Design Criteria of Wind Barriers for Traffic” to study and investigates that vehicle in coastal regions or in a valley area sometimes deviate from their desired path because of the strong crosswind accelerated by the concentration of flow over the bridges or valleys. In Malaysia, no proper attention was given by authorities' awareness of hazard associated with cross winds. Others hand, no emphasis is given by the authorities about the threat of environmental factors to highway users. By observing and predicting the impacts of environmental factors on highways, transportation experts who operate the Nation’s roadways can determine appropriate management strategies such as reducing speed limits to make driving safer during and after inclement weather. These issues are usually taken for granted. Below is a newspaper cutting article regarding crosswind and accident.

SEMASA VIRAL

Juruteknik TNB cedera parah

Wartawan Sinar Harian | 22 April 2015

Anggota bomba memberi bantuan segera kepada mangsa sebaik tiba di lokasi kejadian.

Kereta dinaiki Saharuddin bersama dua anak saudaranya terjunam ke dalam longkang selepas dipukul angin lintang.

KEMAMAN – Seorang juruteknik Tenaga Nasional Bhd (TNB) cedera parah apabila kereta dinaikinya terbabas lalu terjunam ke dalam longkang sedalam 1.5 meter dipercayai akibat terkena tiupan angin lintang, petang kelmarin.

Kemalangan berlaku lebih kurang jam 3.30 petang di Kilometer 265.8 Lebuh Raya Pantai Timur Fasa 2 (LPT2) berdekatan Cheneh.

Ketika kejadian, mangsa, Shaharuddin Mohamad, 30, dalam perjalanan dari rumahnya di Bukit Besi, Dungun menghala ke Kuala Lumpur untuk kembali bekerja selepas beberapa hari bercuti kerana melangsungkan majlis pertunangan.

Figure 2.1: Newspaper Cutting

Based on the articles, precautions should be done to prevent the accident happening. To reduce accidents, criteria for an appropriate driving speed limit and proper countermeasures such as providing wind barriers has been demanded. A large amount of research has been carried out in this field. The monitoring system consists of basic two parts, mechanical and electronic. The wind speed sensor senses the speed of wind and produces a mechanical signal. Then this mechanical signal is converted into electrical signal by using a signal converter and in conclusion this electrical signal converts into pulse train using a pulse generator. Then the processing of electrical

signal has been done by a Microcontroller which counts these pulses and calculates the instantaneous wind speed according to a mapping algorithm which is shown by a Liquid crystal display (LCD).

On the other hand, by sensing this wind speed the wind direction sensor turns to the respective direction and produces a mechanical signal which is converted into an electrical signal with a signal converter. By processing this electrical signal, microcontroller calculates the respective wind direction angle and direction is shown by Light emitting diode (LED). This system by (Shuvra Dey Babu, 2014).

Besides that, an aero vane is one of the devices that is used to measure wind speed and direction. This project mainly focuses on using microcontroller PIC 16F877A to control the circuit and building the aero vane type wind vane model. Hall Effect sensor is used for speed measurement and 10kOhm potentiometer for direction detection. The sensor resolution for speed measurement is one pulse per rotation. For direction, the specific direction is determined at every 45° rotation of the potentiometer. The microcontroller is used as a central controller to measure the speed and direction of the wind and displays it on a 16 x 2 characters LCD. From the measured pulse per minute, the speed is calibrated for displaying the value in km/h. While the direction will be displayed in specific direction which is North, Northeast, East, Southeast, South, Southwest, West, and Northwest. Based on the output, the PIC 16F877A can be an ideal microcontroller for developing this project. However, the aero vane modelling should be done in a more accurate manner to get a more accurate wind measurement said (Mohd Mokhtar Bin Ismail, 2007).

At the other hand, time-difference ultrasonic wind speed and direction detection method is introduced. The two transducers are operated on unilateral V-mode. After the up-stream and down-stream echo signal being sampled, interpolated and cross-correlated, the time-difference of the echo signal is gained in accordance with the peak of the echo signal's cross-correlated function. Through the time-difference, the wind speed and direction can be measured indirectly. The time-resolution of the echo signal is improved and the measure of the minuteness time-difference is realized by the data interpolation. The Wavelet Transform and Temperature Compensation is used to depress the environmental noise and revise the

error of the velocity of sound. The high detection precision and good statistic characters of the system had been proved by the experiment by (Li Yiding, 2007).

