International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 08 Aug. 2024, pp: 340-343 www.ijaem.net ISSN: 2395-5252

Labview Software Application to Control Automotive Engine

Manhnguyen Huu
Ly Tu Trong College Ho Chi Minh City, Vietnam

Date of Submission: 15-08-2024 Date of Acceptance: 25-08-2024

ABSTRACT: In the context of the increasing demand for optimization and automation in the automotive industry, LabVIEW has proven to be a powerful solution for controlling and monitoring automobile engines. This study proposes a method of utilizing LabVIEW to establish an efficient automobile engine control system, enabling precise control and optimization of engine operations. Furthermore, the research explores the use of LabVIEW as a technical training tool in educational environments, assisting students not only in gaining a deep understanding of automobile engine mechanisms but also in practicing and applying their knowledge in engine control and monitoring. The results obtained from applying LabVIEW in both these areas not only demonstrate its versatility and efficacy in the automotive industry but also open up new opportunities for improving teaching and learning methods in the field of technical education. Finally, the study suggests several potential directions for the broader application of LabVIEW in the automotive industry and technical education, emphasizing the importance of integrating technology in training a digital workforce for the future.

Keywords: LabVIEW, automobile engine control, technical training, automation, technical education, engine optimization.

I. INTRODUCTION

1.1. Electronic Throttle Control Overview in Modern Automobiles

Previously, traditional throttle bodies were directly controlled through the pedal via a cable system. However, since 1992, with the introduction of traction control systems, some vehicles started incorporating an auxiliary throttle in the intake system. Moreover, the integration of automatic throttle control systems (Cruise Control) complicated the mechanical control mechanisms, leading to throttle-related issues. To address these, the recent shift towards electrically controlled throttles and electronic management via the Engine Control Unit (ECU) has simplified and enhanced throttle mechanisms.

The Electronic Throttle Control (ETC) system electrically connects the pedal with the throttle valve, replacing the traditional cable and spring setup with position sensors and a servo motor. While electronic throttle control systems have been researched for nearly a decade, their application has only become widespread recently. Unlike traditional systems, the ETC uses position sensors to relay the throttle's position to the ECU, streamlining engine control and improving efficiency.

1.2. Throttle Position Sensor

Installed on the throttle body and operating in tandem with its shaft, the throttle position sensor converts the valve's opening angle into an electrical signal for the ECU[1]. This sensor plays a critical role in:

- Adjusting the fuel mixture ratio according to engine load: At low speeds, a richer mixture is required for performance efficiency (λ = 0.85 – 0.95). As engine load increases, enriching the fuel mixture maximizes engine power, while a balanced mixture (λ =1) at moderate loads enhances fuel efficiency.
- Cutting fuel supply during deceleration: To conserve fuel and reduce emissions, the ECU cuts the fuel supply based on signals from the engine speed sensor and throttle position sensor during deceleration, with the process also depending on coolant temperature - the cut-off speed is higher when the engine temperature is lower.
- Enriching the fuel mixture during sudden acceleration: When the throttle is sharply opened from idle, the ECU adjusts to increase fuel, enriching the mixture for quick acceleration.

Thus, the throttle position sensor is crucial in controlling and optimizing engine performance, from adjusting the fuel mixture ratio to managing fuel supply efficiently.

1.3. Contact-Type Throttle Position Sensor

This On-Off control system operates as the throttle shaft turns, moving a cam inside the sensor. A movable contact slides along the cam groove, determining engine load and sending this signal to the ECU. Typically designed with two contacts, including an IDL contact for idle mode and a PSW contact for high load, the system adjusts fuel mixture, cuts fuel during deceleration, and enhances fuel during acceleration based on the throttle's position. At medium loads with no connection to either IDL or PSW, the ECU adjusts the air-fuel ratio ($\lambda = 1$) for optimal performance and fuel efficiency once the engine reaches normal operating temperature.

