"I / We admit that have read
this work and to my/our opinion this work
was adequate from the aspect of attitude and quality for
Bachelor of Mechanical Engineering (Automotive)"

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1st Supervisor :....Dr Janatul Islah Mohammad.....
Date :....14/05/08.....

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Date :.............................

THE DEVELOPMENT
OF VISUAL INDICATOR
FOR ENGINE MAINTENANCE IN CARS

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"I certify that this report is my own work except summary and references whereby the sources has been clearly justified"

Signature :…………………….
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Date : 27 March 2008

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Alhamdulillah, thank God because I have completed my final year project. First of all, I would like to take this opportunity to express my sincere appreciation to Dr Janatul Islah Bt. Mohammad, my supervisor for her guidance and encouragement in order to succeed this project and to the laboratory management especially the technicians for their co-operation.

Besides, this appreciation is also dedicated to all party which has been involved in this project research in order to succeed this project. I hope this report will be used as reference for the other students in future.

ABSTRACT

Engine maintenances in car are the main factor to keep the engine performance of a car at its best. Therefore, the development of visual indicator for engine maintenance system is required to generate a simple maintenance system for the car. The purpose of this research is to simulate the engine oil level control system in purpose to maintain the desired level of engine oil in pan. On the other hand, the signal of visual output will be displayed which is the present level of engine oil in pan. The programming software which is MATLAB Simulink Application is used to develop the simulation of fluid level control system including transducer, valve actuator and controller in order to generate visual output. It is expected that the simulation of visual indicator will achieve the main objectives of the project.

ABSTRAK

Sistem penyelenggaran enjin kereta adalah merupakan aspek utama yang dapat memelihara prestasi enjin pada tahap yang optimum. Oleh sebab itu, pembangunan sistem kawalan isipadu minyak enjin dalam kereta dapat dilaksanakan untuk membentuk sistem penyelenggaran kereta yang mudah. Tujuan projek ini adalah untuk membangunkan sistem simulasi menggunakan MATLAB yang dapat mengekalkan isipadu minak enjin pada tahap yang dikehendaki sekiranya berlaku sebarang kebocoran pada takungan minyak. Projek ini ini dibangunkan dengan menggunakan sensor, injap dan pengawal bagi memastikan objektif projek ini tercapai.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The automotive industry is quite wide nowadays with the competition among the car manufacturers in development for the new sophisticated technologies in purpose of generating the new sensation of technical systems in car. Mostly, the development of systems for engine still is the main focus for performance enthusiasts which directly contribute to high performance quality of vehicle generation in future. Besides, engine maintenances system is one of the systems to maintain the engine performance lifecycle in purpose to maximize the power output of the cars. The maintenance system of engine consist several parts which required maintaining their optimum condition including piston, valves, camshafts, engine cylinder, and crankshaft. The lubrication system of engine parts is the main factor to enhance the condition quality of those parts. In addition, engine oil is used as a lubricant to reduce the friction between the moving parts of the engine. The lubrication oil is also expected to act as a coolant in purpose to enhance the rings' combustion seal in internal combustion engine operation and to control wear or corrosion. Besides, the oil level in oil pan is the main factor to ensure the volume is sufficient for lubrication process.

1.2 Objectives

The purpose of this project is to design and develop a visual indicator system for engine maintenance in cars. It is focusing on detection of the desired level of engine lubrication oil in the oil pan and then maintaining the level for any decreasing in case of leakage. Besides, the system consists of reserve oil pan, valve actuator, controller and sensor to perform the level maintaining process in the main oil pan.

1.3 Scope of Work

The scope of this project consists of design and development for the visual indicator system using MATLAB/Simulink application and then performing the simulation. The desired volume of engine lubrication oil which should be maintained in main oil pan is 3.9L which is definitely compatible with 2.0cc engine.

1.4 Problems Statement

Commonly, engine lubrication oil serves as a lubricant, a coolant and a vehicle for removing impurities. It will be able to withstand high temperatures without breaking down and have a long working life [1]. The development trend in engines is toward higher operating temperatures, higher speeds, closer tolerance and small oil pan capacity. Besides, the oil level in the oil pan plays a big roll for lubricating process in purpose to ensure the sufficient volume of lubricating agent to lubricate the whole engine parts. Basically, the oil pan is bolted up to the underside of the engine. At the bottom of the oil pan lives a pickup for the oil pump. The purpose of the oil pump is to takes up lubricating oil through the pickup and circulates it trough the engine. Furthermore, the lubricating properties of oil are capable to stop friction and heat from destroying the engine [2]. This process will continue unabated unless the oil level in the oil pan is being neglected. Once it happen, the engine will absolutely damage because of the friction between piston and combustion chamber have increase so that contributing to vehicle breakdown.

