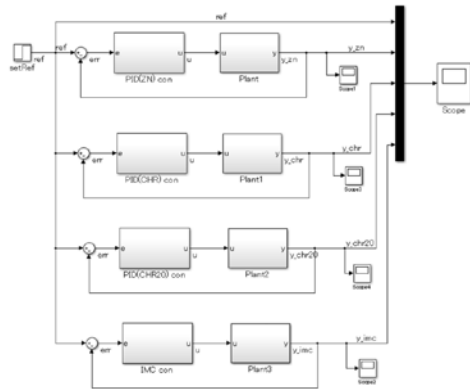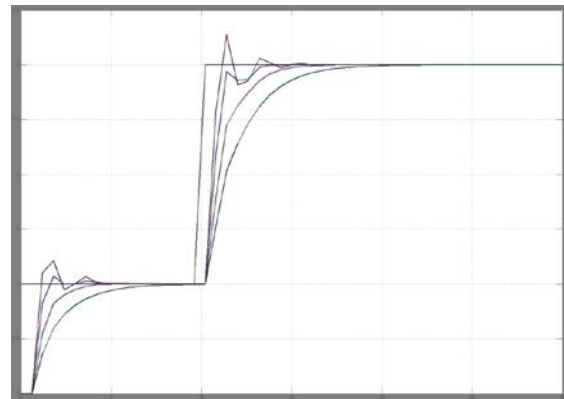1.1 A plant model as a control object, the step response method ZH CHR method respectively, simulation of control system based on IME method, comparison examination:
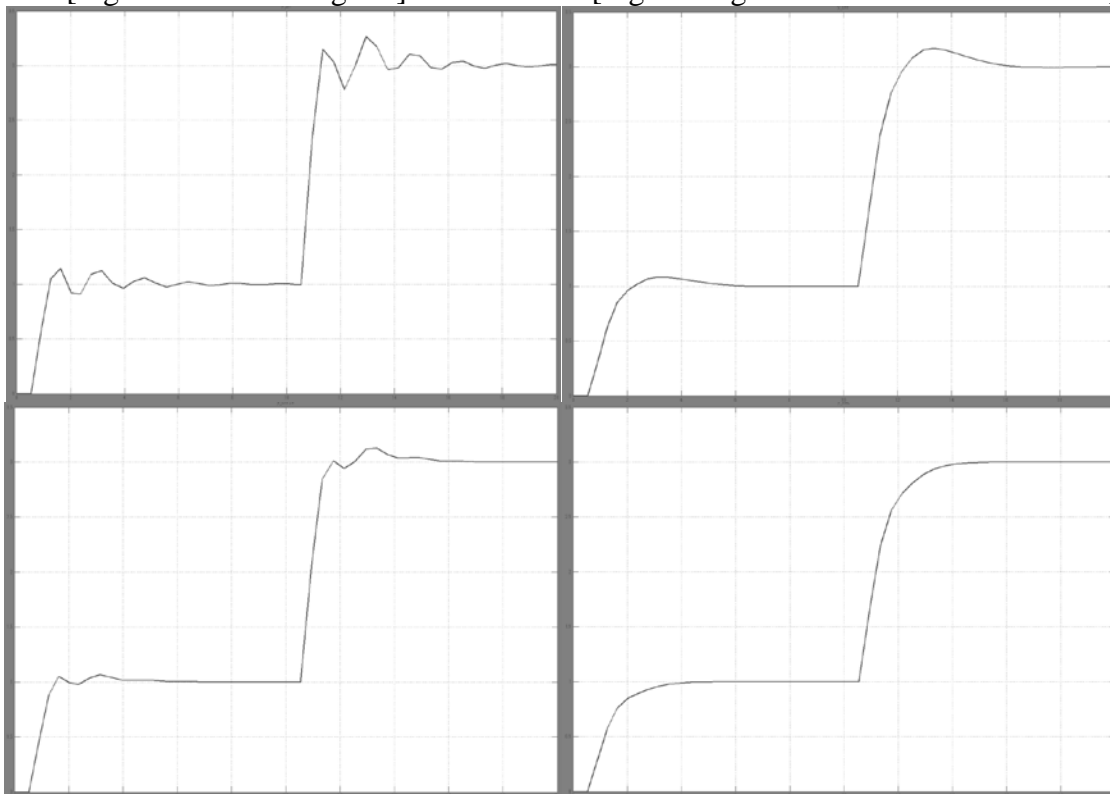
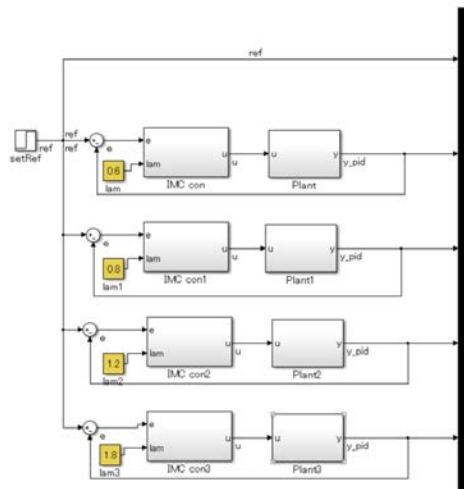Compare different controllers as follow:

[Fig. 1 Simulink Diagram]
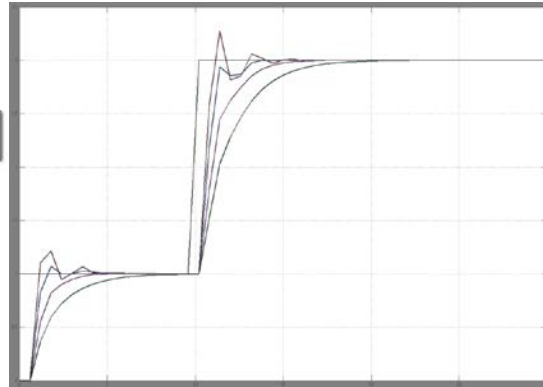

[Fig. 2 Diagram of Different Controllers]

[Fig. 3 Controller Comparison]

According to Fig.2 and Fig.3:
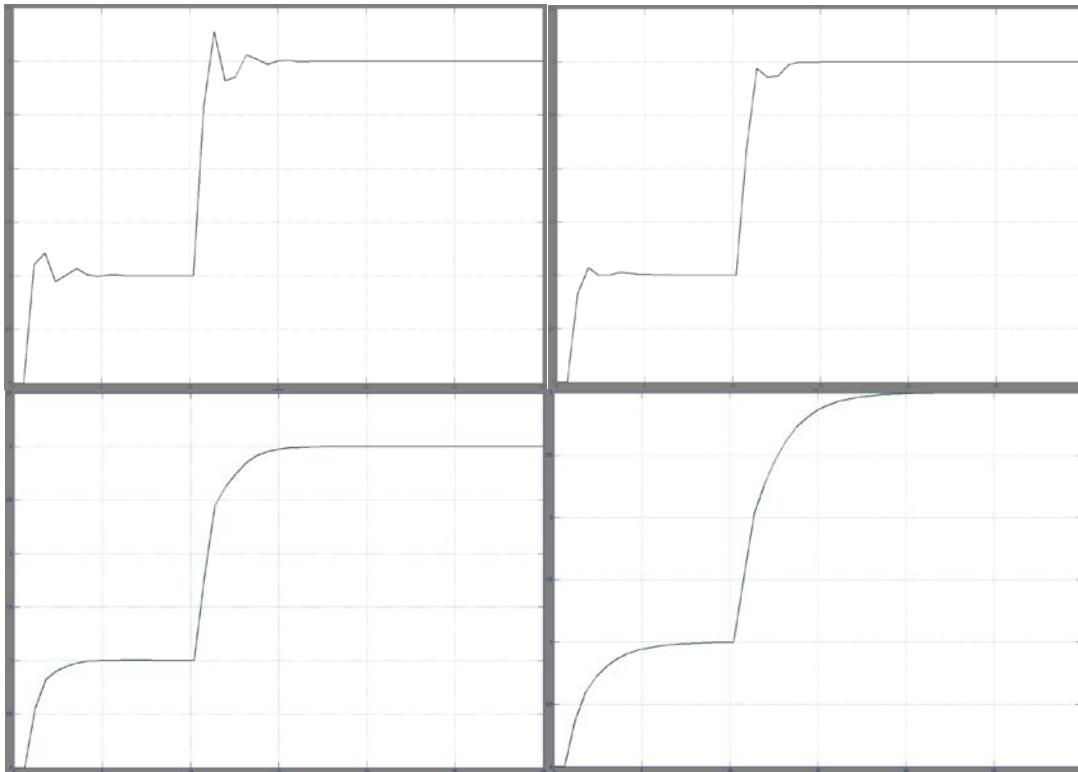
Low time delay will lead to overshoot.

