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THE INFLUENCE OF PROGRAMMABLE ENGINE CONTROL UNIT (ECU) ON THE PERFORMANCE OF THE HONDA CB150R ENGINE

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ABSTRACT

At present, the electronic system in motorcycles has undergone development, namely the Electronic Control Unit (ECU) system. This research aims to find the results of a comparison between the standard ECU and the Programmable ECU. With the use of a Programmable ECU, engine performance can be enhanced. This study compares two types of motorcycle ECUs: the standard ECU and the Programmable ECU, using pertalite fuel. The ECU used is the BRT Juken5 Programmable ECU. In this research, the performance of the Honda CB150R engine with a Programmable ECU showed an increase in power by 12.00% HP and an increase in torque by 5.21% Nm.

Keywords: Electronic Control Unit (ECU), programmable ECU, motor performance, honda CB150R.

Introduction

The development of automotive technology has driven people to create various innovations, one of which is in the form of a means of transportation, namely motorcycles. Numerous automotive companies produce various types of motorcycles, ranging from conventional ones using carburetor systems to the latest technology known as Electronic Fuel Injection (EFI). The increasing number of motorcycles with EFI systems has led to the abandonment of conventional motorcycles using carburetors. This is due to the fact that motorcycles with carburetor systems still have many drawbacks, including the need for routine maintenance on the carburetor system, higher fuel consumption, and difficulty in manually controlling the air-fuel mixture (Hanshaw, 2012).

Many people modify motorcycles by replacing components without understanding the extent of their impact on the resulting performance (Kreuzbauer & Malter, 2005). In the automotive world, there is a

proliferation of racing spare parts for users of fuel-injected motorcycles who wish to make modifications. One such component is the racing injector. Racing injectors are claimed to have the advantage of supplying more fuel due to the increased number of holes and a higher injection rate compared to standard injectors (Chiodi et al., 2013). However, replacing injectors from standard to racing without accompanying changes to the Engine Control Unit (ECU) will have a less significant impact on increasing torque and power. The injector only supplies more fuel, making the fuel mixture rich, and it can also lead to less stable engine performance at high RPMs (How et al., 2018).

To maximize performance on a fuel-injected motorcycle, achieving optimal combustion is crucial. One way to do this is by replacing the standard Engine Control Unit (ECU) with a Programmable ECU.

Based on previous research, the researcher will attempt to examine the impact of using a programmable Engine Control Unit (ECU) on a Honda CB150R motorcycle engine in a study titled research study on the effect of using a programmable ecu on the performance of the honda cb150r engine. This study aims to evaluate various aspects of performance, including power increase, torque, engine response, and fuel efficiency. The research steps may involve installing a programmable ECU on the motorcycle, collecting performance data before and after the use of the programmable ECU, and analyzing the data to assess the impact of these changes.

Several measurable parameters may include engine output data, gas response, and fuel efficiency (Michalek et al., 2004). The results of the research are expected to provide a deeper understanding of how the use of a programmable ECU can affect the performance of the Honda CB150R engine, and whether the improvements are worth the potential costs and modifications made.

It is important to ensure that this research is conducted with careful methodology and accurate data to make the results reliable. Additionally, paying attention to factors such as safety and compliance with automotive regulations is crucial when making modifications to a vehicle.

Research Methods

The research method employed in this study is experimental research. The purpose of this research is to compare the results between the standard ECU and the Programmable ECU, specifically investigating whether there are significant differences when using a Programmable ECU. The benefits of this

research include expanding insights for users and students regarding the impact of ECU usage. The research type utilized is experimental.

In this study, the treatment involves the use of different types of ECUs in a motorcycle, specifically the standard ECU from the Honda CB150R and the Programmable ECU. The variables considered in this study include changes in power and torque. The control variables include engine rotation at 6000–12000 rpm, oil temperature, test chamber temperature, test chamber air humidity, and the use of pertalite fuel. The research material used is the Programmable ECU. The research object involves the use of both the standard ECU and the Programmable ECU on the Honda CB150R engine. The testing standard adheres to the SAE J1349, which is the "Engine Test Code-Spark Ignition and Compression Ignition-Net Power Rating."

This research is a quantitative descriptive study with an experimental nature, wherein the researcher intentionally induces an event or condition and then examines the consequences. The results of the study allow for the calculation of the percentage increase and decrease in engine performance for each ECU usage.

The performance decrease varies between the Standard ECU and the Programmable ECU. The testing results from the Standard ECU yield a power of 16.82 Hp and torque of 13.43 Nm, while the testing results from the use of the Programmable ECU yield a power of 18.84 Hp and torque of 14.13 Nm, resulting in a power increase of 12.00% and a torque increase of 5.21%.

