

Study of Fuzzy Algorithm for Replacement of Engine Oil

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Abstract. To improve these unscientific methods, I would like to design a system that automatically tells replacement time of engine oil by fuzzy algorithm. There are 'time series analysis' and 'cause and effect' analysis in quantitative method. Time series analysis is to forecast the value by choosing one variable with the basis of historical data. All methods of demanding forecasting belong to time series analysis. Cause and effect analysis is the method, which makes a model by the relation between past values of other variables and the particular variable when the variable is influenced by other variables. In the thesis to replace engine oil in optimum time and to be aware of right replacement time of engine oil automatically.

Keywords: ubiquitous, neural network, fuzzy algorithm

1. Introduction

No machine functions well without engine oil. Car engine needs proper amount of engine oil because of its spinning speed and power in ubiquitous environment. It is true that most of car parts needs oil. However it is never enough to emphasize the importance of engine oil.

Ordinary drivers are not aware of replacement time of engine oil. Even when we go to service center, they ask our latest replacement time if engine and distance covered since then. Or to see how much engine oil is consumed, they rely on extremely abstract methods such as using engine oil stick or viscosity of oil.

To improve these unscientific methods, I would like to design a system that automatically tells replacement time of engine oil by fuzzy algorithm. Function of engine oil is to smoothen contacted parts between metals of engine bearing part. This is called lubrication effect of engine oil but there are more functions of engine oil. The representative example is the cooling effect. Even though cooling devices like radiator prevent overheating of engine, engine oil as it circulates inside of engine falls

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its temperature and at the same time cleans its inside. This is called purity effect. Also engine oil has airtight effect. It fills the gap in piston or cylinder so the gas compounds or waste gas in cylinder won't go inside of engine. And the oil adhered to the metal inside of engine prevents the deterioration of metal when they touch each other. This is called shock-absorbing effect. Engine oil gathers on the oil pan that is lower part of engine and from there it circulates inside of engine by oil pump. There's a metal filter called oil strainer where the oil goes up from oil pan and that eliminates the big substance. In the middle there's an oil filter, which eliminates small substance and the oil that reaches at the end, falls back to oil pan.

In the thesis to replace engine oil in optimum time and to be aware of right replacement time of engine oil automatically, in chapter 2, I would like to introduce an old method of forecasting replacement time of engine oil. Also in chapter 3, I will introduce forecasting of replacement of engine oil using neural net and chapter 4 is about algorithm of engine oil replacement.

2. Examination of condition of engine oil

Temperature of engine oil goes up when the vehicle is running and it goes down to the temperature of the air when the vehicle is parked. So every time the temperature changes, the quality of engine oil gets worse. Even when it touches the air, the oil gets oxidized and the condition of engine oil gets deteriorated. Of course, by friction of metals the condition goes bad. Also when the oil is used for a long period, substances like metal dust or sludge get into oil and it makes the airtight effect and lubrication effect of engine oil debased. When engine oil is insufficient or debased the biggest problem is that the engine gets burnt. This is because the engine is not lubricated enough so the metals stick together. In this case, the repairing fee is very expensive. It is very dangerous when the car stops suddenly without any notice.

Only when the engine oil is black is not the right time to replace the engine oil so the viscosity of oil has to be checked as well. When the color is black and the viscosity is high, it means that it is time to replace engine oil immediately. Engine oil is consumed a little inside of engine. However if it gets too serious and makes white smoke, it is necessary to find out the cause and fix.

To forecast the replacement time of engine oil comparatively, history data such as viscosity of the vehicle that replaced engine oil, distance traveled, vehicles for long or short range etc. is needed. The method is forming a model, which tells the tendency of the vehicle. So by using this, one can tell the future. Once again, if present time is t , by using historical data, one can foretell the future ($t+1$). There are two ways of forecasting future. One is qualitative method and the other one is quantitative method. Qualitative method is used when there's no historical data or when it is not possible to make a model. So it is depended on the knowledge and opinion of experts and Delphi is one of the well-known methods.

There are 'time series analysis' and 'cause and effect' analysis in quantitative method. Time series analysis is to forecast the value by choosing one variable with the basis of historical data.