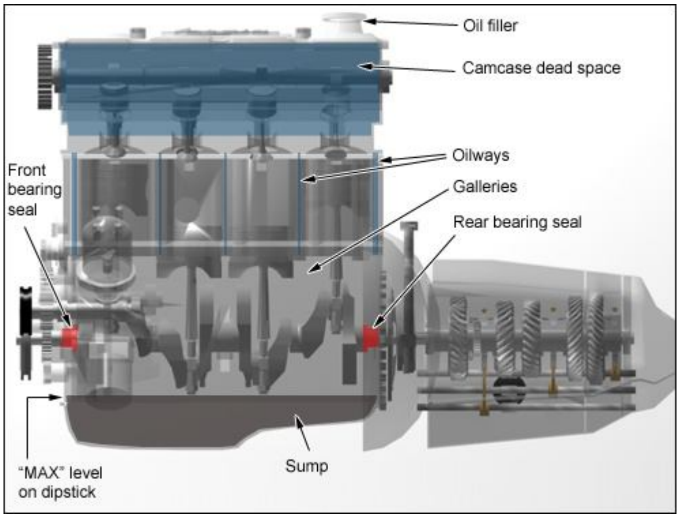

Figure 1: Lubrication System of Engine [3]

Therefore, the relevant of this project is to design, develop and then simulate a visual indicator system as a solution idea in purpose of upgrading the maintenance system in cars. This idea actually is focusing on detection of the desired level of engine lubrication oil in the oil pan and then maintaining the level for any decreasing in case of leakage. This is in purpose of facilitation for automobile ownership responsibility related on engine maintenances.

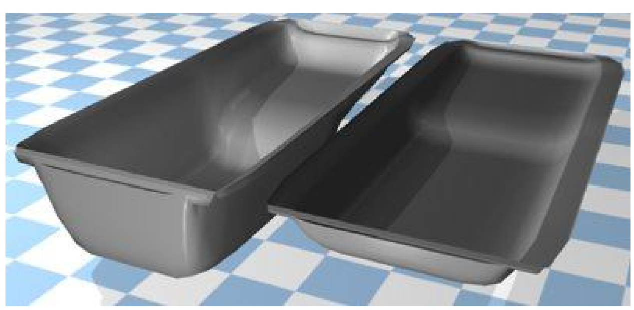

Figure 2: Engine Oil Pan [3]

1.5 Schedule of Activities

July 2007 – November 2007

Activity	**W 1**	**W 2**	**W 3**	**W 4**	**W 5**	**W 6**	**W 7**	**W 8**	**W 9**	**W 10**	**W 11**	**W 12**	**W 13**	**W 14**	**W 15**	**W 16**
Study scope and objective on detail	√															
Problems Statement		√														
Literature Review			√	√	√	√	√	√	√							
Research Methodology						√	√	√								
Simulation									√	√						
Submit Report (1st draft)											√					
Submit Report (Final draft)												√				
Seminar																√

Figure 3: Gantt chart PSM 1

December 2007 – April 2008

Activity	**W 1**	**W 2**	**W 3**	**W 4**	**W 5**	**W 6**	**W 7**	**W 8**	**W 9**	**W 10**	**W 11**	**W 12**	**W 13**	**W 14**	**W 15**	**W 16**
Study on simulation	√															
Modeling Equation	√	√	√	√	√											
Simulation						√	√	√	√	√	√					
Modification							√	√	√	√	√					
Analysis							√	√	√	√	√					
Submit Report (1st draft)												√				
Submit Report (Final draft)													√			
Seminar																√

Figure 4: Gantt chart PSM 2

1.6 Report Structure

Generally, Chapter 1 elaborates the objectives and scope of the project in detail. It is also includes a bit discussion on problems statement of the research which is to be solved in this entire project. Besides, it is also attach the schedule of activities for this entire project.

Besides, Chapter 2 discusses the problems statement which has been briefly stated in Chapter 1. The discussion is based on the previous studies of the research in theoretical.

Moreover, Chapter 3 discusses the methods of the research which is going to be used to develop the visual indicator. This chapter provides detail explanation on how the oil level control system will be developed. It also includes explanation on the components and materials which been used in the project.

Furthermore, Chapter 4 provides the result on the simulation of oil level control system by using MATLAB/Simulink application. The graphs of simulation result are also being attached for further discussion.

Besides, Chapter 5 provides the discussion on all of the results which obtained in simulation. This chapter also provides detail elaboration about the graphs.

