
**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

# Design and Development of a Control System based on Engine Speed

PSM report submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Robotics & Automation) with Honors.

By

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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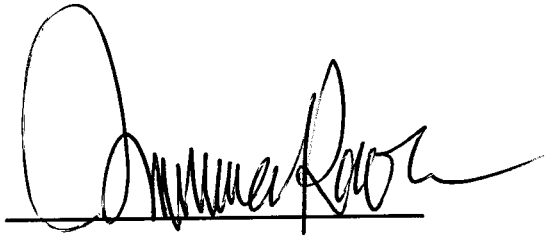
# APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (*Robotic & Automation*). The member of the supervisory committee is as follow:



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# ABSTRACT

Speed sensing application has been known in the automotive industry as mostly all the machines require speed sensing system to control the speed in order to obtain a desirable output. In fact, the speed sensing has been use in many applications such as camshaft and crankshaft, tachometer, anti-skid / traction control, sprocket, transmission of the rpm, conveyer speed, stop motion detection and counters. In accordance to the topic, there are basically four areas that should be covered which consists of engine speed detection; proving when the rpm increases, the output signal also increases; conversion of the signal to voltage and lastly determination of the system that is going to be controlled. First and foremost, the detection and obtainable signal should be performed whereby in this experimental project, the infrared sensor (which is consists of emitter and receiver) is used to detect the signal from the engine. A 6V DC motor is attached to the connection from the engine to the bulb of the motorcycle Honda C70. The DC motor that is attached with a fan is used to produce signal to the sensor. It is seen that when the motorcycle is being rammed gradually, the output signal increases gradually. This can be checked by detecting the rpm fan of the 6V DC motor. Basically, there are two circuits whereby the first circuit is the sensing circuit for the infrared sensor. The second circuit is for converting the frequency or pulses that have been detected by the infrared sensor which consists of complex circuit that contains the IC TC9400. The IC TC9400, in this experiment project, acts as a frequency-to-voltage converter. It will act as integrator and transform the signal to voltage. Last but not least, this is proven when the 3V DC motor (the type of system that is going to be controlled) is lighted up and rotates gradually as the engine of the motor increases in rpm.

# ABSTRAK

Aplikasi pengesan kelajuan telah dikenali dalam industri automotif kerana kebanyakan mesin dalam kenderaan memerlukan sistem pengesan kelajuan pengawal untuk memperoleh output dikehendaki. Malahan, alat pengesan kelajuan telah banyak digunakan dalam pelbagai aplikasi seperti *camshaft* dan *crankshaft*, *tachometer*, pengawal *anti-skid/traction*, *sprocket*, pemindahan rpm, kelajuan sistem konveyer, pengesan pemberhenti pergerakan dan pengira. Berdasarkan topik, terdapat empat sistem diliputi, iaitu pengesanan kelajuan enjin; pembuktian apabila rpm semakin bertambah, signal output juga bertambah; pengubahan signal kepada beza keupayaan dan akhirnya penentuan sistem yang perlu dikawal. Sebagai permulaan, pengesanan dan penerimaan signal sepatutnya dijalankan di mana dalam eksperimental projek ini, sensor inframerah (terdiri daripada pengeluar dan penerima) digunakan untuk mengesan signal dari enjin. Satu motor DC 6V telah disambung kepada penyambung dari enjin ke mentol motosikal Honda C70. DC motor tersebut telah digam dengan kipas yag digunakan untuk menghasilakn signal ke sensor. Ini telah diperhatikan apabila motosikal diramkan, signal output bertambah juga. Ini boleh diuji dengan mengesan rpm motor DC 6V. Asasnya, terdapat dua litar yang mana litar pertama ialah litar pengesan untuk sensor inframerah. Litar kedua pula untuk mengubah denyutan frekuensi atau denyutan yang telah dikesan oleh sensor inframerah yang terdiri daripada litar kompleks yang mengandungi IC TC9400. IC TC9400, dalam projek eksperimental ini, bertindak sebagai penukar frekuensi ke voltan. Ia bertindak sebagai penambah dan menukar signal ke voltan. Akhirnya, ini terbukti apabila motor DC 3V (sistem yang dikawal) dinyalakan dan berputar dengan berdasarkan pada pertambahan rpm motor enjin.

# ACKNOWLEDGEMENTS

It was always going to be hard work, frustrating at times, and the outcome- to try to achieve the goals of the experimental project and obtain cum maintain a desirable results. First and foremost, a word of appreciation is given to my supervisor, Mr Sivarao for continuous support and guidance in completing the entire project. During the experimental project, he has given me uncountable and wise and suggestions to overcome some problems while handling the project. Though sometimes I might be lack in my project, he will be always there to remind me to be back on the track.

On behalf of it, I would like to thank my beloved parents (my father and late mother) and sisters who have contributed directly and indirectly unfailing support in contributing the project into a success.

