Board computer and cruise control design for agricultural vehicles

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Presentation of information such as, distance, fuel consumption, temperature, time, in the drives of agricultural vehicles provides comfort. These features in some of the new vehicles are available. But a lot of old or new vehicles are not still available. In this study, board computer software that can be applied to all vehicles has been made. This software is implemented on an experimental setup. Also vehicle's cruise control can be done with the software. While large agricultural land is cultivating at a constant speed, cruise control can provide great convenience. Cruise control software has been developed with the PID algorithm. In this way, Cruise control can be comfortable and proper.

INTRODUCTION

Traces of technology are seen in new generation vehicles. Emerging sensor technology offers many new features in vehicles. Some of these features are instantaneous and average fuel consumption information, navigation, cruise control, lane tracking system.[1] these features provide comfort, economy and safety for the drivers while traveling. Sensors, which are located in the vehicle, can be used to monitor a lot of information. For this, the only good software is required. If Fuel level and the distance are known, average fuel consumption can be found. In the same way ABS sensor can be used to check the tire pressure. There is no need for additional hardware cost. Tractors and harvesters are mainly preferred for agricultural works. In order to sell these kind of vehicles for low cost many features aren't found within them.

Figure 1: A Sample Board Computer Display

In this study, as many vehicles can be applied subsequently, a board computer is designed. Board computer consists of two parts which are software and hardware. An experiment-setup is designed to implement the system. At the same time, Board computer can control the velocity. A servo mechanism is used for this. In the following sections, board computer parts will be described.

Board Computer

Driving support system or Board Computer is a system, which give some information about vehicle or road to drivers. In this context, the following information is given on the designed board computer; average and instantaneous fuel consumption, date and time, inside and outside temperature, digital speed, fuel-level information and range. Also cruise control is designed by controlling the throttle position. Sensors located on the vehicle are used for the hardware. In addition to these, temperature sensor and the servo mechanism (for cruise control) are used. Speed information is detected from wheel. If there is no sensor on the wheel, an inductive sensor can be added. To connect all of this equipment, some electronic circuits are designed. Finally, the system was put in the box for convenient use.

Figure 2: Designed Board Computer

Fuel-Level Information

Many different methods can be used to measure the fuel level. While the new generation vehicles use non-contact measurement such as ultra-sonic, older vehicles use float level measurement.[2]

Figure 3: Float Liquid Level Measurement Sensor

All methods that have in common are the output electrical signal. Software calibration can be performed for different measurement systems. A fuel level sensor float tube used in the prototype system.

Figure 4: Fuel Level Sensor and Fuel Tank

Float moves with change of fuel in the tank. Thus it results in the chance of resistance. 12V voltage is applied to the sensor. At the output of the fuel level sensor is 0-12V. If Output is 12V, tank is full. Or output is 6V, tank is half. Change of the output voltage varies linearly with the fullness of the tank. The sensor output is analog. If a different sensor which has digital output is used, the software can be adapted to the output.

Figure 5: Fuel Level Signal Calibration Card

Fuel Consumption Information

This information is provided as standard in new cars, which gives average and instantaneous fuel consumption information. Whereby the fuel consumption and driving maximum range with fuel into the tank can be known. If fuel consumed as a result of a process of agricultural machines is known, the cost of the job can be calculated.

Figure 6: Fuel Consumption Display

In this study, fuel consumption information was calculated with the software. With the perception of some of the information, such as fuel level, speed and distance, the fuel consumption was calculated. Proportioning distance and fuel information at specific time intervals, instantaneous and average fuel consumption were calculated.

Fuel consumption can be calculated with a flow sensor which is placed on fuel pipe. So that a more sensitive knowledge of the fuel consumption can be achieved. The system is programmed to work with both methods.[3]

Date Time and Temperature Information

The current date and time are indicated by a liquid crystal display which is located on board computer for the drivers. Drivers can update the date and time. The system takes energy from the vehicle. The date and time will continue to work even if power is shut down. For this, an electronic circuit located on the battery was designed. Two digital temperature sensors are used for temperature measurement. Inside temperature of one of these sensors, and the other shows the outside temperature. If Outside temperature drops below three degrees Celsius, The Blue LED will be active. This is a warning to drivers for icing.

