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Design and Implementation of Driver Main Computer and Head Up Display on Smart Car

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Abstract

Smartcar is a system concept in which car will have its own intelligence to achieve improved riding experience. Smart car computer system can be divided into main driver computer system and auxiliary computer system. The function of driver main computer system is as main source of information for the driver about car condition and the surrounding environment. This system, which is integrated with obstacle avoidance computer via ethernet network, provides warning and guidance to driver to avoid accident. All of information, warning, and guidance will be shown on Head Up Display. The data which is retrieved from sensors in the car will be sent to the driver main computer and will be shown on the head up display.

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1. Introduction

There are some factors which is causing accident on the road. Those factors are human error, vehicle error, and the accident itself which can not be avoided. The sources of accident because of human error are sleepy, drunk, or using mobile phone while driving. The sources of accident because of vehicle error are brake malfunction, old vehicle, and the engine which is not properly maintained.

To solve that problem, a system is needed to improve the driving safety. The driver is still able to access the communication device and multimedia device without distracting the driving process.

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Smart car system has some purposes amongst which includes :

- Car can interact with user
- Car can interact with other car
- Car can interact with surrounding network (navigation, traffic information, etc)

The purpose of this research is to design and implement driver main computer system and head up display which is a part of the intelligent transport system.

2. System Design

2.1. Intelligent transportation system

Computer system for smart car focused on the interaction between driver and car and the interaction between driver and surrounding network. The intelligent transport system, which is being developed, is shown below.

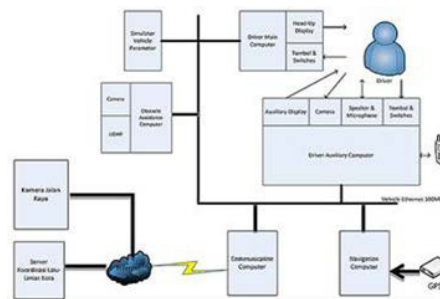


Fig. 1. Intelligent transportation system.

The computer system for smart car is divided into the following parts:

- Driver main computer
- Driver auxiliary computer
- Navigation Computer
- Obstacle avoidance computer
- Communication Computer
- Cloud Server

The driver main computer dan auxiliary computer will interact directly with the driver, the other system will process the required data such as car condition, traffic condition and surrounding environment, communication and navigation. Car condition and surrounding environment information will be shown on the head up display from the main driver computer. Navigation information will be shown on the auxiliary computer.

Driver main computer has two main function.

- Processing the data which is retrieved from simulator vehicle parameter
- Displaying processed data to head up display

Head up display will replace the indicator cluster in dashboard on common car. The data that will be shown on head up display are as follow:

- Vehicle speed
- Engine temperature

- Engine speed
- Fuel capacity
- Pedestrian and vehicle warning
- Objek avoidance guidance

Driver auxiliary computer acts as driver assistant for navigation, phone access, and multimedia. The functions of driver auxiliary computer as follows:

- Mobile phone access (phone call, SMS, multimedia)
- Display navigation information, traffic information, and mobile phone interaction
- Handle the voice command for mobile phone interaction
- Passenger condition monitoring

Navigation computer processes data which is required for navigation, such as origin location, destination, coordinate from GPS, routing, and road sign. The processed data will be shown in the form of route on the map or sequential sign.

Obstacle avoidance computer detects the condition of nearby environment which has potential to distract the driving activity. The things that has potential to distract the driving activity are obstacle object, pedestrian, and road sign. Communication computer handles communication process to cloud server.

Navigation computer will received data from car and will give recommendation to navigation system which is suitable with traffic condition. The recommendation is given in the form of new routing to avoid traffic jam in particular location.

2.2. Servo motor

The function, or task, of a servo can be described as follows. A command signal which is issued from the user's interface panel comes into the servo's "positioning controller". The positioning controller is the device which stores information about various jobs or tasks. It has been programmed to activate the motor/load, i.e. change speed/position.

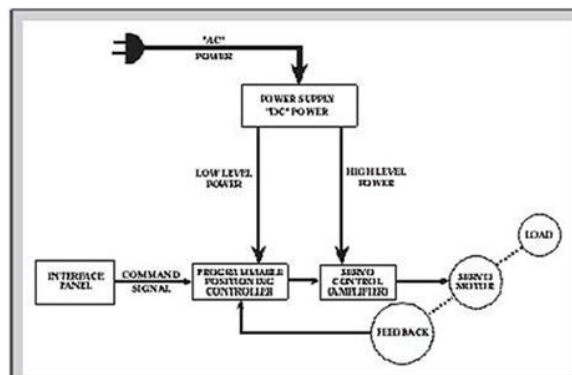


Fig. 2. The concept of servo system.