1.2 Simulation of IMC method, lamda equal to 0.6, 0.8, 1.2 and 1.8, compared control performance:

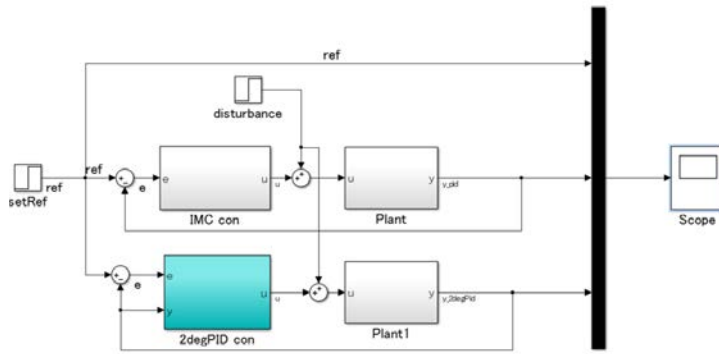[Fig. 4 Simulink Diagram]   [Fig. 5 Diagram of Different Controllers]

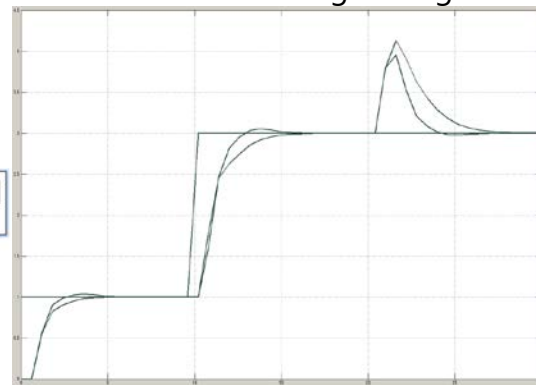[Fig. 6 Controller Comparison]

According to Fig. 5 and Fig. 6:
Delay time gets longer and overshoot gets smaller, as lamda becoming large.
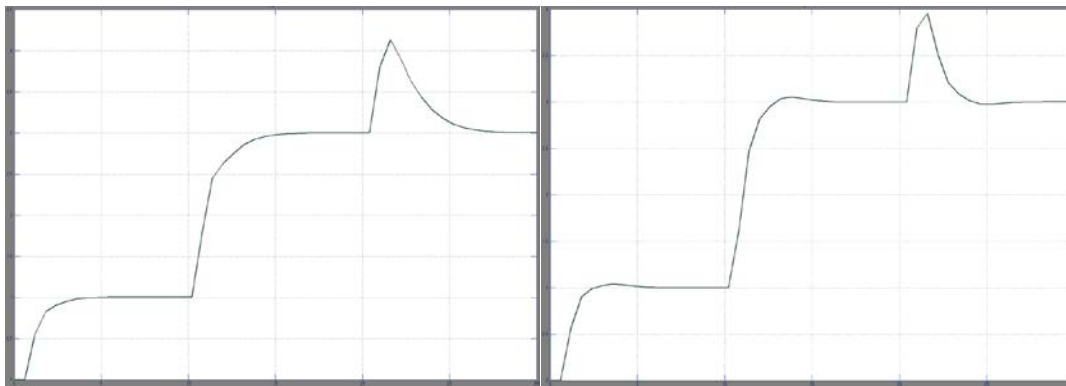
2.1 One degree of freedom and the control system of the IMC method with optimal parameters of two degree of freedom control as result of the comparison, the control system PID result.

[Fig. 7 Simulink Diagram]


[Fig. 8 Diagram of Different Controllers]

[Fig. 9 Controller Comparison]

According to Fig. 8 and Fig. 9:

Both of the two controller have approximate delay time, but 2-degree PID controller has a smaller overshoot.

3.1 Describe the Map implementation, control system, control is executed by Map function simulation of starting the engine.