All methods of demanding forecasting belong to time series analysis. Cause and effect analysis is the method, which makes a model by the relation between past values of other variables and the particular variable when the variable is influenced by other variables. From that, one can forecast the future value of certain variable. However it is very difficult to clarify the relationship and analysis of other variable.

3. Forecasting the replacement time of engine oil by using neural net.

The process of demanding forecasting is as below and on it means time on X-axis and value of variable on Y-axis.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \epsilon \quad (1)$$

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But, right replacement time of engine oil

- : Fact 1 affecting dependent variable.
- : Fact 2 affecting dependent variable.
- : Fact 3 affecting dependent variable.
- ⋮
- : Fact 10 affecting dependent variable.

The following shows about neural network algorithm discussed in this thesis.

- ① Initialize offsets and weight.
- ② Indicate input and target on the neural network.
- ③ getting errors and deltas of output neurons, transmit inversely to concealed layer

$$e_j = t_j - a_j$$

$$\delta_j = a_j (1 - a_j) e_j$$

- ④ From the delta transmitted inversely, get the errors and deltas of the neurons in the concealed layer and transmit it in reverse.

$$e_j = \sum_k w_{jk} \delta_k$$

$$\delta_j = a_j (1 - a_j) e_j$$

- ⑤ Adjust the connected weight according to delta rules.

$$W_{(new)ij} = W_{(old)ij} + \alpha \delta_i a_j + \beta \Delta w_{ij}(old)$$

$$bias_{(new)ij} = bias_{(old)ij} + \alpha \delta_i + \beta \Delta bias_{ij}(old)$$

- ⑥ Repeat the 1-5 process on all the input pattern

- ⑦ Repeat the process 4 until the neural network is completely learnt

4. Fuzzy algorithm for replacement of engine oil

Generally fuzzy relation is fuzzificated concept of relationship in mathematics. For example, such relation like 'X is very similar to Y' or 'X is more active than Y' is fuzzy relation. Fuzzy relation is very important method to express fuzzy conditional sentences in fuzzy inference.

When cartesian product of Set X and Y is $X \times Y$, a subset of $X \times Y$, R, is called 'relation'. When (X,Y) becomes elements of R, X and Y has relation. If _____, x and y has no relation. If relation R is fuzzy set, R is fuzzy relation from X to Y. At this point, level of relation of X,Y is shown as position function _____. As relation is generally shown by graphs and determinants, fuzzy relation can be shown by fuzzy graphs and fuzzy determinants as well. Fuzzy graph is expressed by using vertex and arc, and here arc means intensity of relation. Sometimes it does not end with fuzzification of arc but it can substitute vertex set with fuzzy set, not ordinary set.

5. Conclusion

Korea is the leading country in IT field and motor industry. However sharp curve road, sleeping driving, fog area, freezing point is announced at the right time, the number of traffic accident will be decreased a lot. This thesis explains the heat sensor to forecast the right replacement time of engine oil. Also this proposed fuzzy rule and fuzzy system that decide replacement time of engine. Everybody tell the importance of engine oil but all have different opinions about its replacement time. Some says every 5000 Km and some says every 10,000 Km or some says ever 20,000 Km. It is not easy to tell which is right because it differs from kinds of vehicles and driving habit. Generally it is known that it is good to replace engine oil twice a year.

Because it differs from ever vehicle, it is good to check the replacement time of engine oil by oneself. If the engine oil is not replaced at the right time, it will cause the braking of engine. Forecasting of replacement time of engine oil is possible with neural net algorithm. For the results of the test, by using neural net and fuzzy method made 25% of increase of life of engine oil.

Engine oil is one of the essential parts to run the vehicle smoothly. But not many drivers make record of their engine oil period so it is not easy to tell when to replace their engine oil. Also even the driver replaces the engine oil regularly, if the vehicle runs long distance, it will cause the leak of engine oil. Therefore using fuzzy algorithm will tell the right time to replace the engine oil automatically and it is good for the vehicles and drivers as well.

Proposed system is good and effective. Also it prevents the pollution and disorder of engine. To solve these problems, suppose all vehicle has rfid tag which has identification, blood type, contact and registered number, I would like to suggest a safety system that automatically reads the rfid tag automatically when car accident occurs. By 900 Mhz rfid tag that is produced by Kiss Com can give call to nearest hospital automatically by reading rfid tag. Process is as below.

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