Results and Discussion

Power Testing

Power testing is conducted to determine the comparison of the performance of a 150cc 4-stroke engine with variations in the Standard ECU and the Juken1 fuel 2%, Juken2 fuel 4%, Juken3 fuel 6%, and Juken4 fuel 8% Programmable ECUs. The testing is performed with the engine rotating between 6,000 rpm to 11,000 rpm using the standard engine. The results can be seen in Table 1, and the ignition degree settings adjusted for the Programmable ECU can be observed in Graph 1.

The table below shows the power comparison of a 150cc 4-stroke engine with variations in the Standard ECU and the Juken1 fuel 2%, Juken2 fuel 4%, Juken3 fuel 6%, and Juken4 fuel 8% Programmable ECUs at different engine speeds:

Table 1. Correlations

	Standrt	Juken 2%	Juken 4%	Juken 6%	Juken 8%
Engine Speed	Power	Power	Power	Power	Power
6000	8.65	10.69	10.58	10.02	10.46
6500	11.37	11.95	11.67	11.71	11.62
7000	12.99	13.25	13.2	13.62	13.11
7500	13.87	14.35	14.48	14.23	14.44
8000	15.14	15.38	15.46	15.45	15.21
8500	15.74	16.18	15.99	15.85	16.16
9000	16.37	16.61	16.72	16.63	16.13
9500	16.08	16.8	16.95	16.5	16.81
10000	16.08	16.75	16.54	16.34	16.77
10500	15.56	17.5	17.13	17.63	16.19
10600	16.82	17.62	17.39	17.93	16.62
11000	16.35	17.09	18.18	16.75	17.72
11300	16.64	17.71	17.3	17.24	17.57
11400	14.22	17.21	16.48	16.08	17.2

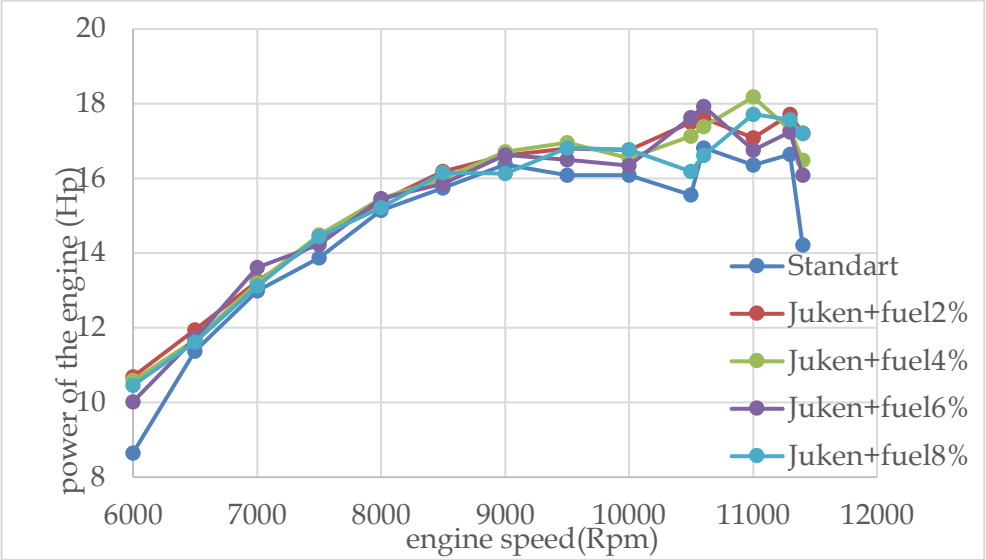

Figure 1. Comparison of power variations with Standard ECU, Juken fuel 2%, Juken fuel 4%, Juken fuel 6%, and Juken fuel 8% are shown in Figure 1.

Figure 1. Normality

Gambar 1 illustrates the results of testing the performance of a 4-stroke 150cc engine using both the Standard ECU and various Juken ECUs. In this test, the highest power obtained with the Standard ECU was 16.74 HP at 10,800 rpm, while with the Juken ECU, the highest power was achieved using the Juken fuel 4%, reaching 18.18 HP at 11,000 rpm.

