ANALYSIS OF INTERNAL COMBUSTION ENGINE BEHAVIOR VIA KNOCKING CONDITION

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ABSTRACT: Engine knocking condition is well-recognized phenomenon in an internal combustion engine. These phenomenon contribute to less fuel efficient system and causing damage to engine components and affect the engine behaviour. In this paper, the study of crank position sensor (CPS) and microcontroller response are carried out thru the knocking and firing phenomenon and analysed the engine performance after the modification. The study uses a single cylinder four stroke engine equipped with carburetor system. Arduino controller is design to initiate spark plug ignition timing for the system. The signals are recorded by Instrustar DAQ. It is to analyse and compare with previous research.

KEYWORDS: *spark plug, controller, ignition timing, knocking, signal,*

1.0 INTRODUCTION

The growing number of vehicle on the road around the world arose the possibility of high pollution environment. This issue is a major concern for the future generation.(Mansha, Shahid, & Qureshi, 2012) mentioned about the pollution from exhaust emission is dangerous to human health and can produce more hazardous pollution. Spark ignition combustion engine is well known in automobile industry and widely be implemented for every vehicle. Spark plus is used to ignite the flame inside the combustion chamber.

In the combustion engine system, spark plug play a vital role to ignite the flame inside the combustion chamber. (Reyes, Tinaut, Melgar, & Pérez, 2016) suggested spark plugs can be manipulated to overcome the imbalance combustion. Improper combustion inside the combustion chamber will lead to knocking phenomenon and also contribute to exhaust emissions (Pauzi, Bakar, & Ismail, 2016). This matter can be solve by developing the multiple variable controller to actuate the right timing to the spark plugs by (Beccari, Pipitone, & Genchi, 2016). Low cost experiment setup is used by Ajmir et. al to get specific signal of knocking(Ajmir, Elmi, Nazir, & Nabil Asyraf, 2019). This paper is to propose acquire signal of CPS from an engine to initiate the spark plug timing. Signals will be recorded to identification the knocking condition.

2.0 METHODOLOGY

Charging coil is identified and reviewed as the part is used to actuate the spark plug. The study of signals of ignition timing is carried out based on the frequency emitted by the CPS and knock sensor will be reviewed alongside this signal. An engine controller will be designed to initiate the spark plug timing based on these parameters and the data will be recorded and analyze for further analysis. The overall project flowchart is shown below in Figure 1.

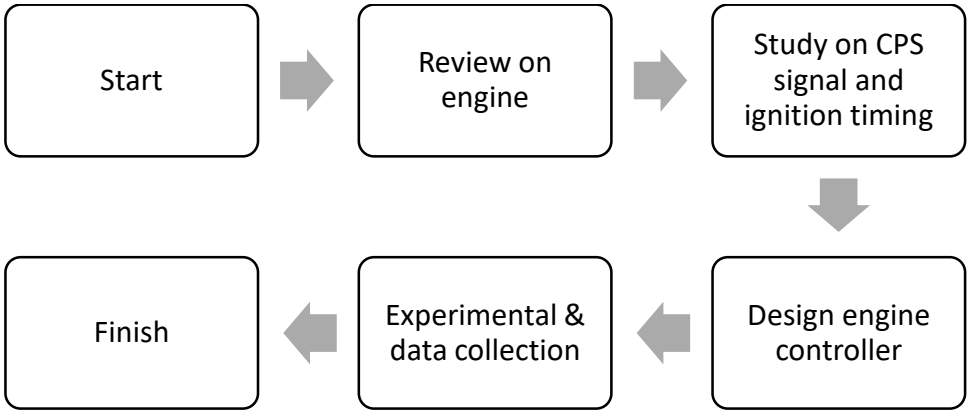

Figure 1: Project Flowchart

The signal from crank position sensor (CPS) to actuate the spark plug ignition. Based on these signals a microcontroller can be designed to monitor the ignition timing and knocking condition. The microcontroller is used to actuate the artificial signal to the system. Arduino MEGA is used for this purpose. The engine knock is monitored by using knock sensor where the knocking signal will be recorded. All the sensors are connected to the oscilloscope for the data acquisition. Multi VirAnalyzer software is used to record the desired signals from the oscilloscope. The signal analysis is carried out in MATLAB software. Signal processing is studied to obtain the preferred signal. Figure 1 showed the overall flowchart of the project.

The development of the artificial signals,engine bench fabrication, and characterizing the engine knock are carried out. Signal from the Yamaha LC135 engine is collected. This engine is a 4 stroke single cylinder engine. Figure 2 shows the equipment for the experiment.

Figure 2: Experiment setup.

Figure 3 show a knock sensor is mounted to the engine block. The knock sensor will produce small voltage due to vibration. The DAQ will attached to the knock sensor and the CPS. It is to record signal during engine running.

