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Gesture Recognition Using a Touchless Sensor to Reduce Driver Distraction

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Abstract - *Touchless sensors are the next development in Human Machine Interface (HMI) technology, which is the descendant of touch screen technology. Touchless or Infrared (IR) proximity sensors are poised to usher in the next user interface innovations centered on touchless gesturing. Touchless sensors are yet to make a footprint in the mobile phone, medical, aero, automotive, industries, robotics, etc. Touchless gesture recognition in a vehicle improves driving safety. The driver spends less time navigating through menus, the maximum time that can be spent focusing on the road. Driver distractions are a leading cause of an amazing number of serious car accidents. Some of the main actions that cause distracted driving are varying the radio station, adjusting CD or Mp3 player settings by reaching to the infotainment system, etc. This paper will discuss on the touchless sensor based gesture recognition solution for vehicle infotainment systems.*

Key Words: Proximity Sensor, HMI-Human Machine Interface, ECU-Electronic Control Unit, Touch Screen.

Introduction:

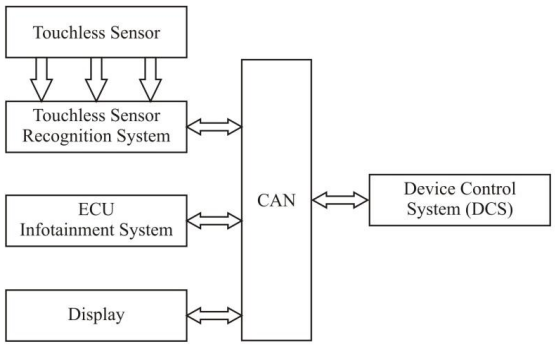
Human hand gestures provide the significant and effective resources of non-verbal communication with the human and computer. Hand gestures are meaningful expressive body motions that are actions of fingers and hands. Hand gestures ranges from simple identical or static gestures that are used to point to the objects around, with the more complex gestures or dynamic gestures that express person's thoughts and allows to communicate with others.

By using image processing methods a vision based interaction can be established. Gesture recognition and processing is the best example of vision based interaction [1]. Gesture recognition is a field which interprets the gestures of human body parts like hands and fingers. Gesture recognition interfaces which are used as way of natural communication between man and machine give rise to a variety of applications such as equipment free remote control systems. Sign language interpretation and many more [2].

Several Hand gesture recognition techniques have already exited and most of them are based on Hidden Markov Models [7], Fuzzy Logic, Neural networks, etc. [3, 4, 5, 6]. These methods provide exact recognition of hand gestures, but the computational cost required to achieve this is very high. Therefore, those methods are not robust enough for real-time execution. To overcome this, we have developed a robust method for recognizing simple hand gestures which depend purely on the easy segmentation and techniques.

Hand Gesture Recognition Techniques:

Consider a system navigation problem, in which a system responds to the hand pose signs given by a human, visually observed by the system through a sensor. We are interested in an algorithm that enables the system to identify a hand pose sign in the input image, as one of five possible instructions (or counts). The identified command will then be used as a control input for the system to perform a certain action or execute a certain task.



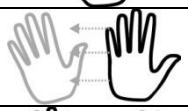
Block diagram of touchless gesture recognition system

The above block diagram shows the basic building blocks for a touchless gesture recognition system for the vehicle infotainment system. The IR touchless sensors send the signal to the sensor recognition system which is connected with CAN, depending upon the driver's hand movements. When the hand is waved over the sensors, the transmitted IR signal is reflected by the hand back to the IR receiver at the same time the movement of hand position display in the infotainment system. Depending upon which IR receiver received the signal first and last, the algorithm that resides in the sensor recognition system understands the hand movement and sends the control signal for the infotainment display through the infotainment system Electronic Control Unit (ECU). In-Vehicle Infotainment (IVI) is an auto industry term that refers to vehicle systems that combine entertainment and information delivery to drivers and passengers. IVI systems use audio/video (A/V)

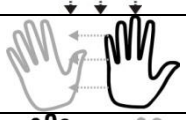
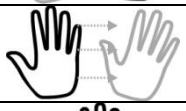
interfaces, touch screens, keypads and other types of devices to provide these types of services [18].