The signal then passes into the servo control or "amplifier" section. The servo control takes this low power level signal and increases, or amplifies, the power up to appropriate levels to actually result in movement of the servo motor/load. These low power level signals must be amplified: Higher voltage levels are needed to rotate the servo motor at appropriate higher speeds and higher current levels are required to provide torque to move heavier loads. This power is supplied to the servo control (amplifier) from the "power supply" which simply converts AC power into the required DC level. It also supplies any low level voltage required for operation of integrated circuits. As power is applied onto the servo motor, the load begins to move, speed and position changes. As the load moves, so does some other "device" move. This other "device" is either a tachometer, resolver or encoder (providing a signal

which is "sent back" to the controller). This "feedback" signal is informing the positioning controller whether the motor is doing the proper job.

The positioning controller looks at this feedback signal and determines if the load is being moved properly by the servo motor; and, if not, then the controller makes appropriate corrections. For example, assume the command signal was to drive the load at 1000 rpm. For some reason it is actually rotating at 900 rpm. The feedback signal will inform the controller that the speed is 900 rpm. The controller then compares the command signal (desired speed) of 1000 rpm and the feedback signal (actual speed) of 900 rpm and notes an error. The controller then outputs a signal to apply more voltage onto the servo motor to increase speed until the feedback signal equals the command signal, i.e. there is no error.

Therefore, a servo involves several devices. It is a system of devices for controlling some item (load). The item (load) which is controlled (regulated) can be controlled in any manner, i.e. position, direction, speed. The speed or position is controlled in relation to a reference (command signal), as long as the proper feedback device (error detection device) is used. The feedback and command signals are compared, and the corrections made. Thus, the definition of a servo system is, that it consists of several devices which control or regulate speed/position of a load[1].

2.3. Head-up display

No doubt the defense industry is one of the greatest technology incubators the world has ever seen. One of the technology used in jet fighter is used in car, that is head-up display.

During World War I, aircraft engineers got the idea to combine electrical illumination with the then-rudimentary optical reflector sight to help pilots aim planes' machine guns. Pilot would no longer have to align their heads precisely with mechanical sights to make an accurate shot. By the 1950s, such displays had expanded to include complex, radar-guided lead-finding sights as well as basic flight information like altitude, air speed, compass, and artificial horizon indicators.

The HUD is basically a development of the conventional Attitude Display Indicator (ADI). Its basic task is to provide both lateral and vertical guidance for approach and flare, lateral guidance for roll out but also other relevant data regarding the flight in progress, such as altitude, speed and navigation information. This information is presented onto a semitransparent glass situated between the windshield of the aircraft and the pilot's position.

The view from the external scene in front of the aircraft passes directly through the semitransparent glass and to the pilot's eyes. The view observed from the pilot's seat, looking through the HUD, is thus a combination of the real world outside and the information derived from the HUD[2].

In 1988, General Motors was the first company to install a monochrome HUD in a civilian motor vehicle, adding color in 1998, and then partnered with Raytheon to offer HUD-based infrared night vision in 2000 (it was discontinued in 2004). Other automakers followed. BMW was the first European manufacturer to offer an HUD, in 2003.

Both companies appear to be committed to the HUD. In 2010, GM announced it was working on a system that gathered data from a bank of sensors and cameras, parsed the info, and projected laser-generated images – outlining a sharp curve on a foggy day, for example, or highlighting a faint obstacle in the dark – onto the surface of the windshield. That system has not yet been incorporated into a production car.



Fig. 3. General Motor’s head-up display [3].

3. Implementation and testing of driver main computer system and head up display

3.1. Implementation process

The implementation of main driver computer system and head up display is based on the previous design. The steps of implementation is shown on the flowchart below.

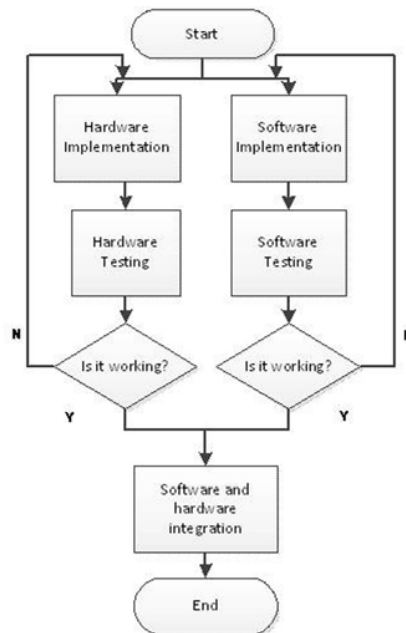


Fig. 4. Implementation process of main computer system and head up display.