Last but not least, on behalf of it, I would like to thank my colleague, Lim Seng Keat (Bachelor Degree in Electrical Engineering – Power Electronics and Drives) for his continuous support in knowledge in overcoming some difficulties in circuits. He has spent uncountable time discussing though he is extremely busy in his studies and project too.

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# LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

| | | |
|---|---|---|
| BRGC | - | Binary-reflected Gray code |
| lC | - | Integrated circuit |
| LSB | - | Least Significant Bit |
| mA | - | Milliampere |
| MSB | - | Most Significant Bit |
| rpm | - | Rotation per Minute |
| tp | - | Time interval (s) |
| $t_w$ | - | Pulse width |
| V | - | Voltage |
| $V_{cc}$ | - | Voltage output |

# CHAPTER 1
# INTRODUCTION

## 1.1 Background

Speed sensing application has been very well famous in the automotive industry as many modes of transportation require the speed sensing to control the speed in order to obtain a desirable output. In fact, the speed sensing has been use in many applications such as camshaft and crankshaft, tachometer, anti-skid / traction control, sprocket, transmission of the rpm, conveyer speed, stop motion detection and counters.

Speed sensing application can be achieved with a variety of approaches. One of the known famous solutions is to use a ferrous metal gear with a gear tooth sensor. Basically, the gear tooth sensor is the magnetic pick-up coil. The gear tooth will pass by the sensor face which will focuses and concentrates on the magnetic flux from the bias magnet in the sensor. The gear tooth sensor will detect the change in the flux level and translates it into a change in the sensor output.

There is also another type of speed sensing which uses the digital Hall-effect sensor with a ring magnet. As the poles of the magnet pass by the sensor, the output is then changes.

Nevertheless, almost all the invention of the engine speed sensing system basically will be used only for a particular product (mode of transportation) of a company. The speed sensing system that has been invented may not be applicable to other usage of the

vehicles that requires the engine speed sensing. For instance, a four cylinder tachometer will not show the correct rpm value for a twelve cylinder engine.

Therefore, there is a need to invent and implement an engine speed sensing detection that can be applied to many other vehicles and does not focus into one application only.

## 1.2 Objective

It cannot be denied that there are many inventions, projects and researches on speed sensing system that has been carried out and with success. Nevertheless, the sensing systems that have been invented are basically to be allied into their own end products which cannot be applied to other type of machines or vehicles. There are still very less sensing systems that can immediately give readings or output and control another system with the signal produced. For instance, the Honeywell Company is just inventing a speed sensing system (Solid state sensors 1GT101DC, SS400 Series) that can be used only in motorcycles only. This study cum invention is important in order that the invention can be used many mode of transportation industries that requires sensing system to control another output.

Basically, this project is to design and development of a control system based on engine speed. The power source used in this experimental project is the Motorcycle Honda C70 which has700cc engine. The signal is obtained from the magneto of the engine of the motorcycle. The objective targeted in this experimental project is to:

I. Detect and obtain signal of the motorcycle's engine speed rpm
II. Utilize the engine rpm output signal as an input for another system
III. Validate the signal correlate with the engine's rpm
IV. Identify the appropriate system to be controlled

## 1.3 Scope

The scope of this experimental project will be covering the following:

I. Design and develop a rpm speed detection system especially for Honda 700cc engine.
II. Obtain the required signal from the engine's rpm and the output is utilized to control another system
III. Validate the output signal from the circuit correlates with the rpm engine's signal

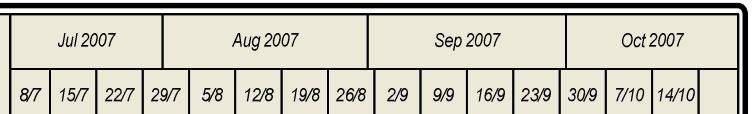
## 1.4 Problem Statement

There are many types of speed sensing that have been discovered and invented. One of the company that have been invented the speed sensing is the Honeywell Sensing and Control Company which the part is Solid State AP 00286. Nevertheless, it seems that every company that produces the speed sensing system is just to fulfill their criteria of the end product. For instance, a variety of speed sensing have been built to perform the rpm sensing for a certain part of machines such as camshaft and crankshaft, transmission, tachometers, anti-skid/traction control, sprocket speed and stop motion detection. Thus, this indicates that there is a need to invent a speed sensing control system so that it can be used is all the machines and other modes of transportation. Furthermore, the new invention of the speed sensing system can be used in all applications and fields such as agricultural cum construction equipment, buses, lorries, lawn and garden equipments, golf carts, escalators and ski mobiles just to name a few.