Application Examples:

The applications that can be developed for the infotainment system access using hand gestures are listed in Table 1.

Sl. No.	Hand Gesture Input	Hand Position	Application Output
1	Hand over		the sensor Select
2	Right to Left		Slide Screen Left/Select Next Play
3	Left to Right		Slide Screen Right/Select Previous Play Station or Song
4	Bottom to Top		Scroll Up
5	Top to Bottom		Scroll Down

In addition to the infotainment applications depicted in Table 1, the same hand gesture input can be used for automatic door/rare view mirror, bonnet (hood) and dicky (trunk) opening, as well as automatic lighting systems, which are listed in Table 2.

Sl. No.	Hand Gesture	Hand Position	Input Application Output
1	Bottom to Top		Bonnet/Dicky Open
2	Top to Bottom		Bonnet/Dicky Close
3	Right to Left		Door/ Rare view mirror Open
4	Left to Right		Door/Rare view mirror Close
5	Hand over		On / Off

Disadvantages of the Current System:

The current vision-based gesture recognition system which has many disadvantages, including:

1) Costly solution
2) Need high resolution cameras (HD)
3) Needs very high speed image processing (S/W, H/W)
4) Highly sensitive to noise in image processing (lens aberrations)

Advantages of Touchless Gesture Recognition:

The disadvantages of the vision-based recognition system have been overcome in the touchless based gesture recognition system.

The advantages of the touchless sensing system are:

1) Cheaper solution
2) Touchless
3) Easy to develop
4) Easy to maintain
5) Easy to replace
6) Easy to access

Best Practices

Touchless sensors are the newest advancement in the real time human machine interface [17], which is slowly being incorporated into mobile phones, tablets, PDAs and other computer-related products. It is yet to be available in the automotive industry for infotainment access.

The existing technology for automotive infotainment access is a touch screen. The main disadvantage of this technology is that the driver has to take his/her eyes off the road to access the infotainment. This is not in the case with a touchless sensing system. Another way to reduce driver distraction is by blocking access to the infotainment system while driving, which means the driver either has to preset the play list or navigation system, or has to stop the car to access the infotainment system.

Common Issues

Some of the common challenges in solution development are recognizing the hardware, stack development, and algorithm development. The greatest challenge in the touchless gesture recognition system is in the resolution of accessing the navigation application, for example minimizing and maximizing the map. The issues in text typing applications like typing an email, entering a phone number, etc., can be resolved by technology fusion, i.e. by merging speech-to-text with this solution.

Challenges

There are many challenges associated with, the accuracy and usefulness of gesture recognition software. For image-based gesture recognition there are limitations on the equipment used and image noise. Images or video may not be under consistent lighting, or in the same location. Items in the background or distinct features of the users may make recognition more difficult.

The variety of implementations for image-based gesture recognition may also cause issues for the viability of the technology to general usage. For example, an

algorithm calibrated for one camera may not work for a different camera. The amount of background noise also causes tracking and recognition difficulties, especially when occlusions (partial and full) occur. Furthermore, the distance from the camera, and the camera's resolution and quality, also cause variations in recognition accuracy.

In order to capture human gestures by visual sensors, robust computer vision methods are also required, for example for hand tracking and hand posture recognition [8 - 16] or for capturing movements of the head, facial expressions or gaze direction.

Conclusion

According to this proposed touchless sensor method gesture recognition system that allows users to make use of gesture input without touching holding or wearing any device. It is very low power consuming method because of no need for an external sensing unit like a camera. The fault identification level also very low, compact to exciting vision based method.

The growth for touchless and gesture recognition is going to be huge, so the implementation to play very high in this technology. Using this technology, we can develop a cheaper safety solution for vehicle infotainment system access.

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