Therefore, Chapter 6 concludes the report and suggests some work to be carried out for project furtherwork in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Commonly, the purpose of this literature review is to summarize the available previous study on theoretically that is related to engine maintenances system in car. The review includes basic information on maintenance systems of engine lubrication including engine parts and internal combustion engine operation.

2.2 Internal Combustion Engine

Generally, the internal combustion engine is a heat engine [4] that converts chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas than expands against the mechanical mechanisms of the engine. The expansion is converted by mechanical linkages of the engine to a rotating crankshaft which is the output of the engine. The crankshaft, in turn, is connected to a transmission or power train to transmit the rotating mechanical energy to the desired final use. Besides, most internal combustion engines are reciprocating engines having pistons that reciprocate back and forth in cylinders internally within the engine.

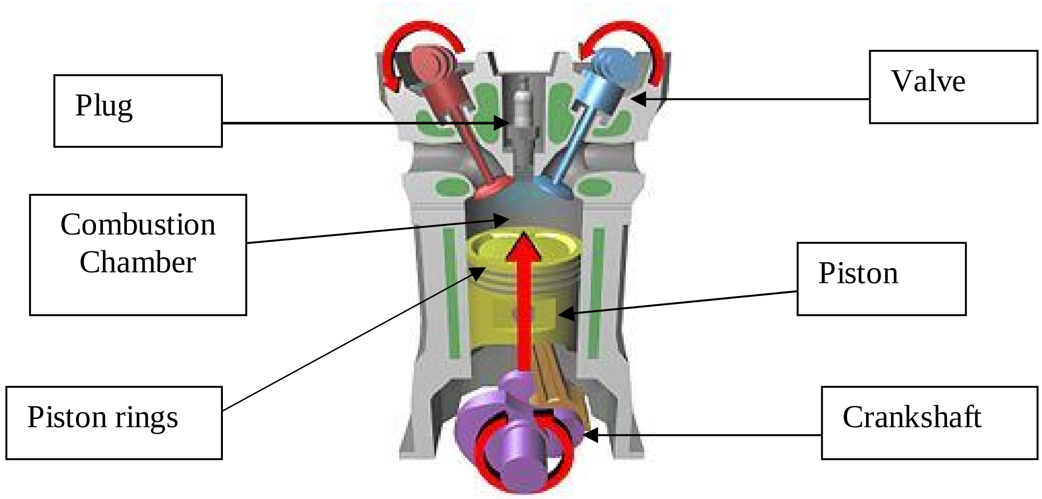

Figure 5: Engine Structure [3]

2.3 Mechanical Friction in Engine

Basically, the two solid surfaces will touch each other at the roughness high spots when they are in contact in an engine. The smoother the surfaces are machined, the lower will be the surface high points and the less will be the average distance separating them [2]. If one surface is move relatively to the other, the high points will come into contact so that resisting the friction. In addition, points of contact will become hot and sometimes trying to weld together [4]. Therefore, lubrication oil is added to the space between the surfaces in order to greatly reduce resistance of surface-to-surface motion. Lubricating oil adheres to the solid surfaces so that when one surface moves relative to the other, oil is dragged along with the surface. The oil holds the surfaces apart and one surface hydraulically floats on the other surface. Furthermore, the only resistance to relative motion is the shearing of fluid layers between the surfaces which is orders or magnitude less than that of dry surface motion.

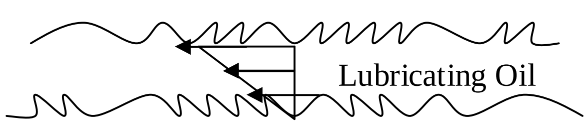

Figure 6: Lubricated surface showing reduction of friction [4]

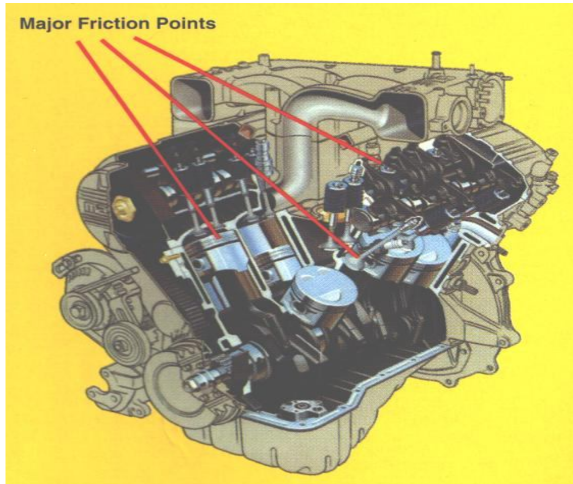

Figure 7: Friction in Engine [3]

