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FACULTY OF TRANSPORTATION ENGINEERING
Department Automotive and Engine

DESIGN AN ELECTRONIC THROTTLE VALVE POSITION CONTROL SYSTEM

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I. Introduction

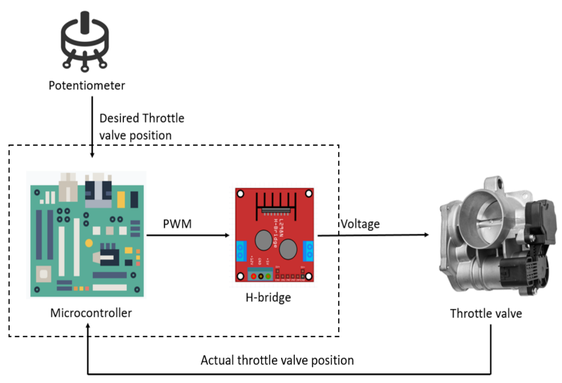


Figure 1: Pictorial diagram of the system

- Among the development of the control system. Throttle valve control plays an important role in optimizing performance of the engine, helping to save fuel, optimize the amount and composition of emissions.
- Therefore, the main task of this project is to design an electronic throttle valve position control system.

II. Theoretical basis

Throttle valve structure

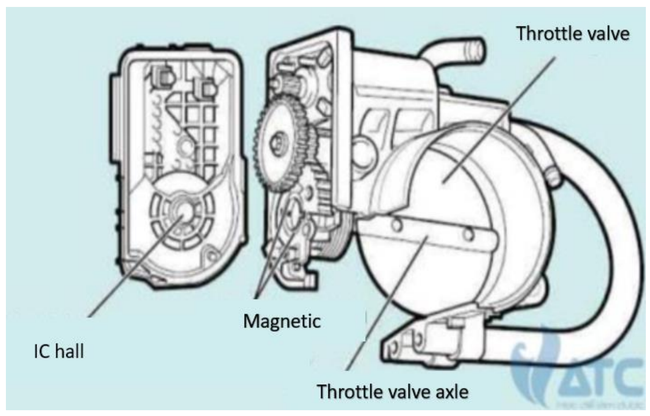


Figure 2.1: Throttle valve structure

Throttle valve position sensor

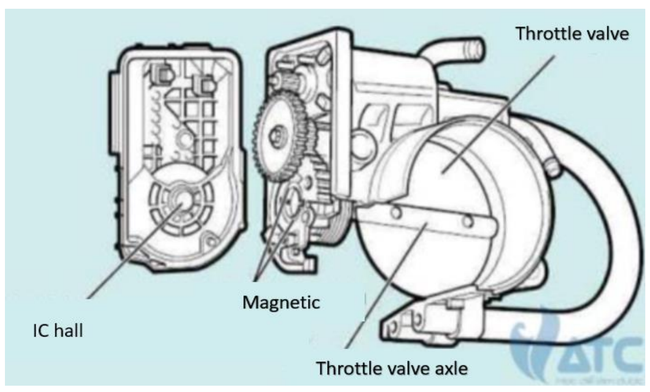


Figure 2.2: Hall throttle valve position sensor

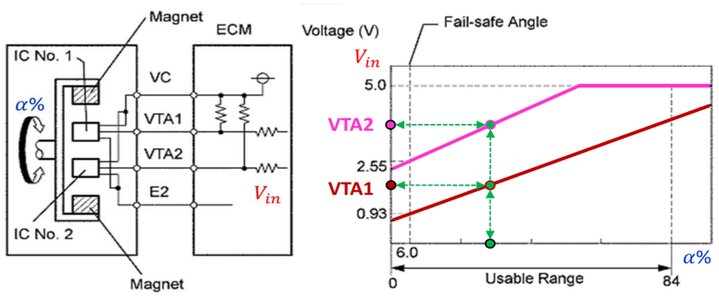


Figure 2.3: Hall sensor and throttle valve position signal characteristic diagram

The throttle valve opening angle detected by the sensor terminal VTA1 is expressed as a percentage

- Between 10% and 24%: throttle valve fully close
- Between 64% and 96%: throttle valve fully open
- Approximately 16%: Fail-safe angle(6^o)