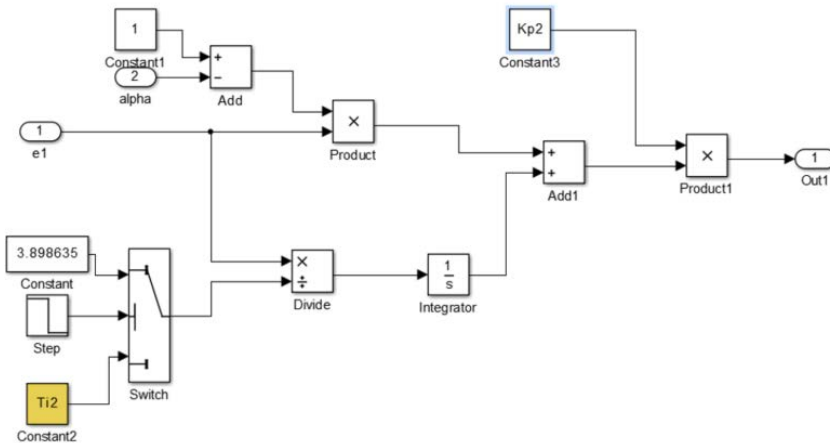[Fig. 10 Control System]

[Fig. 11 Control System Data]
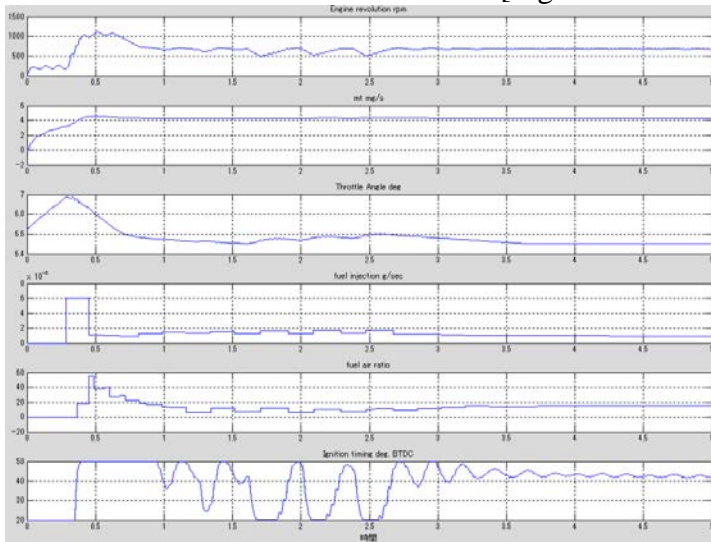

[Fig. 11 Control System Error]
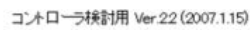
3.2 System will be described in a two degree of