Table 2. Correlations

	Standart	Juken+Ig 2	Juken+Ig 4	Juken+Ig 6	Juken+Ig 8
Engine Speed (Rpm)	Power (Hp)	Power (Hp)	Power (Hp)	Power (Hp)	Power (Hp)
6000	8.65	8.82	10.86	9.22	10.58
6500	11.37	12.18	12.13	12.13	11.96
7000	12.99	13.56	13.36	13.49	13.65
7500	13.87	14.43	14.41	14.3	14.45
8000	15.14	15.38	15.38	15.58	15.52
8500	15.74	16.2	16.17	16.17	16.29
9000	16.37	16.88	16.77	16.31	16.79
9500	16.08	17.03	17.23	17.07	17.34
10000	16.08	17.38	17.5	17.06	17.58
10600	16.82	17.56	17.05	18.23	17.49

11000	16.35	17.4	17.92	17.69	18.6
11200	15.96	18.1	17.96	17.45	18.84
11400	14.22	17.78	16.9	16.89	17.64

The test results comparing the power of the Standard ECU with the Juken ECUs, specifically Juken IGN 2°, Juken IGN 4°, Juken IGN 6°, and Juken IGN 8°, can be observed in Figure 2.

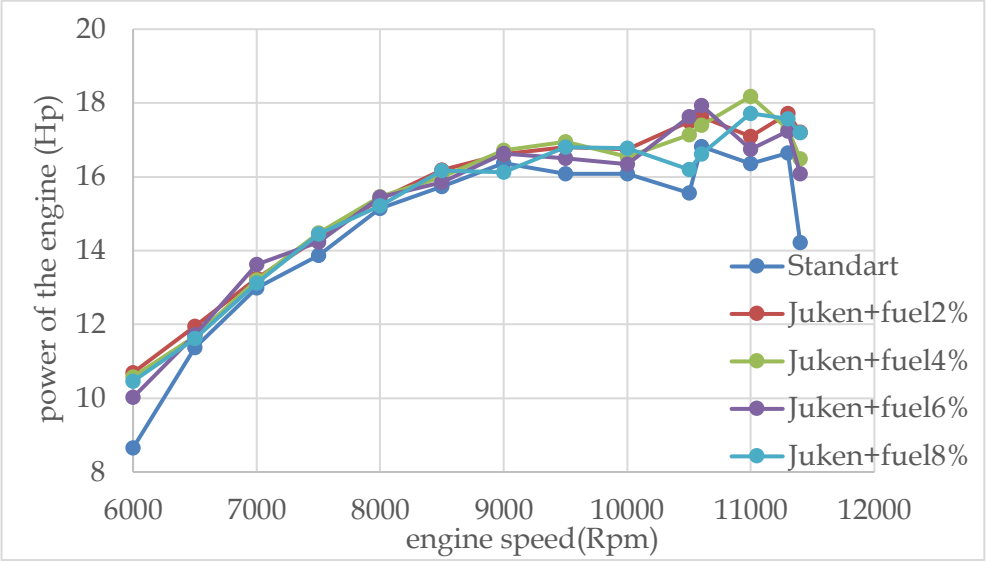

Figure 2. Comparison of power variations with Standard ECU, Juken fuel IGN2˚, Juken IGN 4˚, Juken IGN 6˚, and Juken IGN 8˚ are shown in Figure 2.

The text describes the results of testing the performance of a 4-stroke 150cc engine using various ECUs, including the Standard ECU and Juken ECUs with different ignition timings (IGN 2°, IGN 4°, IGN 6°, IGN 8°). Additionally, the comparison includes testing with the addition of fuel and adjusting the Ignition Timing Mapping, resulting in a change of a few percentage points.

In the first test, it is noted that the Standard ECU produced lower efficiency, yielding 16.74 HP, while the Juken with added fuel achieved the highest power output at 18.18 HP. In the second test, the Standard ECU again produced 16.74 HP, and the Juken IGN+ achieved the highest power output at 18.84 HP. The increase in power is attributed to the use of a Programmable ECU, which optimizes combustion by advancing the ignition timing by 8 degrees, resulting in higher power output.

The text describes torque testing conducted to determine the torque comparison of a 4-stroke 150cc engine with variations in the Standard ECU, Juken ECU with added fuel (2% to 8%), and Juken ECU with IGN (Ignition Timing) variations from 2° to 8°. The testing was performed at engine speeds ranging from 6000rpm to 11,400rpm using a standard engine. The results of the testing can be observed in Figures 3 and 4.

