OPTIMUM USE OF ENGINE OIL THROUGH MULTI-FUNCTIONAL SENSING AND A FUZZY BASED DECISION MAKING ALGORITHM

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ABSTRACT

A multifunctional sensor is designed to measure viscosity, cleanness, temperature and capacitance of engine oil to make a clear decision on its condition. The simple structure helps easy fabrication and low cost while measuring four parameters by one sensor. The operation is described theoretically and is supported by experimental data. A fuzzy based algorithm to fuse the four kinds of data from multi-functional sensor in order to make a decision on the best time to change the oil is proposed.

INTRODUCTION

Automobile engine oil changing at right intervals ensures the maximum engine life, fuel economy as well as low pollution. According to a typical maintenance schedule for gasoline-fueled passenger cars and light-duty trucks, the oil should be changed in every 4,800km or three months whichever first occurs. This is specially recommended when the outside temperature is below freezing and usual run lengths are short. A 12,000km or one year oil change interval is typically recommended for ideal driving conditions with long run lengths and mild outside temperatures[1].

The above numerical figures show the degree of uncertainty of a decision made to change the engine oil according to a maintenance schedule without analyzing the engine condition, outside temperature and usual run lengths. Therefore, it is essential to monitor the actual condition of engine oil, in order to optimize the use of engine oil and for the safety of the engine.

There are several good approaches among the literature in this field[1]-[8]. Most of them involve with sophisticated equipment and complicated test procedures. In contrast, this proposed method is very simple and straight-forward.

In conventional sensing, only one information is available from one sensor, but in multi-functional sensing two or more information can be extracted from the same sensor. Multi-functional sensing is becoming popular among sensor designers[9],[10], due to its advantages of low cost, easy signal processing and compactness. Here in this paper we describe a multi-functional sensing device, which can output four different information of the engine oil sample being tested.

In this approach, the viscosity, cleanness, temperature and capacitance of the engine oil are measured to make a decision on the oil condition. Viscosity is the main parameter of importance and the temperature is to be measured to give it a real meaning because each lubricant has its own viscosity index. Transparency of the oil is next parameter tested and in recent researches capacitance of engine oil has been proven as a factor for determining the oil condition[5]. In the proposed method, while measuring, it makes decisions on whether to perform the next parameter measurement or to make a decision on oil changing with the information in hand. This makes it an intelligent sensor.

SENSOR STRUCTURE

Fig. 1 shows the designed multifunctional sensor. It mainly consists of a disk driven by a variable speed DC motor, an ultra high power LED, a phototransistor and fixed aluminum plates. A 0.3mm thick aluminum disk is fixed on one side of the rotating disk and four blades of the same thickness are fixed to the other side as shown in the figure. A miniature bearing of 3mm inner diameter is fixed to the end of the motor spindle and it is housed on the fixed plate holder providing minimum friction for rotation. All the machined components in this prototype were made with acrylic. This is a fully submersible type-sensing device so that when in operation, it is fully covered by oil.

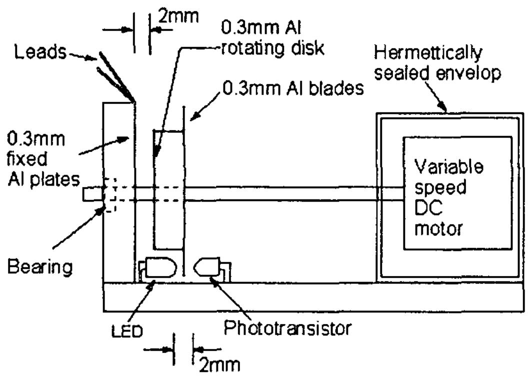

Fig.1 The designed multi-functional sensor

EXPERIMENTAL PROCEDURE

The designed multi-functional sensor was tested with number of oil samples. The oil samples were made by Mixing new engine oil (Mitsubishi SAE30), with used oil to various ratios. The used oil percentages in the samples were 0%, 20%, 40%, 60%, 80% and 100% by