The implementation of driver main computer system and head up display consists of hardware implementation and software implementation. Hardware is built with wood frame, LCD monitor, acrylic screen 3 mm thick, servo motor, micro-controller system with ATmega16 as servo motor controller.

The software is consists of many programs. There are dummy clients for object avoidance computer and simulator vehicle parameter. These dummy clients generate random numbers to simulate the actual object avoidance computer and simulator vehicle parameter. There are also two projects of Visual Studio 2010. The first one is a class of gauge design which is used for head up display [4]. Class from this gauge design has user control so the user can customize the form and color of the gauge. The second project is the main program from head up display. All of the data that has been processed from dummy clients will be displayed on head up display.

Driver main computer system is developed with the following environment:

- Operating System: Windows 7
- Programming software: Visual Studio 10
- Programming Model: .NET Framework 4
- Programming Language: C#
- Development Platform: Windows Presentation Form

The features of driver main computer and head up display are:

- On head up display, the image from LCD monitor is reflected on the acrylic screen. To have a clear image reflection, the acrylic screen must be tilted at 45°. Servo motor is used to tilt the acrylic screen. The servo motor is controlled by ATmega16. Hitec HS-645MG motor servo is used. It has maximum torque 9,6 kg.cm[5]. The servo motor is mounted on the wood frame, bolted on both side. The user can tilt the acrylic screen by push the button on the right side of the frame.
- Pedestrian and vehicle warning system is implemented on driver main computer. This system will warn the driver if there is pedestrian or car in front of smart car to avoid collision.

Obstacle avoidance computer will recognize any object in front of smart car. The object will be recognized as vehicle or pedestrian. After the object is recognized, obstacle avoidance computer will command driver main computer to warn the driver. The warning will be displayed on head up display. Driver main computer also will give advice to driver to turn left, turn right, or brake to avoid the collision.

The implemented driver main computer and head up display is shown in the figure below.

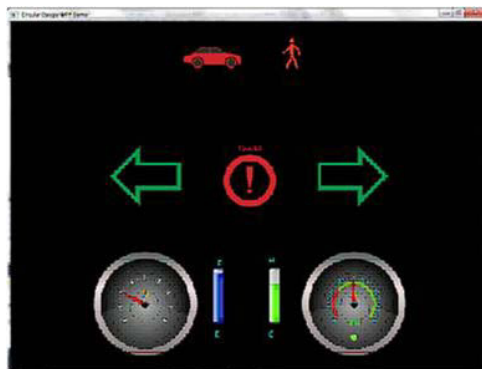


Fig. 5. The result of implementation of driver main computer and head up display.

3.2. Testing

The testing is mainly focused on communication between driver main computer system, obstacle avoidance computer, and simulator vehicle parameter. The obstacle avoidance computer and simulator vehicle parameter is

simulated with dummy client software on the same computer with driver main computer. Simulator vehicle parameter will generate random numbers to simulate the car condition such as car speed, engine speed, engine temperature, and fuel capacity.

Obstacle avoidance computer will generate random number from 1 to 6 to simulate the obstacle case. Number 1 is for a case when there is pedestrian on the left side of the car. The driver main computer will warn and suggest the driver to turn the car to the right. Number 2 is for a case when there is a pedestrian on the right side of the car. The driver main computer will warn and suggest the driver to turn the car to the left. Number 3 is for a case when there is pedestrian right in front of the car. The driver main computer will warn and suggest the driver to step on the brake pedal. Number 4 is a case when there is a vehicle on the right side of the car. The driver main computer will warn and suggest the driver to turn car to the left. Number 5 is a case when there is a vehicle on the left side of the car. The driver main computer will warn and suggest the driver to turn car to the right. Number 6 is a case when there is a vehicle right in front of the car. The driver main computer will warn the driver and suggest the driver to step on brake pedal.

The system have been tested and work properly. Obstacle avoidance computer has successfully sent the command to driver main computer via ethernet and the driver main computer has successfully display the warning and suggestion to head-up display. Simulator vehicle parameter has successfully sent data to driver main computer via ethernet and the driver main computer also be able to display the data to head-up display

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