The table below shows the torque comparison of a 150cc 4-stroke engine with variations in the Standard ECU and the Juken1 fuel 2%, Juken2 fuel 4%, Juken3 fuel 6%, and Juken4 fuel 8% Programmable ECUs at different engine speeds:

Table 3. Correlations

	Standart	**Juken 2%**	**Juken 4%**	**Juken 6%**	**Juken 8%**
Engine Speed (Rpm)	**Torque (Nm)**	**Torque (Nm)**	**Torque (Nm)**	**Torque (Nm)**	**Torque (Nm)**
6000	10.23	12.65	12.52	11.84	12.37
6500	12.41	13.05	12.74	12.79	12.69
7000	13.17	13.43	13.39	13.8	13.29
7300	13.16	13.61	13.47	13.79	13.76
7600	13.18	13.71	13.75	13.44	13.64
7700	13.14	13.92	13.73	13.44	13.5
7900	13.34	13.56	13.58	13.81	13.4
8000	13.43	13.64	13.71	13.71	13.5
8500	13.14	13.51	13.35	13.24	13.49
9000	12.91	13.1	13.19	13.12	12.72
9500	12.01	12.55	12.66	12.44	12.56
10000	11.41	11.89	11.74	11.6	11.9
10500	10.52	11.05	11.58	11.92	11.8
11000	9.87	11.03	11.73	10.81	11.44
11400	8.86	10.76	10.26	10.01	10.48

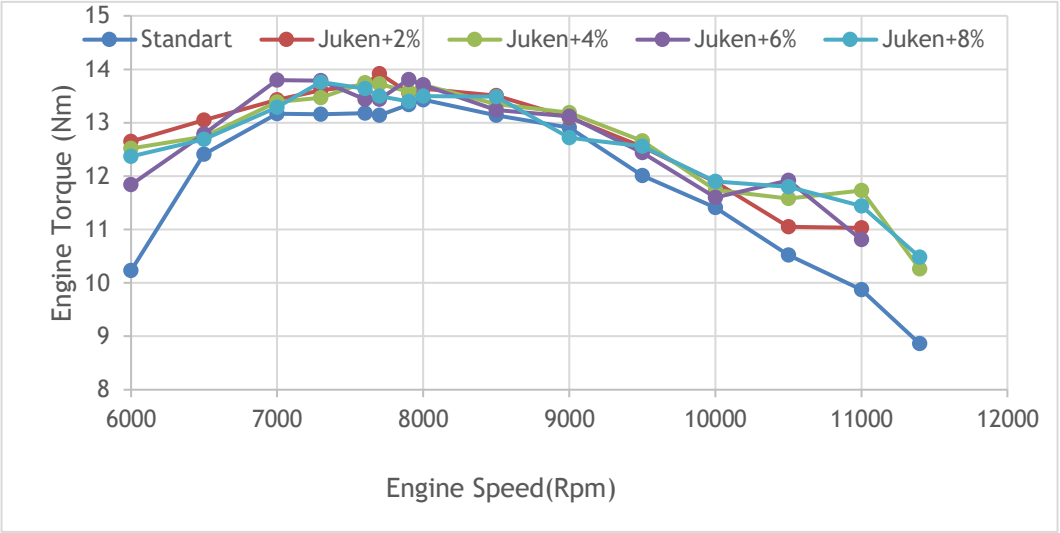

Figure 3. Comparison of Torque variations with Standard ECU, Juken fuel 2%, Juken fuel 4%, Juken fuel 6%, and Juken fuel 8% are shown in Figure 3.

The text describes the results of torque testing on a 4-stroke 150cc engine using the Standard ECU and various Programmable ECUs. In this test, the highest torque was achieved using the Juken ECU with a 2% fuel variation, reaching 13.92 Nm at an engine speed of 7,600rpm.

The Juken ECU demonstrated the capability to achieve peak torque faster and at a higher level compared to the Standard ECU. The Standard ECU reached a peak torque of 13.43 Nm at an engine speed of 8,000rpm, while the Juken ECU achieved 13.92 Nm at a lower engine speed of 7,600rpm. The increase in torque is attributed to more efficient combustion, resulting in higher torque output.

Table 4. Correlations

Engine Speed (Rpm)	Standart Torque (Nm)	Juken+Ig2 Torque (Nm)	Juken+Ig4 Torque (Nm)	Juken+Ig6 Torque (Nm)	Juken+Ig8 Torque (Nm)
6000	10.23	9.24	12.85	12.85	12.51
6500	12.41	13.3	13.25	13.25	13.06
7000	13.17	13.75	13.54	13.54	13.84
7300	13.16	13.9	13.65	13.65	14.13
7500	13.13	13.65	13.64	13.64	13.68

7900	13.34	13.73	13.87	13.87	13.95
8000	13.43	13.65	13.65	13.65	13.77
8500	13.14	13.53	13.5	13.5	13.61
9000	12.91	13.16	13.22	13.22	13.24
9500	12.01	12.59	12.87	12.87	12.95
10000	11.41	12.21	12.42	12.42	12.48
10500	10.52	11.81	11.62	11.62	12.03
11000	9.87	11.13	11.56	11.56	12
11400	8.86	11.59	11.49	11.49	10.98