Then, a coupled Computational Fluid Dynamics (CFD) and heat transfer model of an ice-covered FRP hot stick, elaborated in a previous study, could well explain why the flow of partial discharge current could be sufficient to raise the temperature of an iced pollution layer just below freezing, where the cold-fog flashover mechanism prevails. However, the ice-covered hot stick was modeled as a solid “ice rod” having an equivalent cross section of ice meaning that the exposed ice surface is smaller in the model compared to reality. As well, the simulations were performed for a relatively low wind speed of 1 m/s, while average wind speeds of 6.1-14.4 m/s were reported for the two Manitoba flashovers. Both of these problems are addressed in this paper to deal with the site incident conditions. The ice cover is considered as a thin layer having a thickness of 1 mm on the FRP hot stick. The effects of wind speeds of 0.1-15 m/s and wind direction as parallel and perpendicular to ice-covered FRP hot stick are studied. The paper also presents experimental investigations on the most reliable reproduction of four separate FRP hot sticks flashover incidents in Canada achieved at CIGELE laboratories (Mona Ghassemi, 2015).

2.2 Microcontroller PIC18F4550

The microcontroller is a single IC containing microprocessors, memory, I/O capability and other sources. Among the favorites are a microchip PIC, Motorola's 68HC11, Intel 8051 and others. The development of microcontroller driven by various factors such as versatility, ease of programming, low cost and small size (John Iovine, 2004).

Microcontrollers are usually embedded in Mechatronic systems for implementing intelligent control based on various inputs. For example, a microcontroller in air conditioner which monitors the control panel for user input updates the necessary graphical control and control for user input, update necessary graphical control and control temperature (John Iovine, 2004).

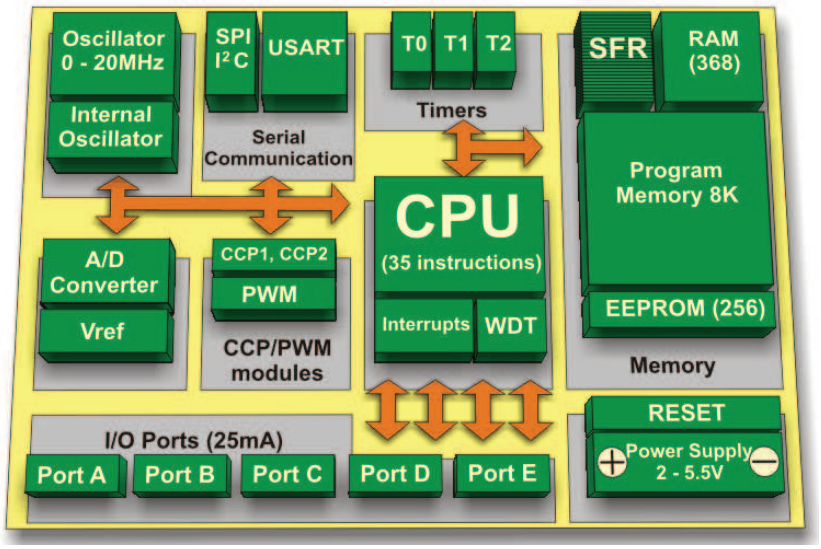

Figure 2.2: Typical Diagram of Microcontroller

Figure 2.1 shows a block diagram of a typical full-featured microcontroller. CPU (Central Processing Unit) is responsible for executing software stored in ROM and controls all the other components. The RAM is volatile data storage components. It is used to store settings and values when the program is running during. When the power is turned off, all data in RAM will be lost as well. While RAM is temporary storage components, ROM is used to store data permanently (non-volatile).

The digital I/O ports, analog to digital converter (A/D) and digital to analog converter (D/A) is used for input / output interfacing and signal conditioning. The I/O port can also be used to transmit signals to and from other microcontrollers to coordinate various functions.

The microcontroller can use the serial port to transmit data to and from external devices, provided that the equipment supports the same serial communication protocol. On board timers are usually provided to help ensure event or creating a delay occur at precise time intervals.

The Microchip PIC18F4550 microcontroller was chosen for this project because a lot of information online, easily accessible (close, cash and carry), low cost and ease of use.

2.2.1 PIC18F4550 Details

Figure 2.2 shows the general framework PIC18Fxx microcontrollers. The detailed documentation of all microcontroller's features and capabilities can be found in the manufacturer's data sheet which is available on the microchip web site.