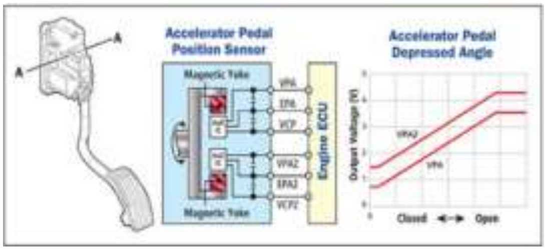

Fig. 1. Typical Toyota dual HALL sensor APPS – Analogue output type (varying voltage)

II. DESIGN AND FABRICATION OF A THROTTLE CONTROL CIRCUIT

2.1. Servo Motor

Traditional DC and stepper motors, by design, operate as open-loop systems - they function based on power supply without providing accurate feedback on their rotational degree. Even with stepper motors, which rotate a specific angle per given pulse, precise information about their rotation is generally lacking. Setting up a control system that can accurately determine and overcome rotational obstacles for motors is not straightforward.

In contrast, servo motors are engineered specifically for use in closed-loop feedback systems. They are connected to a control circuit capable of receiving data about the motor's velocity and position as it rotates. If any obstruction hampers the rotational movement, the feedback system detects it, and the control circuit adjusts accordingly, ensuring the motor achieves the desired precision.

Servo motors come in various designs and sizes, catering to a broad range of applications—from CNC lathes to model airplanes and remote-controlled cars. The latest frontier for servo motor application is the robotics industry, utilizing technology akin to that in model aircraft and car engines. This opens up vast and versatile application possibilities for high-tech designs, marking a significant step forward in the deployment of sophisticated control mechanisms in modern engineering solutions.

Fig. 2. Servo motor: Structure and functioning[2]

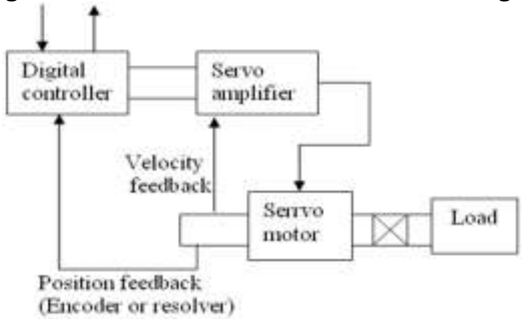

Fig. 3. Block diagram of servo drive system

2.2. Arduino Microcontroller

The Arduino platform is equipped with the powerful 8-bit megaAVR processors from Atmel, notably the AT Mega 328 and AT Mega2560 chips. These processors unlock the potential for developing versatile control applications, thanks to their robust configuration system that includes ROM, RAM, and Flash memory. Additionally, they offer a multitude of digital input/output (I/O) ports, including those supporting PWM signals, analog signal reading capabilities, and the support for various flexible communication protocols such as UART, SPI, and TWI (I2C). This enhances the Arduino's interaction and control capabilities, making it a versatile tool for a wide range of applications.

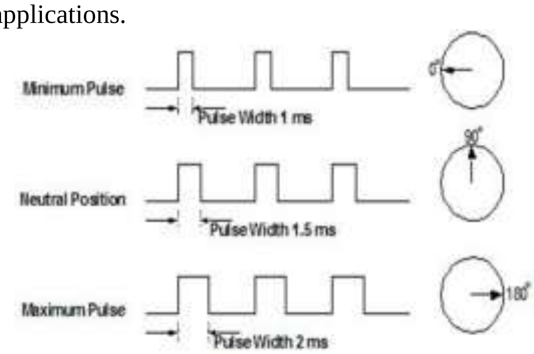

Fig. 4. Servo control

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 08 Aug. 2024, pp: 340-343 www.ijaem.net ISSN: 2395-5252

III. MODEL OF AN ELECTRONIC THROTTLE CONTROL SYSTEM

The designed model aims to regulate the throttle of an automobile engine through a servo motor, which is connected to and controlled by a computer using LabVIEW software. The objective is to establish an automated control system capable of simulating real-world scenarios related to engine throttle adjustments, thereby enhancing the efficiency of teaching and learning processes.

3.1. Principal Components

Servo Motor: Utilized for controlling the position of the throttle valve.
Automobile Engine: Equipped with a throttle, it serves as the primary control target within the model.
Computer: Installed with LabVIEW software, it functions as the control center and user interface.
LabVIEW Interface: A user interface designed for servo motor control and displaying information about the throttle valve's status.
Position Sensor: Employed to record the actual position of the throttle valve and relay this information back to the computer.