2.4 Lubrication System of Engine

Basically, the engine lubrication system is designed to deliver clean oil at the correct temperature and pressure to every part of the engine. The oil is sucked out of the pan into the pump, which is the heart of the system and then forced through an oil filter and pressure is being feed to the main bearings and to the oil pressure gauge. From the main bearings, the oil passes through feed-holes into drilled passages in the crankshaft and on to the big-end bearings of the connecting rod. Moreover, the cylinder walls and piston-pin bearings are lubricated by oil fling dispersed by the rotating crankshaft. A bleed or tributary from the main supply passage feeds each camshaft bearing. Another bleed supplies the timing chain or gears on the camshaft drive. The excess oil then drains back into the pan, where the heat is dispersed to the surrounding air.

Besides, the oil level is being checked as simple as popping the hood and reading the dipstick. Since the dipstick only reads how much oil is in the pan itself, there are a few rules which need to be followed. The first and foremost rule is to check oil only when the vehicle is on level ground. Since the dipstick extends into the bottom of the oil pan, it will give an inaccurate reading if the oil is gathered up at the back, front, or sides of the pan. Furthermore, the second rule is to wait long enough for oil to drain back down from the engine into the oil pan before checking the oil.

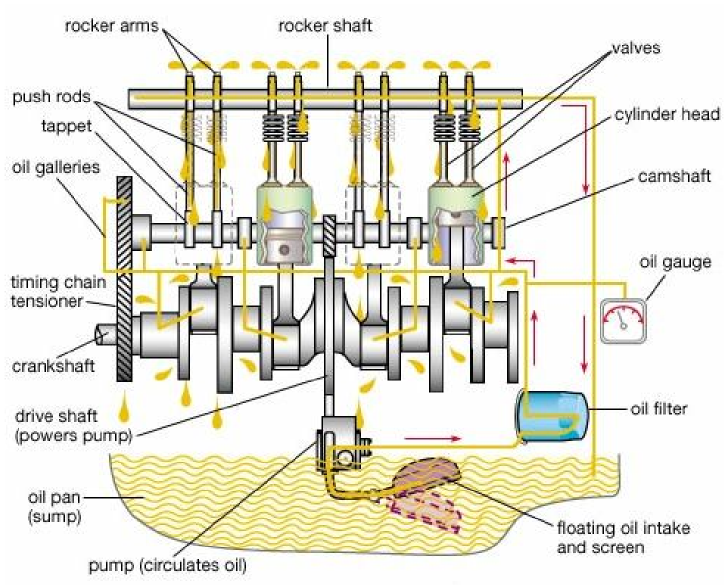

Figure 8: Engine Lubrication System [3]

Figure 9: Oil Level Is Checked Using Dipstick [5]

2.5 Engine Lubrication Oil

Generally, the oil which is used in engine is acting as a lubricant, a coolant and impurities remover. It is capable to operate at high temperature without breaking down and have long working life [4]. The development trend in engines is towards higher operating temperatures, higher speeds, closer tolerances and lower fuel consumption. Certainly, the technology of the engine oil industry has to continue to improve along with the technology growth of engine and fuel.

Besides, modern cars engine can run hotter and have closer tolerances which can keep lower fuel consumption and have smaller oil pan due to space limitations. Moreover, it can generate more power with smaller engines by running faster and with higher compression ratios. This indicates that the modern engine needs higher forces and a good lubrication to run smoothly. A the same time, many car manufacturers now suggest changing the engine oil every 4800 driving kilometers or 3 months driving period [4] and new oil is not added between the oil changes. Besides, an old engine that consumed some engine oil required periodic makeup oil to be added. This makeup oil mixed with the remaining used oil and improved the overall lubrication properties within the engine. Some modern high-performance automobiles (Mercedes, Corvette) have sensors in the oil pan that monitor the oil level, age and temperature [4]. These systems tell the operator when the oil has degraded to a point which an oil change is required.