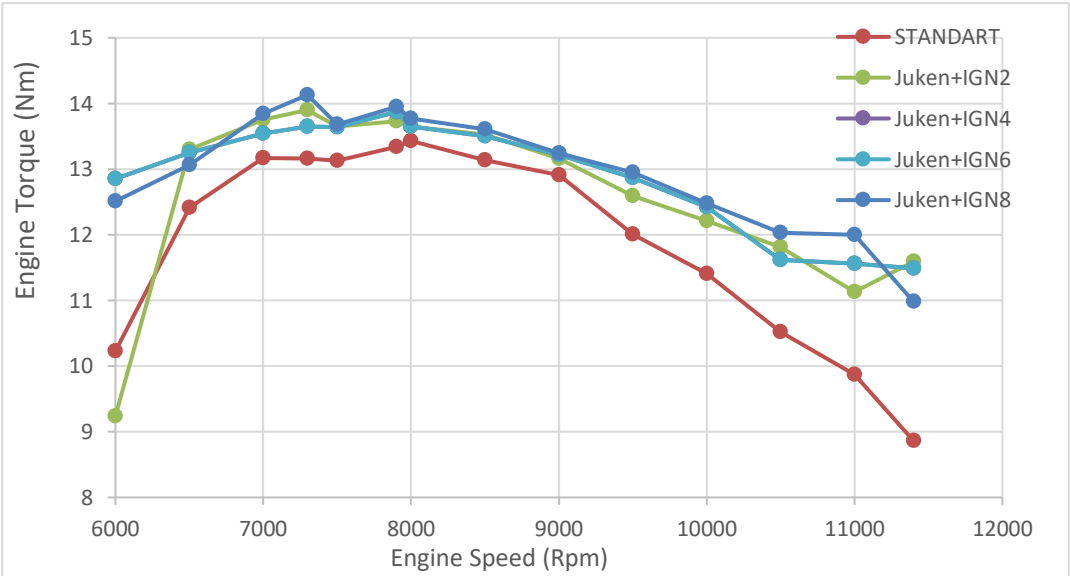

Figure 4. Comparison of Torque variations with Standard ECU, Juken IGN 2˚, Juken IGN 4˚, Juken IGN 6˚, and Juken IGN 8˚ are shown in Figure 4.

The results of the torque comparison testing between the Standard ECU and the Programmable ECU with IGN (Ignition Timing) variations of 2˚, 4˚, 6˚, and 8˚ can be observed in Figure 4.

In Figure 4, the results of torque testing for a 4-stroke 150cc engine using the Standard ECU and variations of the Programmable ECU with IGN2˚, IGN4˚, IGN6˚, and IGN8˚ can be observed. The test results indicate that the highest torque is achieved when using the Programmable ECU with IGN8˚, reaching a torque value of 14.13 Nm at an engine speed of 7,400 rpm.

The increase in torque is attributed to the adjustment of Ignition Timing advanced by 8° before Top Dead Center (TDC) to achieve more optimal combustion, especially when using pertalite fuel.

The Programmable ECU demonstrates the ability to reach peak torque faster and at a higher level compared to the Standard ECU. The Standard ECU reaches a peak torque of 13.43 Nm at an engine speed of 8000 rpm, while the Programmable ECU is capable of reaching 14.13 Nm at an engine speed of 7,400 rpm.

Therefore, the Programmable ECU produces higher torque compared to the Standard ECU, with an increase in torque of 5.21%.

Conclusion

The final results indicate that the use of the Programmable ECU is superior to the use of the Standard ECU in terms of both power and torque. The usage of the Programmable ECU shows an improvement compared to the use of the Standard ECU. In the case of the Standard ECU, the highest power is 16.82 HP at an engine speed of 10,600 RPM, while with the Programmable ECU, the highest power is 18.84 HP at an engine speed of 11,200 RPM in the Juken test with an 8° advance in ignition timing before Top Dead Center (TDC). The percentage increase in power is calculated as ((18.84 - 16.82) / 16.82) x 100 = 12.00%.

As for torque, the Standard ECU yields the highest torque of 13.43 Nm at 8,000 RPM, while with the Programmable ECU, the highest torque is 14.13 Nm at 7,300 RPM by advancing the ignition timing by 8° before TDC. The percentage increase in torque is calculated as ((14.13 - 13.43) / 13.43) x 100 = 5.21%.

In summary, the overall increase in power and torque is 12.00% for power and 5.21% for torque.

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