3.2. Layout Diagram

Computer: Acts as the control hub, directly interconnected with the servo motor through the LabVIEW interface[3].
LabVIEW Interface: Runs on the computer, with an interface designed for controlling and monitoring purposes.
Servo Motor: Linked to the computer via a communication port (USB or RS232) and to the engine's throttle valve.
Automobile Engine and Throttle Valve: The throttle valve is directly connected to the servo motor.
Position Sensor: Positioned near the throttle valve to note its position and transmit data back to the computer through LabVIEW.
This model delineates a sophisticated approach towards the study and manipulation of throttle mechanisms, leveraging advanced software tools and hardware integration to simulate and understand the dynamics of automotive throttle control systems[4].

Fig. 5. Control program code on LabView

Enhanced Academic Overview: Operational Process and Developmental Trajectories in Automotive Throttle Control Systems

3.3. Operational Protocol

Initiation: Users activate the LabVIEW interface on their computers and configure the desired control parameters. This initial step establishes the groundwork for subsequent interactions between the user, the control software, and the physical throttle mechanism[5].
Servo Motor Control Execution: Following commands issued from the LabVIEW interface, the computer dispatches control signals to the servo motor, orchestrating the adjustment of the throttle valve's position. This pivotal process translates digital commands into mechanical actions, directly influencing the engine's throttle response.
Feedback Acquisition from Position Sensors: Position sensors diligently record the actual stance of the throttle valve, relaying this crucial data back to the computer for display on the LabVIEW interface. This feedback loop is instrumental in ensuring the accuracy and reliability of throttle adjustments, enabling real-time monitoring and adjustments.
Adjustment & Monitoring: Users can perpetually refine control parameters via the LabVIEW interface, leveraging the feedback to supervise and adjust the throttle valve's operational state. This model exemplifies and scrutinizes control principles in a tangible setting, offering an efficacious tool for educational and learning purposes within automotive dynamics systems.

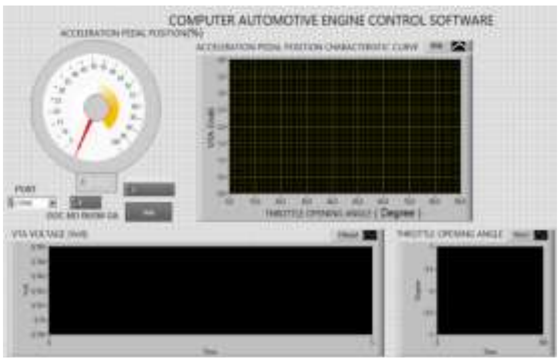

Figure 8: Software Interface Display

IV. CONCLUSION AND FUTURE DIRECTIONS

The outcomes of this exploration underscore the significant advantages of integrating LabVIEW with computer-automobile engine connections. This integration not only elevates the pedagogical effectiveness but also unveils numerous opportunities in the testing, maintenance, and repair of automobile engines. The model presents a cost-effective, flexible, and efficient solution for the automotive industry, particularly within the context of contemporary industrialization and modernization.

This paper concludes that the application of LabVIEW in bridging computer and automotive engine technologies within the Automotive Engineering Department represents a critical advancement. It contributes significantly to enhancing the learning, teaching, and research processes in the automotive dynamics field. Furthermore, the study paves the way for new developmental avenues in incorporating information technology into the automotive sector, aiming to devise digital solutions for present and future challenges in the industry.

REFERENCES

[1]. Gilbert, D. W., & Trinidad, O. "Toyota Electronic Throttle Control Investigation: Preliminary Report," retrieved February 21, 2010. [Online]. Available: https://premierautotrade.com.au/news/accelerator-pedal-position-sensors.php
[2]. Baumüller Group. "Servo Motors: Structure, Uses & Special Features." [Online]. Available: https://www.baumueller.com/en/insights/basics/servo-motors-structure-uses-special-features
[3]. National Instruments Corporate Headquarters. "LabVIEW Fundamentals," 2005. [Online]. Available: https://neurophysics.ucsd.edu/Manuals/National%20Instruments/LV_Fundamentals.pdf
[4]. National Instruments Corporate Headquarters. "LabVIEW User Manual," January 1998 Edition. [Online]. Available: https://engineering.purdue.edu/~aae520/Labview_manuals/LVUser.pdf
[5]. Ras, J., & Cheng, A. M. K. "On the Toyota's Throttle Control Problem," presented at the 2010 IEEE/ACM International Conference on Green Computing and Communications & International Conference on Cyber, Physical and Social Computing, December 18-20, 2010.