III. General layout design

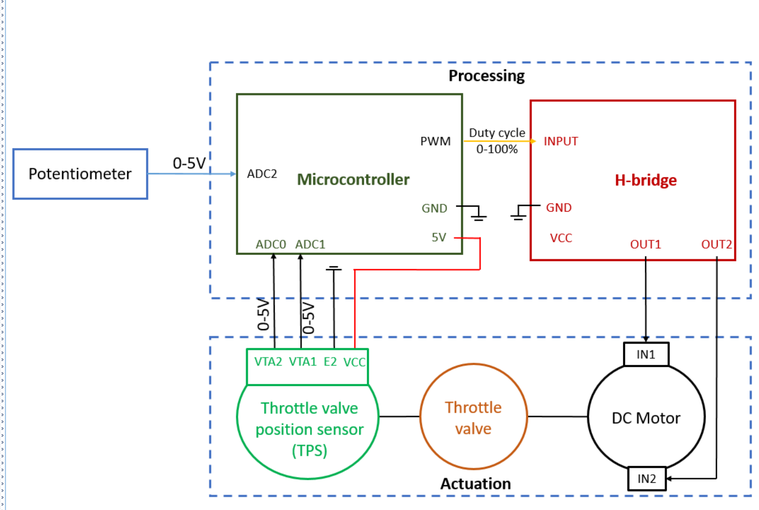


Figure 3.1: General layout diagram of electronic throttle valve system

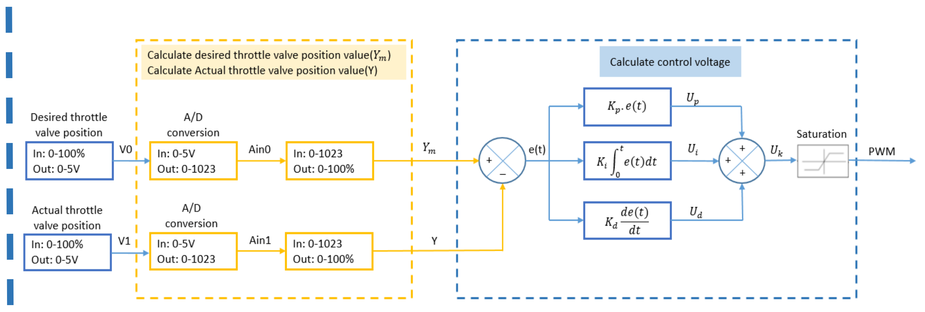


Figure 3.2: processing scheme

Sum of 3 components we have the control variable U_k

$$U_k = U_p + U_i + U_d = K_p.e(t) + K_i.\int_0^t e(t)dt + K_d.\frac{de(t)}{dt}$$

- If U_k < 0→ PWM = 0
- If U_k > Max → PWM = 100%
- If U_k ϵ (-Max;Max) → PWM = (U_k ×100)/Max(%)