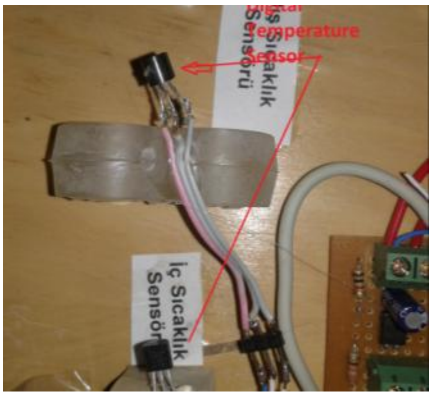

Figure 7: Digital Temperature Sensors

Sensors can operate between -55 to +125 degrees Celsius. The temperature unit can be changed by the user. (°F / °C / °K)
For Agricultural activities, the outdoor humidity information may be requested. A humidity sensor may be added to this system.

Speed Information

Speed information is detected from the movement of the wheel rotation. Four magnets at equal angles on the prototype wheel are placed. Magnets are detected by magnetic sensor, which is placed opposite of them. Although multiplied by the number of rotation of the wheel diameter, the distance can be known.

Figure 8: Wheel and Speed Sensor

Speed is the distance covered per unit of time. Although multiplied by the number of rotation of the wheel diameter, the distance can be known.

$$v = \frac{d}{t}$$

Where v is speed, d is distance, and t is time, if s is the length of the path travelled until time t, the speed equals the time derivative of s:

$$v = |v| = |\dot{r}| = \frac{dr}{dt}$$

In mathematical terms, the speed v is defined as the magnitude of the velocity v, that is, the derivative of the position r with respect to time:

$$v = \frac{ds}{dt}$$

Mathematically, instantaneous acceleration-acceleration over an infinitesimal interval of time-is the rate of change of velocity over time:

$$a = \lim_{\Delta t \to \infty} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

All of this information is calculated with the software. The calculated data is shown on the screen. Speed and distance information is digitally displayed. Speed information will be used to control the speed.

Cruise Control

Cruise control, constant speed driving for long periods of time provides great convenience for drivers, such as, long-distance drivers, agricultural machinery operators working in large farmlands.

The cruise control is basically carried out by controlling the position of the throttle valve. Braking system can also be used for advanced speed control. In this study, the speed control is performed based on the throttle position. Throttle position was controlled by a servo-mechanism moving linearly. When the throttle position is changed, vehicle speed may increase or decrease. The throttle position is detected by potentiometer in the prototype system. Changing of resistance shift the motor speed.

Figure 9: Servo-Mechanism and Throttle Position Sensor

Speed information is set to a value. After that, Vehicle goes at a constant speed. The fixed speed can be changed from the board computer panel. Instantaneous velocity difference with set speed is error. The system changes the position of the servo mechanism to reduce error. PID controller for speed control in a good way to the system is used.

Figure 10 is a schematic of the PID control algorithm block.

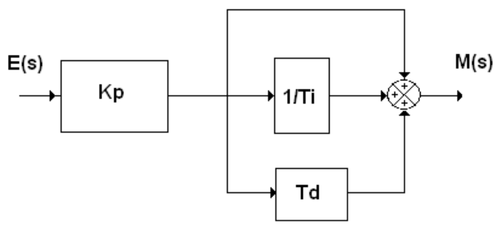

Figure 10: PID Block Diagram

PID coefficients are chosen as follows.

K_p=10, K_i=0.2, K_D=0.01

It has been observed that the successful control of the system with this PID coefficients.[5,6]

```
ki=0.2;
kp=10;
kd=0.01;

error = cchiz - hiz;

ITerm += (ki * error);
if(ITerm > 1000) ITerm= 1000;//1000=max out
else if(ITerm < -1000) ITerm= -1000;//-1000= min out
float dInput = (hiz - lasthiz);

servoout = kp * error + ITerm- kd * dInput;
```

Figure 11: PID Routine

The Experimental Setup

The experimental setup is shown in the figure. The board computer was put in the box to be used in vehicles. The system takes energy from the car battery. It works with 12/24V voltage. There are four buttons on the panel. These are the menu, the cruise control on / off, up and down function.

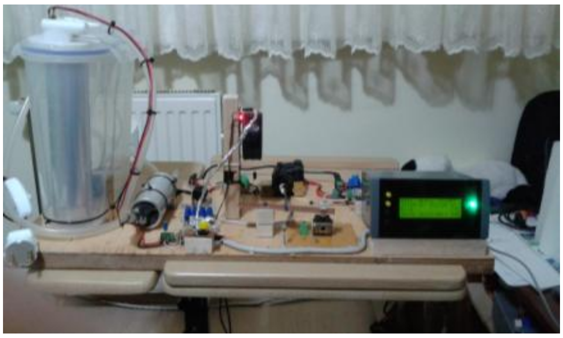

Figure 12: Prototype Experimental Setup

When the cruise control does not work, the green LED on the panel will be active. "CC:off" will be shown off on the display. Current speed, inside and outside temperatures, the date and time are displayed on the panel. In addition, according to user choice, bar graph fuel level, range and fuel consumption (average / instant) can be displayed. This selection is done by pressing up or down.

