Intelligent Assisted Driving System Based on Multi-MCU

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Abstract—The multi-eye vision image acquisition method is used to allow multiple cameras to collect panorama information around the car and send it to multiple MCUs (Microcontroller Units) to process the images at the same time, and then extract valid information. The main MCU comprehensively processes these valid signals to get the most urgent control signal, then drives the voice broadcast module to assist the driver in driving the vehicle. At the same time, the auxiliary MCU is set to monitor the operation of the main MCU and perform various control actions instead of the main MCU when it fails. This not only solves the contradiction between the high complexity of image processing and the requirement for fast signal processing and transmission speed, but also makes the car have good visual processing capabilities, control flexibility and safety.

1. INTRODUCTION
In this era, more and more researches are being done on automobiles in the field of intelligence, and intelligent driving has also become a practical research content. Smart cars are comprehensive systems that integrate environmental awareness, decision-making planning, and assisted driving. The intelligent driving assistance system can more accurately detect pedestrians, vehicles, and obstacles on the road, and warn the driver with a notice in the form of voice announcements, helping the driver to make more accurate judgments, avoiding accidents caused by the driver's subjective judgment or misjudgments. Therefore, it is necessary for multiple cameras to cooperate with each other to collect image information, so as to obtain all the information of the car and its surroundings[1]. Due to the large amount of image information collected and the complexity of image processing, using only one MCU to process will naturally highlight the delay in image information matching and processing, and even give wrong information and cause misjudgements of the driver which reduces the safety of the smart car during use. Therefore, we need to improve on this basis, and constantly improve the safety, real-time and reliability of the smart car in the process of use[2][3], so that science and technology can truly enter people's lives and serve us.

2. OVERALL DESIGN PLAN
The panorama of the smart car and its surroundings needs to be quickly collected, processed, and transmitted to ensure its safety and accuracy of the prompt information. The designed multi-MCU
structure system[4][5] is shown in Figure 1. Multiple cameras outside the car collect the panoramic information of the car's surroundings, and distribute it to the corresponding multiple MCUs to obtain the valid information after processing at the same time. Then, the effective signals are transmitted to the main MCU. The main MCU comprehensively processes the signals from multiple MCUs to give the final control signal which can drive the voice broadcast module to perform relevant voice broadcasts, and prompt the situation outside the vehicle in real time. The built-in camera is mainly responsible for collecting the status information of the driver in the car and sending it to the corresponding MCU for processing to obtain a valid signal. If the driver is fatigued or distracted, the multi-MCU system uses voice broadcasting to remind the driver to pay attention to safe driving[6]. At the same time, the auxiliary MCU is set to monitor the control signal of the main MCU. Once, the main MCU fails, the auxiliary MCU completely replaces the main MCU for related control, thereby ensuring that the voice broadcast module can still work normally. This method can not only meet the timeliness of image information matching and processing, but also significantly reduce the load on the MCU, so that the security performance of the system is more guaranteed.

Fig. 1. Overall block diagram of the multi-MCU Architecture.

3. TECHNICAL ANALYSIS OF IMAGE PROCESSING MCU

The complete image processing[7] work system can automatically acquire pictures or videos information to enhance, distinguish, measure, judge, and output the results[8], which is the core of the smart car's driving information to the driver. The information provided by the smart car must be correct to ensure the safety of the car during driving, otherwise it will cause incalculable consequences. Therefore, the multi-eye visual image acquisition method is used to obtain all-round image information of the car, then quickly process it and prompt the driver in time to ensure the driving safety. However, due to the large amount of image data, tedious and time-consuming processing, and the smart car's walking process requires strict real-time image information[9]. If just one MCU is used to process the image information collected by multiple cameras, not only can it not meet the real-time requirements, but also it may cause obvious delays in the given prompt information or give wrong prompt information, and may even make the MCU work for a long time and be damaged by overload. Adopt a multi-MCU
structure system, so that each camera corresponds to a single MCU. These MCUs simultaneously process image signals collected from different cameras, and then pass the processed signals to the main MCU. After comprehensive processing by the main MCU, the control signal is obtained to drive the voice module to broadcast. This method not only greatly improves the timeliness of image signal acquisition, processing, and transmission, but also significantly reduces the load of the main control MCU. High-speed, high-efficiency serial interface technology is used between MCUs. The hardware is powerful and the structure is simple and easy to use. It is a good choice.

![Interconnected communication connection diagram of each MCU.](image)

**Fig. 2.** Interconnected communication connection diagram of each MCU.

### 4. IMAGE PROCESSING MCU MONITORING RANGE

#### 4.1. Pedestrian and animal monitoring

In addition to vehicles coming and going on the road, there will also be pedestrians, pets, livestock and so on. Pedestrians, pets, and livestock are not only walking at random, but also changing directions easily. Monitoring them is necessary and important. As we all know, under normal circumstances, the temperature of people, pets, and livestock is higher than the surrounding environment, so the hotspot regions in the infrared image can be analyzed to segment the candidate areas of pedestrians, pets, and livestock[10] After the MCU processes the infrared image, it can identify the number and location of these objects, and then drive the voice broadcast module to give the driver voice prompt information to help the driver make better judgments. Not only that, the infrared image also plays a good monitoring role in places with low visibility at night such as insufficient lighting, heavy fog, and dust[11].