IV. Technical design

Hardware design

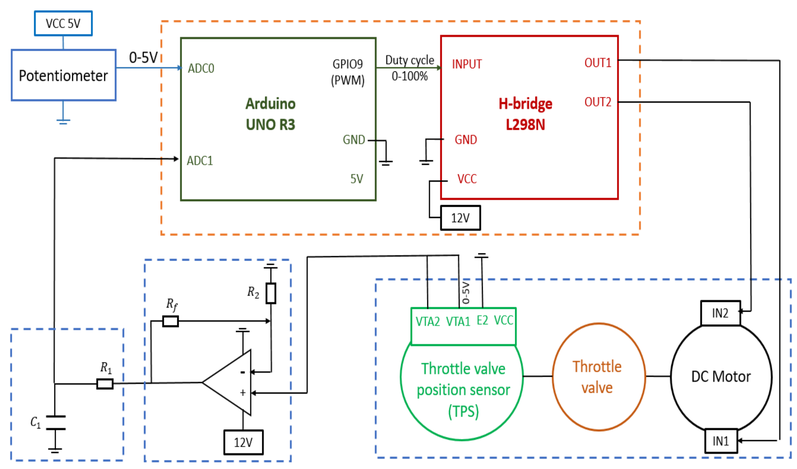


Figure 4.1: Electrical scheme of the system

Software design

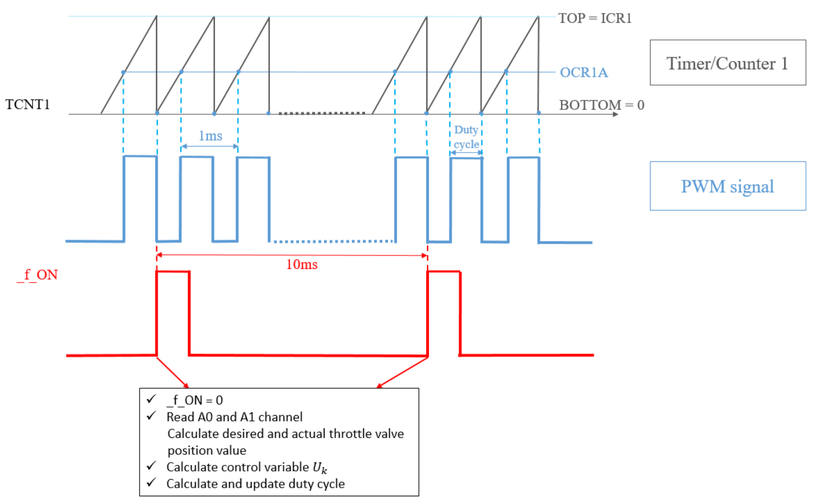


Figure 4.2: Timing diagram of the system

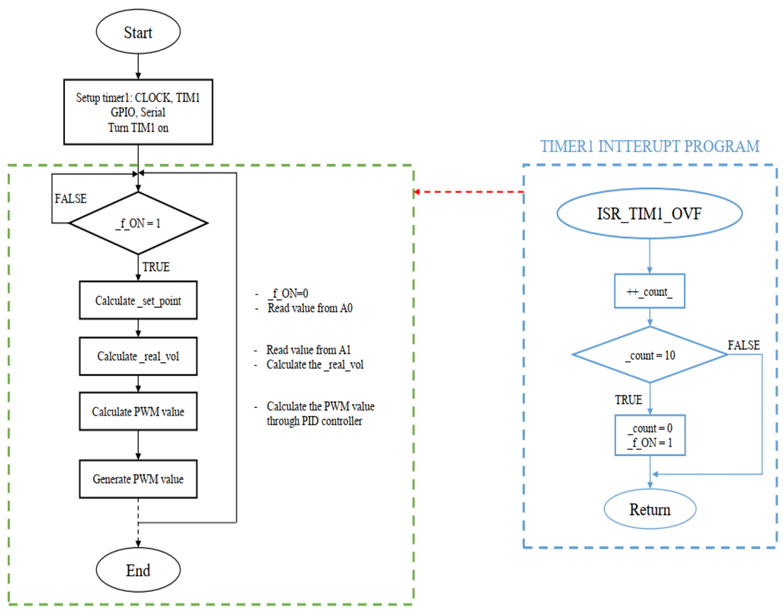
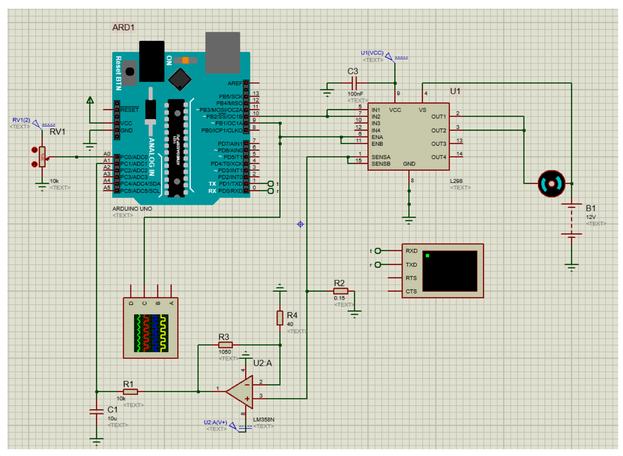


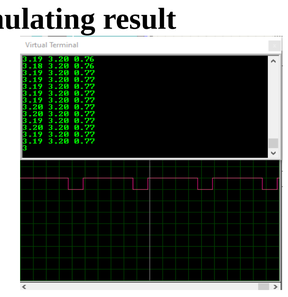
Figure 4.3: Flowchart of the system

V. Simulation and result

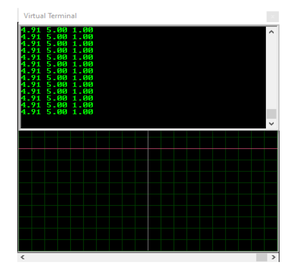
Proteus simulation



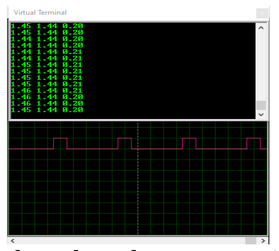
Simulating result



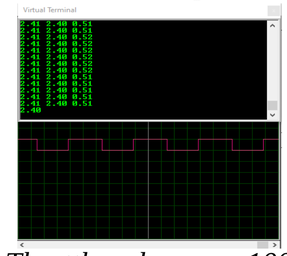
Throttle valve open 20%



Throttle valve open 50%



Throttle valve open 75%



Throttle valve open 100%

Desire voltage value	Actual voltage value	PWM value	ERROR
25% ~1.44V	~1.45V	0.20	0.6%
50% ~2.40V	~2.41V	0.51	0.4%
75% ~3.20V	~3.19V	0.77	0.3%
100%~5	~4.91	1	1.8%

Conclusion

- Lagging in PID controller that make the results are less reliable
- Desire throttle valve position value is simulated by the potentiometer, not link with acceleration pedal
- The system has satisfied the conditions is regulate the desire throttle valve position through simulation, calculate and control the motor by PWM value

VI. Reference

[1] Electronicstutorials – 2021– Non-inverting Operational Amplifier
[2] VATC – 2021 – Cảm biến vị trí bướm ga – TPS sensor
[3] Elprocus – 2021 – Throttle Position Sensor – Working Principle and Applications
[4] Atmel corporation – 01/2015 – 1600 Technology Drive, San Jose, CA 95110 USA - Atmega328p Datasheet
[5] Electronicstutorials – 2021 – Passive low pass filter