freedom control system implements the two-degrees-of-freedom control system to control the simulation of engine start.
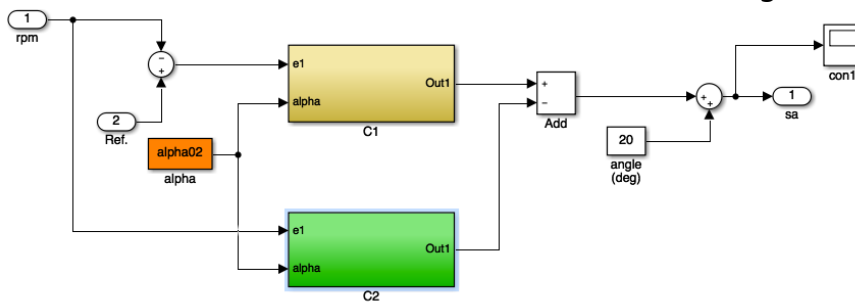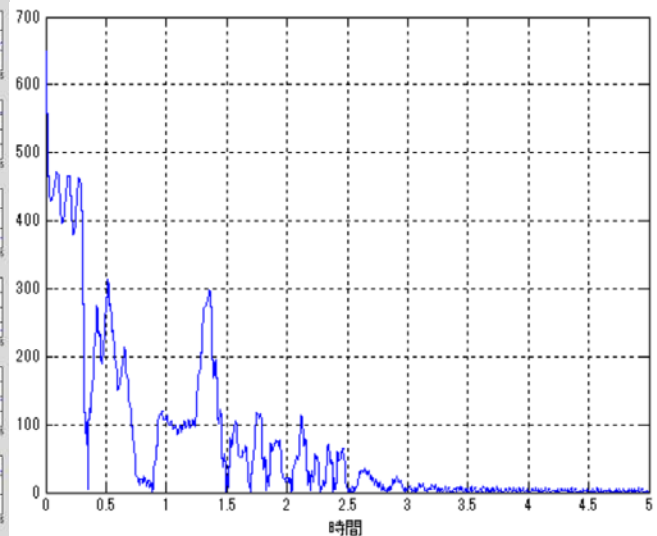
[Fig.12 PID Controller]
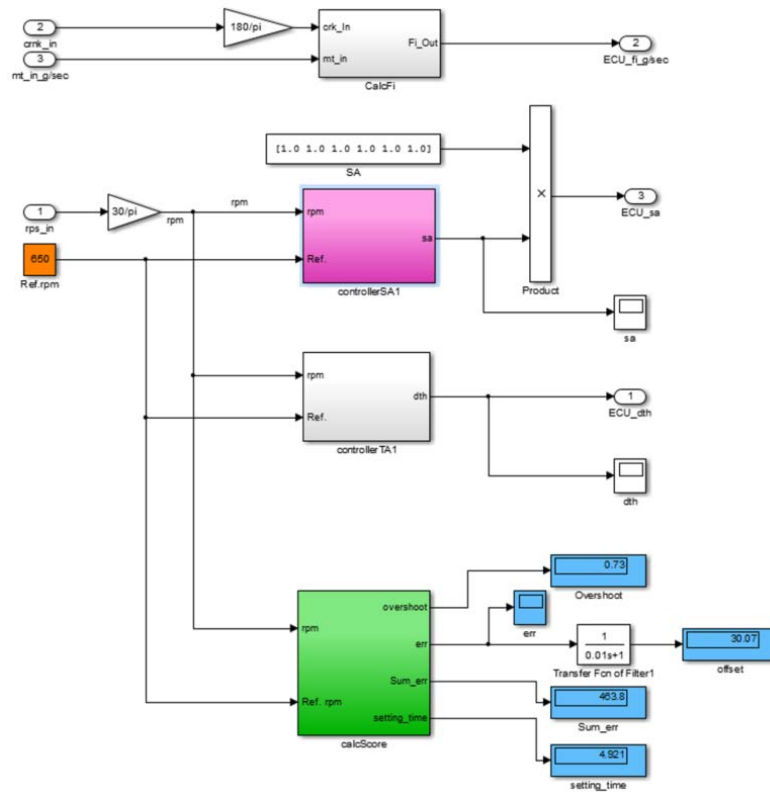