Figure 13: Board Computer Screen Views

When the cruise control is active, the instantaneous velocity information is the set speed. Servo mechanism is activated to control the throttle valve position. The set speed can be changed with the up and down keys. When there is an active cruise control, the menu key is not used. Off button is pressed to stop the cruise control. If brake or accelerator pedal is pressed, the system will be disabled. Press the Menu button to customize the system settings.

Conclusion

In this study, a board computer was designed for Vehicles which does not have. If drivers are provided to follow some of the information, such as inside and outside temperature, fuel level, date and time, fuel consumption. In addition this, board computer, makes speed control.

The system maintains constant speed, which set before, with the linear servo mechanism. This provides a great convenience for operators working farmlands and long-distance drivers. The board computer was put in a box to be used in agricultural vehicles. Energy requirement is designed to be taken from the vehicle. Board computer, which is designed, can be applied the vehicle economically later. The board computer has been tested on the prototype. PID coefficients for the cruise control have been properly selected. The system software is designed to meet different needs.

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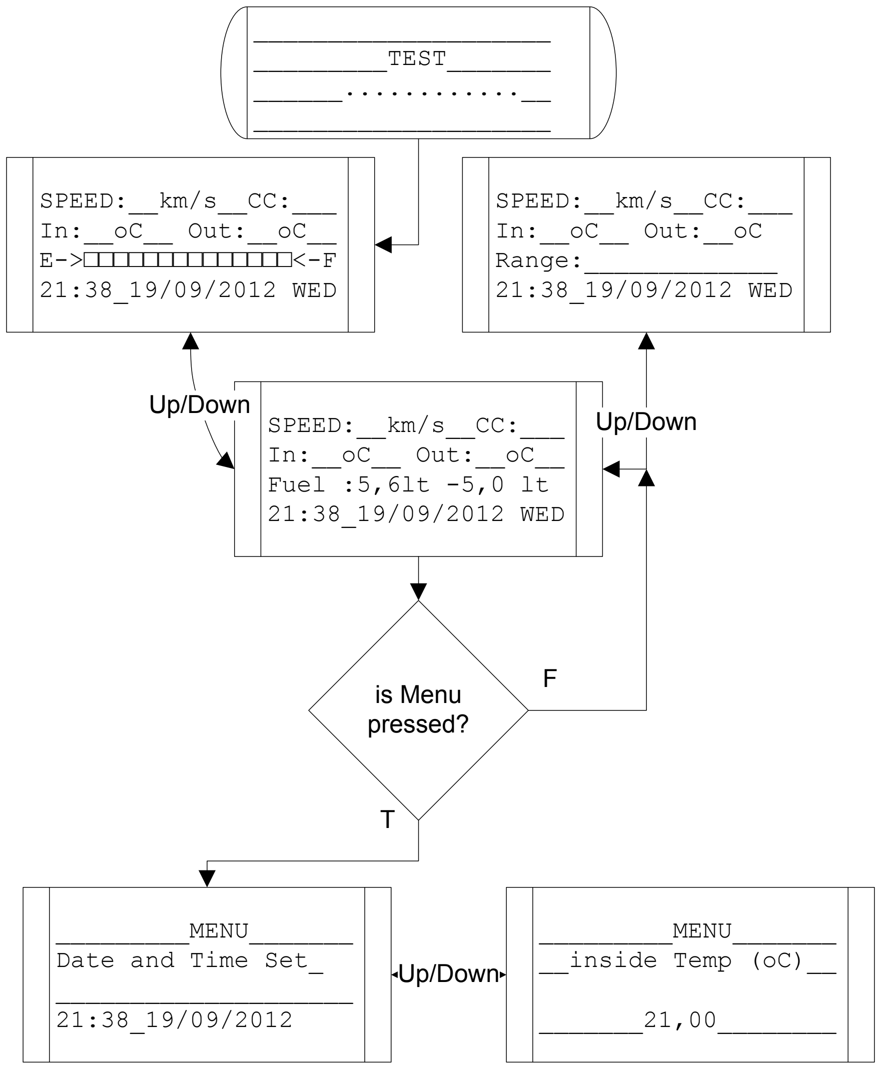

Figure 14: Board Computer Flow Chart

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Glossary and Symbols

İç .... : Inside

Dış...................... : Outside

Hız...................... : Speed

Yakıt................... : Fuel

Menzil................. : Range

CC...................... :Cruise Control (Set Speed)

E......................... : Empty

F .... :Full

v .... :Velocity

t .... :Time