#### 4.2. Rear and side vehicle monitoring

Generally, when driving a vehicle, the driver observes the conditions of the side and the rear road through the left and right rear-view mirrors and the interior rear-view mirrors. This requires the driver to pay attention to the situation in the four directions at all times to make a correct judgment during driving, which will lead to the situation of losing sight of each other. And for large trucks, when the driver turns right, the visual field that the driver observes from the right rear-view mirror will also cause blind spots, which will also cause some accidents. In addition, the left and right rear-view mirrors are generally more prominent than the vehicle body. When driving on a narrow road, two cars’ meeting may not be completed because of the distance between the two rear-view mirrors, which brings a lot of inconvenience. Therefore, cameras can be used to replace these rear-view mirrors. On the one hand, the image information collected by these rear-view mirrors can be directly transmitted to the LCD of the car in real time[12], allowing the driver to observe the details of road information in four directions without tilting his head back and forth; on the other hand, the image information collected can be processed by the MCU corresponding to the camera to monitor whether the rear vehicle maintains a safe distance from the vehicle driven by a driver, the speed of the side vehicle and the possibility of overtaking. After processing by multiple MCUs, the signals are transmitted to the main MCU. After the comprehensive processing of the master MCU, the voice broadcast module is driven to give corresponding voice prompt information to assist the driver.
4.3. Ground condition monitoring
When a car enters a country road or a mountain road, the rough road surface will cause great trouble to the driver. Based on his driving experience, the driver can distinguish protrusions, broken stones or depressions that are obviously higher than the chassis of the car on the road, so as to effectively avoid and prevent the chassis of the car from being scratched or important components being damaged. Those protrusions and broken stones that are slightly higher than the chassis of the car will make the driver judge inaccurately and damage the chassis of the car. Based on this, a camera can be installed at the front of the chassis of the car to monitor the road surface in front of the car in real time. The image information of the road surface collected by the camera is transmitted to the corresponding MCU. After it processes, the effective image information is transmitted to the main MCU, the main MCU calculates and compares to predict whether the protrusions, gravels and depressions in front will touch the car chassis. If they can be reached, the main MCU will drive the voice broadcast module to remind the driver of the road information ahead, and pay attention to avoiding.

4.4. Driver condition monitoring
Fatigue driving and driving distraction are the main causes of major traffic accidents. Compared with awake driving, the more heterogeneous indicators of fatigue are: fine adjustment of the steering wheel, forward tilt of the head, blinking of the eyelids and even closure[13]. The built-in camera in the car is mainly responsible for collecting the driver's facial information. After receiving the graphic information, the corresponding MCU judges the driving state of the driver based on the characteristics of fatigue driving and the algorithm of artificial intelligence. If it is detected that the driver is in a state of fatigue driving, the main control MCU drives the voice broadcast module to give relevant prompts.

5. COORDINATION BETWEEN MAIN AND AUXILIARY MCUS
The dual MCU structure framework adopted in reference[14], the design process includes the main MCU and the auxiliary MCU. The task of the main MCU is to accept the image signals processed by multiple MCUs in advance, and synthesize these signals according to the different priorities of these signals to obtain the most urgent control signal, and then transmit this signal to the voice broadcast module. The auxiliary MCU only monitors the main MCU under the normal operation of the main MCU. Once the main control MCU fails, it will give the bus to the auxiliary MCU and light the warning light, so that the auxiliary MCU is completely Replacing the main control MCU to carry out relevant control, to ensure the normal operation of various components in the vehicle, not to be unable to control or difficult to move when the vehicle fails, which greatly improves the safety performance of the car. And the lighted warning lights can clearly inform the driver of the vehicle failure, and remind the driver to send the vehicle for maintenance and repair as soon as possible.
6. CONCLUSION
This article focuses on the use of a multi-MCU structure system to assist the driver. The image information collected by multiple cameras is processed by the corresponding MCU to obtain valid information according to different focuses. These MCUs transmit the valid information to the main MCU. After receiving the information, it will obtain an effective control signal after comparison calculation and comprehensive processing, and drive the voice broadcast module to give relevant voice prompts. The multi-MCU system separates complex image processing and analysis calculations, and is completed by different MCUs. Compared with only one MCU, the multi-MCU structure system effectively reduces the MCU's load and greatly accelerates the real-time processing of image information. Furthermore, the additional auxiliary MCU is equivalent to a backup, which significantly improves the system's fault tolerance rate and reduces the risk. The multi-MCU structure system enhances the system's real-time performance, security, processing efficiency, and fault tolerance rate, and significantly improves the overall performance of the system.

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