Figure 3: Accelerometer attached to the engine and CPS wire for signals identification.

3.0 RESULT AND DISCUSSION

Figure 4 show signals from CPS at channel 1 and spark at channel 2 are recorded. The signals indicate an acceleration at high speed of 4000rpm. The fluctuations show it produced alternate current, constantly within 5V. The voltage drop will produce ignition in the combustion chamber.

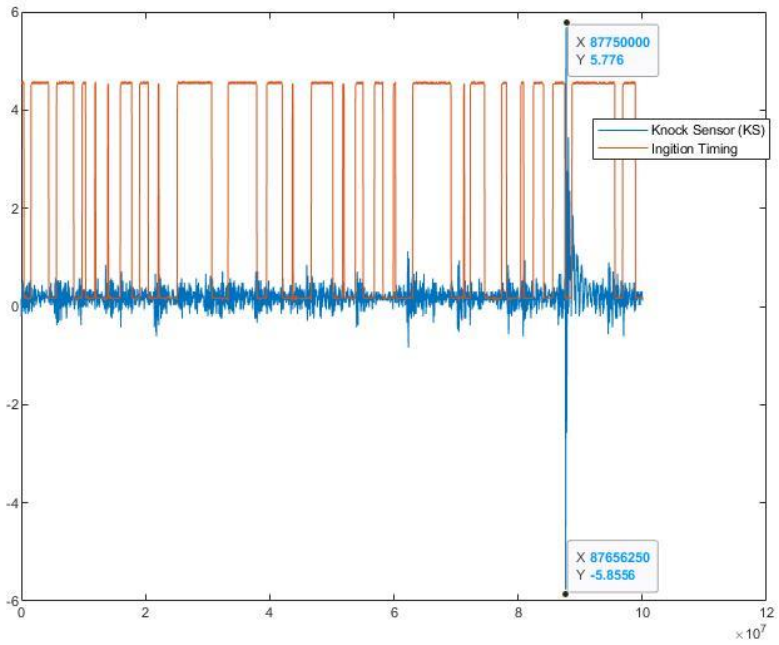

Figure 4: Knocking signals

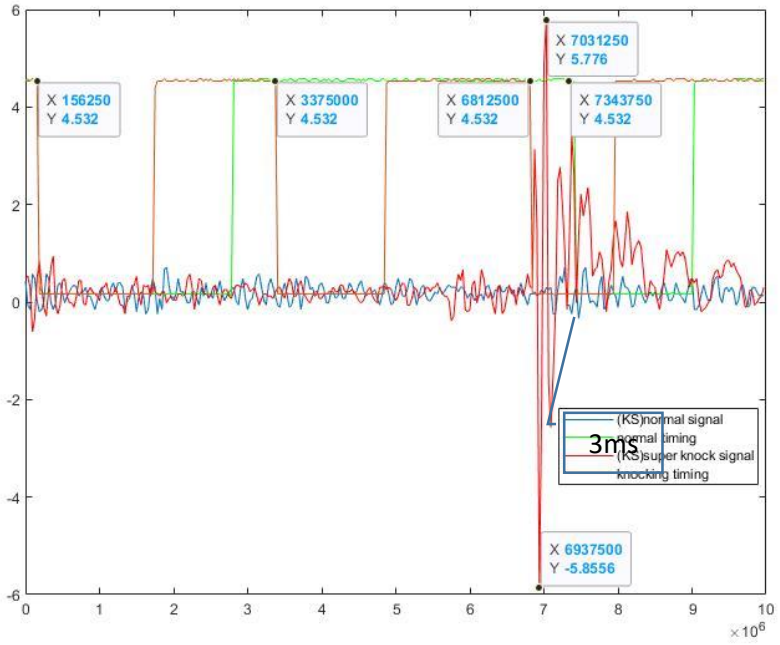

Figure 5: Super knock detected

3.1 DISCUSSION

From the signals recorded, at 8ms a super knock was identified (figure 4). By close look into the signal, it show an ignition timing occurs earlier than normal timing. The timing occur at 3ms (figure 5). The normal timing suppost to be initiate at 7ms. This situation show the combustion occurs within the intake stroke, early before the piston reaching the top dead center (TDC). Therefore large vibration occur. It may damage the intake valve, piston, conrod and all attached to the moving part of the engine.

4.0 CONCLUSION

Based on the analyzed signal, if mistiming occur, knocking condition will apply. Knocking conditions that have been recorded indicate a super knock phenomenon. It is an extreme knocking state, which can lead to damage to the vehicle components. Voltage generated by knock sensor reaches 5.7 V. This signal is useful for avoiding mistiming for designing a system that can identify the presence of knocking before the super knock is produced.

5.0 REFERENCES

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