Generally, the devices in the PIC18F4550 are available in 28-pin and 40/44-pin packages. The devices are differentiated from each other in six ways:

i. Flash program memory (24 KBytes for PIC18FX455 devices, 32 KBytes for PIC18FX550).
ii. A/D channels (10 for 28-pin devices, 13 for 40/44-pin devices).
iii. I/O ports (3 bidirectional ports and 1 input only port on 28-pin devices, 5 bidirectional ports on 40/44-pin devices).
iv. CCP and Enhanced CCP implementation (28-pin devices have 2 standard CCP modules, 40/44-pin devices have one standard CCP module and one ECCP module).
v. Streaming Parallel Port (present only on 40/44-pin devices).

Like all Microchip PIC18 devices, members of the PIC18F2455/2550/4455/4550 family are available as both standard and low-voltage devices. Standard devices with Enhanced Flash memory, designated with an "F" in the part number (such as PIC18F2550), accommodate an operating VDD range of 4.2V to 5.5V. Low-voltage parts, designated by "LF" (such as PIC18LF2550), function over an extended VDD range of 2.0V to 5.5V (Martin P Bates, 2004).

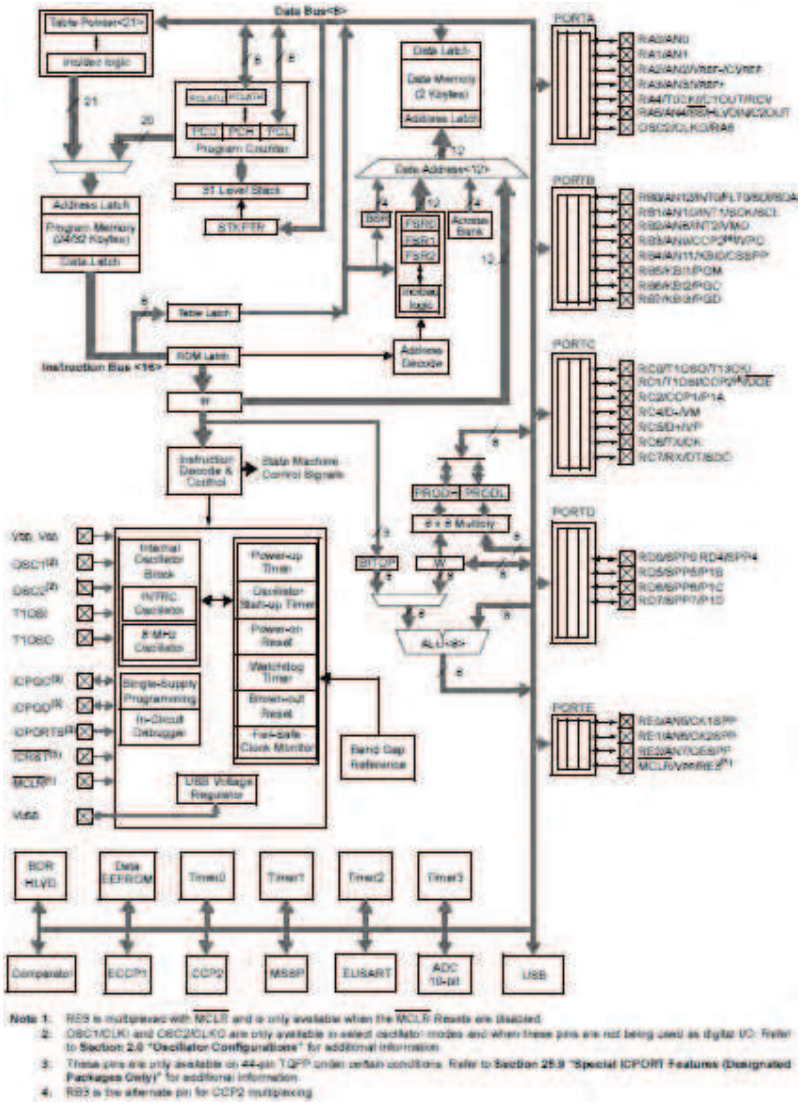

Figure 2.3: PIC18F4550 Block Diagram

2.2.2 SK40C 40 Pins Pic Start-Up Kit

The figure 2.4 showed the SK40C as the main circuit for this project, which is used the 40pins PIC microcontroller start-up kit. It is designed to offer am easy to start boarding for the PIC MCU user. This board with the basic element to begin project development. It offers plug and use features. It is able to utilize the function of PIC by directly plug in the I/O component in whatever way that is convenient for use. With UIC00A/B connector on board, it's easy to develop the project.