[Fig.13 C1 in PID Controller]
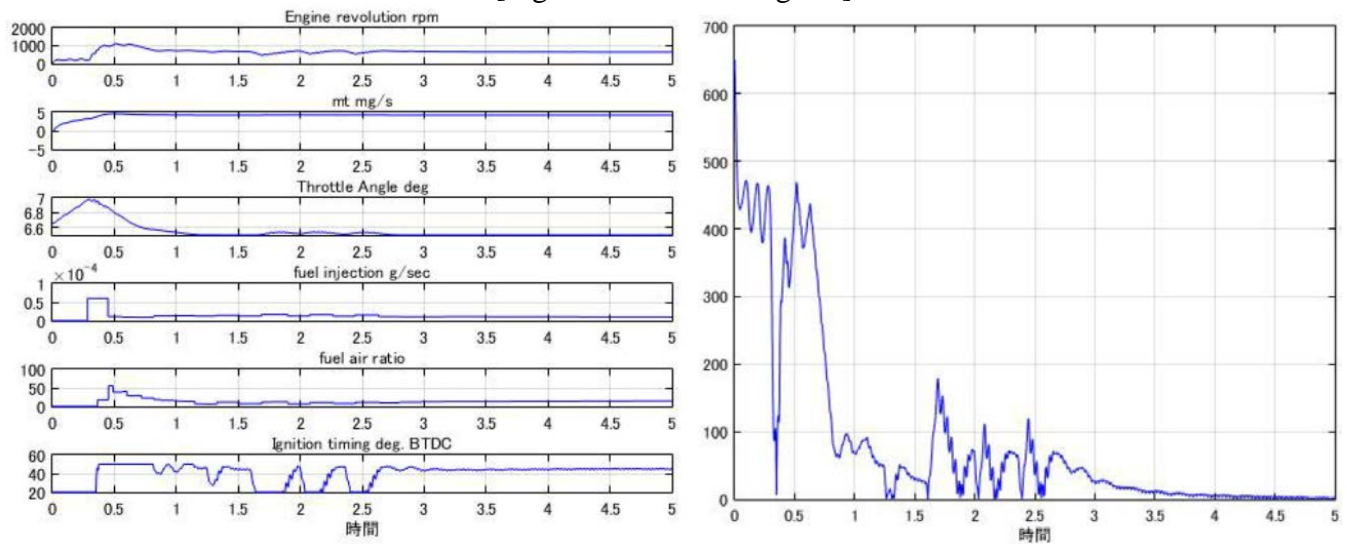

[Fig.14 Data of 2-Degree PID Control]   [Fig.15 Error of 2-Degree PID Control]
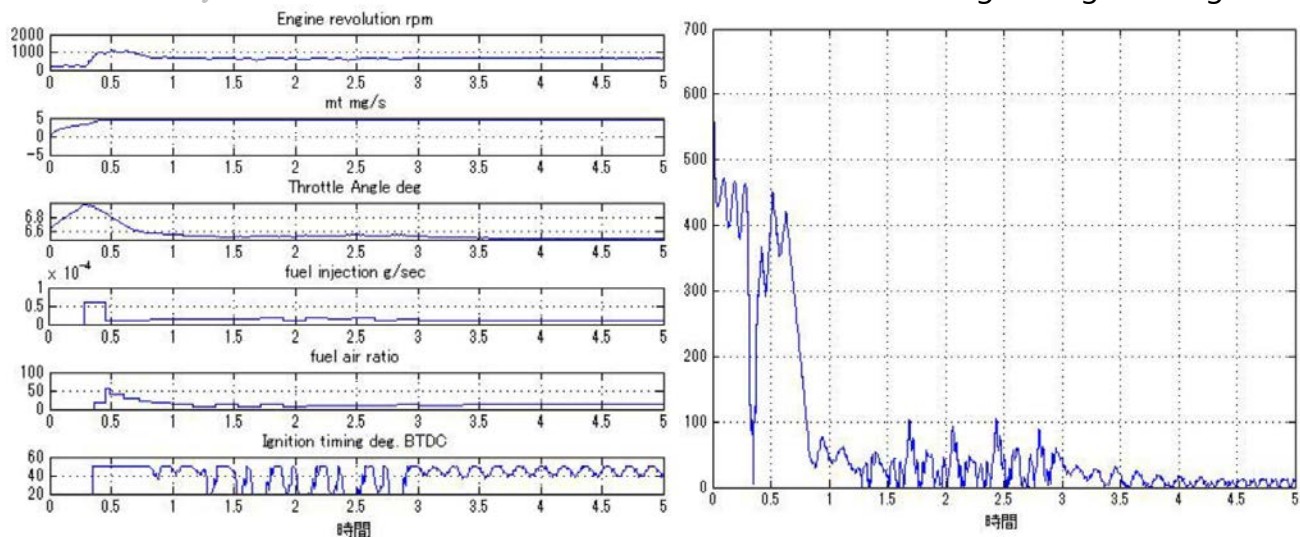
3.3 The control by the control Map PI by CHR, control method, IMC PI by 2 degrees of freedom of PS control simulation was carried out, and the control performance of the following items and fills in the table.

[Fig. 16 Simulink Diagram]

[Fig. 17IMC Data and Error]

[Fig. 17 CHR Data and Error]

Method	Sum of error	Overshoot	Offset	Setting time
Map	463.8	0.73	30.07	4.921
PI(CHR)	385.1	0.6952	8.456	3.128
PI(IMC)	424.4	0.7221	1.351	2.964
2-Degree PI(IMC)	359.9	0.4837	1.804	2.678

[Table 1 Performance of different controllers]

Evaluation:

1. Map is the simplest method.
2. PI(CHR) controller has a small sum of error, but both the offset and setting time is not small enough. The effect of disturbance signal can be reduced.
3. PI(IMC) controller has a small offset and setting and setting time.
4. 2-Degree PI (IMC) has the best performance.