Moreover, the oils in modern engines must operate over an extreme temperature range. They must lubricate properly from the starting temperature of a cold engine to beyond the steady-state temperatures that occur within the engine cylinders. They must not oxidize on the combustion chamber walls or at other hot spots such as the center crown of the piston or at the top piston ring. Besides, oil should adhere to surfaces so that they always lubricate and provide a protective covering against corrosion. This is often called oiliness. Oil should have high film strength to assure no metal-to-metal contact even under extreme loads. Oil should also be non-toxic and non-explosive. Lubricating oil must satisfy the following needs:

A. Lubrication. It must reduce friction and wear within the engine. It improves engine efficiency by reducing friction forces between moving parts.
B. Coolant
C. Removal of contaminants
D. Enhancement of ring seal and reduction of blow
E. Slow corrosion
F. Stability over a large temperature range
G. Long life span
H. Low cost

Furthermore, the base ingredients in most lubricating oils are hydrocarbon components made from crude oil. These are species with larger molecular weights obtained from the distillation process. Various other components are added to create a lubricant that will allow for maximum performance and life span of the engine. These additives include the following:

A. Antifoam agents. These reduce the foaming that would result when the crankshaft and other components rotate at high speed in the crankcase oil sump.
B. Oxidation inhibitors. Oxygen is trapped in the oil when foaming occurs and this leads to possible oxidation of engine components. One such additive is zinc dithiophosphate.
C. Antirust agents
D. Detergents. These are made from organic salts and metallic salts. They help to keep deposits and impurities in suspension and stop reactions that form varnish and other surface deposits. They help neutralize acid formed from sulfur in the fuel.
E. Friction reducers
F. Viscosity index improvers

Besides, lubricating oils are generally rated using a viscosity scale established by the Society of Automotive Engineering (SAE). The higher viscosity value contributes greater force which needed to move adjacent surfaces or to pump oil through a passage. Viscosity is highly dependent on temperature which is increasing and decreasing temperature. In the temperature range of engine operation, the dynamic viscosity of the oil can change by several orders of magnitude. Oil viscosity also changes with shear which is decrease with increasing shear. Shear rates within an engine range from very low values to extremely high values in the bearings and between piston and cylinder walls. The change of viscosity over these extremes can be several orders of magnitude. The following viscosity grades are commonly used in engines [11]:

A. SAE 5
B. SAE 10
C. SAE 20
D. SAE 30
E. SAE 40
F. SAE 45
G. SAE 50

The oils with lower numbers are less viscous and are used in cold-weather operation. Those with higher numbers are more viscous and are used in modern high-temperature, high-speed and close-tolerance engines. Oil become more viscous with age because of the components with lower molecular weights evaporates quicker. If oil viscosity is too high, more work is required to pump it and to shear it between moving parts. This results in greater friction work and reduced brake work and power output Fuel consumption can be increased by as much as 15% [11]. Therefore, the cold engine is very difficult to start because of it has been lubricated with high-viscosity oil.

Besides, the multigrade engine oil was developed so that oil viscosity would be more constant over the operating temperature range of an engine. When certain polymers are added to oil, the temperature dependency of the oil viscosity is reduced. These oils have low number viscosity values when they are cold are will higher number of viscosity when they are hot. For example, a value such as SAE 10W-30 means that the oil has properties of 10 viscosity when it is cold (W= winter) and 30 viscosity when it is hot [4]. Moreover, this is extremely important when starting a cold engine. This is because when the engine and oil are cold, the viscosity must be low enough so that the engine can be started without too much difficulty because the oil flows with less resistance and the engine gets proper lubrication. It would be very difficult to start a cold engine with high-viscosity oil because the oil would resist engine rotation and poor lubrication would result because of difficulty in pumping the oil. On the other hand, when the engine gets up to operating temperature, it is desirable to have higher viscosity oil. Therefore, high temperature reduces the viscosity so that oil with low viscosity number would not give adequate lubrication.

Furthermore, some studies show that polymers added to modify viscosity do not lubricate as well as the base hydrocarbon oils. At cold temperatures SAE 5 oil lubricates better than SAE 5W-30 and at high temperatures SAE 30 oil lubricates better. However, if SAE 30 engine oil is used, starting a cold engine will be very difficult so that poor lubrication and very high wear will result before the engine warms up. The following multigrade oils [11] are commonly available:

SAE 5W-20	SAE 10W-40
SAE 5W-30	SAE 10W-50
SAE 5W-40	SAE 15W-40
SAE 5W-50	SAE 15W-50
SAE 10W-30	SAE 20W-50

However, in engine oil development industry, a number of synthetically made oils are available that give better performance than those made from crude oil. They are better at reducing friction and engine wear and also have good detergency properties which keep the engine cleaner, offer less resistance for moving parts and require less pumping power for distribution. The main reason for this better performance is that the base synthetic material is a homogenous fluid with similar molecules of the same structure and molecular weight. On the other hand, crude oil lubricant has a base fluid structure made up of dissimilar molecules with a range of molecular weights. With good thermal properties, synthetic oils provide better engine cooling and less variation in