## 1.5 Gantt Charts

Gantt Chart PSM1

| NO | Task | Start | Finish | Duration |
|---|---|---|---|---|
| 1 | Planning on PSM 1 & 2 | 09/07/2007 | 20/07/2007 | 2w |
| 2 | Literature review | 16/07/2007 | 05/10/2007 | 12w |
| 3 | Selection on the appropriate engine speed detector | 16/07/2007 | 17/08/2007 | 5w |
| 4 | Learning on the new way to implement the output of the rpm system to control another system | 23/07/2007 | 12/10/2007 | 12w |
| 5 | Conduct experiment identification | 13/08/2007 | 21/09/2007 | 6w |
| 6 | Prepare appropriate material and procedures for experiment | 17/08/2007 | 26/10/2007 | 10.2w |
| 7 | Conduct experiment | 24/09/2007 | 26/10/2007 | 5w |
| 8 | Verification of experiment and modification | 24/09/2007 | 26/10/2007 | 5w |




PREPARED BY: CHAN CHOW KHUEN APPROVED BY: MR. SIVARAO DATE: 26/07/2007 REV: 01

**Figure 1.1: Gantt Chart for PSM 1**

# Gantt Chart of PSM 2

| NO | Task | Start | Finish | Duration |
|---|---|---|---|---|
| 1 | Launch PSM 2/ improving on PSM 1 | 07/01/2008 | 04/02/2008 | 4.2w |
| 2 | Literature review | 07/01/2008 | 07/04/2008 | 13.2w |
| 3 | Literature Study | 07/01/2008 | 07/04/2008 | 13.2w |
| 4 | Review of new invention of similar topic (from time to time) | 07/01/2008 | 07/04/2008 | 13.2w |
| 5 | Procedure 1: Attachment circuit rpm source to rotary driver | 07/01/2008 | 11/01/2008 | 1w |
| 6 | Procedure 2: Attachment circuit of sensor to detact the rotation of the rotating driver | 07/01/2008 | 18/01/2008 | 2w |
| 7 | Procedure 3: Identify the output of the sensor | 14/01/2008 | 18/01/2008 | 1w |
| 8 | Procedure 4: Attachment circuit of sensor to the frequency-to-voltage converter | 21/01/2008 | 01/02/2008 | 2w |
| 9 | Procedure 5: Identify the ouput of the LM2917 | 21/01/2008 | 01/02/2008 | 2w |
| 10 | Procedure 6: Passes through a set of relays | 07/01/2008 | 19/02/2008 | 6.4w |
| 11 | Procedure 7: Change the set of relays to the desired system to be controlled | 11/02/2008 | 28/03/2008 | 7w |
| 12 | Results analysis and improvement | 27/02/2008 | 27/03/2008 | 4.4w |
| 13 | Complete report and submission | 28/03/2008 | 08/05/2008 | 6w |
| 14 | Prepare for presentation PSM 2 | 14/04/2008 | 22/04/2008 | 1.4w |
| 15 | Presentation on PSM2 | 21/04/2008 | 25/04/2008 | 1w |

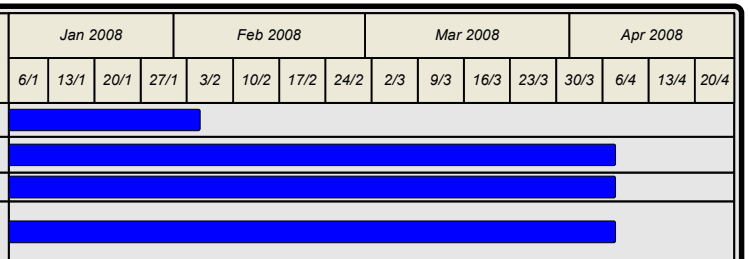



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**Figure 1.2: Gantt Chart for PSM 2**

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction to Sensor

Basically, sensor is a device that produces output signals to sense a "phenomenon" (Alciatore, 2003). To be specific, sensor is sensitive and able to response when being simulated physically (eg., light). Many people have mistakenly assumed that the sensor is transducer. Nevertheless, the transducer is device that is categorized under the sensor and is also a device that converts signal form one form to another form. In the case of transducer, the quantities of the input signal will be different than the output signal. But basically, the quantity of the output is lesser than the quantities of the input that are detected. A perfect example is the piezoelectric crystal which will output a current or charge when actuated mechanically.

In determining the right sensor to be used, there are several factors that have to be taken into account. There are the measurement, application, precision, usage condition (environment), dynamic range, cost, time and ease of maintenance (Alciatore, 2003).

It must be reminded that the sensor can be divided into four classifications. There are the signal characteristics, power supply, and mode of operation and subject of measurement. In signal characteristics, it can be divided into analog and digital form. In the power supply, it can be divided into passive and active power supply whereas in the mode of

operation, it can be divided into null and deflection type. Acoustic, biological, chemical, electric, mechanical, optical, radiation and thermal are some of the examples of subject of measurement. This can clearly picture in Table 2.1.

**Table 2.1: Classification of Sensor**

| CLASSIFICATION | SENSOR TYPE |
|---|---|
| Signal characteristics | Analog<br>Digital |
| Power supply | Active<br>Passive |
| Mode of operation | Null type<br>Deflection type |
| Subject of measurement | Acoustic<br>Biological<br>Chemical<br>Electric<br>Mechanical<br>Optical<br>Radiation<br>Thermal |

Source: Alciatore (2003)