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NIGHT VISION SYSTEM IN CAR

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ABSTRACT

Night vision signifies the ability to see in dark (night). This capability is normally possessed by owls and cats, but with the development of science and technology devices has been develop which enables human being to see in dark as well an in adverse atmospheric conditions such as fog, rain, dust etc. The muscles in the human eye have the ability to stretch or contract automatically, depending upon the intensity of light falling on the eye. When we go out in bright sunlight, the pupil gets contracted. Alternatively, when we enter a shaded or dark room at that time the muscles of eye relax and make the aperture of the eye lens big enough to allow sufficient amount of light to pass through, therefore the objects in the room appear blurred. Because of this human eye have limitations. The muscles of eye cannot increase the aperture indefinitely. Therefore, in poor light we are unable to see the objects because the image cannot be formed on the retina clearly. The capability to detect and identify targets at night and under poor visibility conditions has been an essential military requirement. The modern army's need to operate at night and under conditions of extremely poor visibility , Since the soldiers have to often fight in the dark at night, they have to face a severe stress as far as the location of target is concerned. Also various wild life observer have to face problems of low light because many wild animals are more active during night time than day, therefore to observe there lifestyle and study it night vision is important. Therefore to make human being unable to see in dark by technological means, night vision technology has been developed. This paper describes various techniques and different devices developed to enable viewing in dark.

1.1WHAT IS NIGHT VISION SYSTEM?

The Car night vision system provides the driver with the black and white image of the driving environment ahead of the vehicle in the central information display (CID).Car night vision is 100% passive system without active infrared illumination. Objects situated ahead of the vehicle are shown in varying degrees of the brightness depending upon the temp of these objects. This enables the driver to detect in good time heat emitting objects such as peoples. Animals and the other vehicles.

1.2 USE OF THE NIGHT VISION SYSTEM IN CARS

This thermal image is recorded with a far Infrared camera (FIR) via a special imaging sensor which detects the infrared radiations in a specific wavelength range. The Car system is distinguished from infrared system with active illumination by its long range, and its clearly structured image. Infrared energy coming from an object is focused by the optics onto an infrared detector. A thermal imaging camera can produce a comprehensive image on which the smallest of the temperature difference can be seen. Contrary to other technologies, such as e.g. light amplification, that need at least small amount of light to generate an image, thermal imaging needs no light at all. Improve vision in twilight and darkness and the display does not dazzle by the head lights of the oncoming vehicles. Pronounced highlighting of process, animals and warm objects as well greater overview of driving situation due to display of course of road beyond that illuminated by headlights. It gives magnified image of the distant objects when driving fast through zoom function improved reorganisation of objects on bends in the road through horizontally adjustable image section. It enhances personal safety of dark ways and garage entrance through display of living creature.

2. SYSTEM OVERVIEW

Figure 1 shows the system. It illustrates the interactions between the hardware and software modules. To provide a convenient, fast and simple input interface, a touch screen is used to get the driver's input and display the processed videos. The driver can also use virtual keyboard on the touch screen for data input. Unlike normal cameras, the infrared cameras are sensitive to infrared and, therefore, it captures objects that reflect infrared.

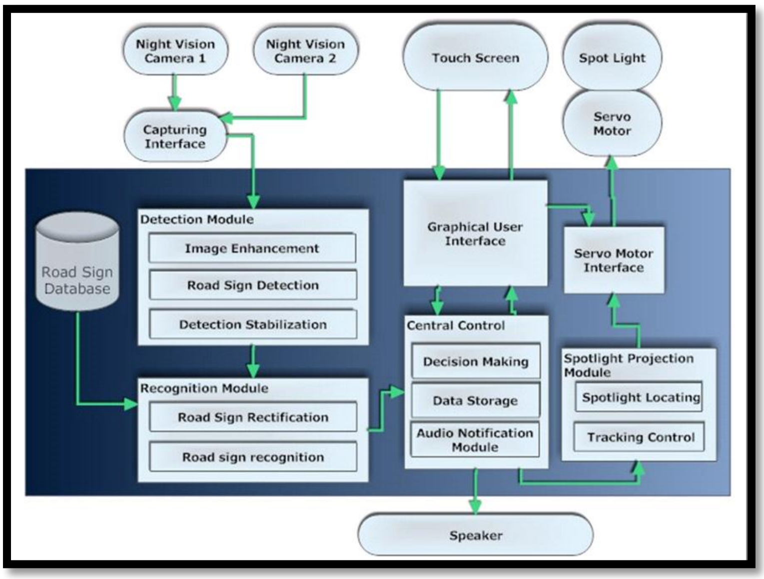

Figure no. 1: System Overview

3. SYSTEM COMPONENTS AND DESCRIPTION:

The Car Night Vision system consists of the following components:

- Night Vision camera with camera bracket and camera washer jet
- Night Vision control unit
- Button in light switch centre
- Sensor system

These main components of the night vision system are explained one by one below

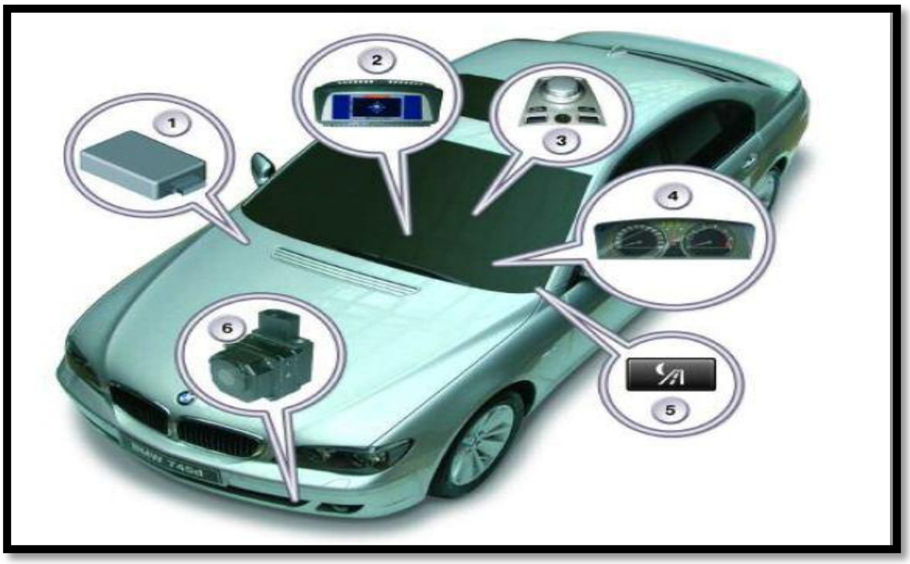

Figure.no. 2: Component of night vision system.

No.	Explanation
1	Night vision control unit
2	controller display
3	controller
4	Instrument Cluster
5	Button in light switch centre
6	Night vision camera

3.1 NIGHT VISION CAMERA

Fig. no.3: Component of night vision system.

The thermal imaging camera consists of a heated optical element and a thermal imaging sensor. The thermal imaging sensor is made up of a multitude of sensor elements. Each display pixel is assigned one such sensor element. The sensor elements generate an electrical signal as a function of the impinging intensity of heat radiation. The higher the temperature, the brighter the corresponding pixel will be displayed. The heat radiation is converted into electrical signals on the basis of the principle of a change in resistance. The image can be replaced up to 60 times per second. In order to ensure an image of consistent quality, it is necessary for the camera to be calibrated roughly every 120 seconds. This calibration can take up to approx. 0.5 seconds. For this reason, the image may be seen to freeze in the display. The Night Vision camera is mounted with a bracket directly behind the left ventilation grille on the bumper mounting bracket. The camera is equipped with a sensor which detects heat-emitting objects in the Far Infrared range (wavelengths from 8 µm to 15 µm). The camera resolution is 320 x 240 pixels. The maximum angle of view is 36°. The calculations forte "Bend/curve mode" functions are made in the camera. The camera operates in an ambient-temperature range of - 104°F to 185°F (40°C to +85°C). The camera and imaging sensor are thermally insulated to provide protection against heat influences from the camera surroundings. The washer jet is screwed to the camera bracket and is situated directly above the camera's front lens. It is directly connected to the headlight washer system and therefore operates in conjunction with the latter. A heater element incorporated on the inside of the camera-housing cover to prevent the optical element from misting over or freezing up.

3.2 NIGHT VISION CONTROL UNIT

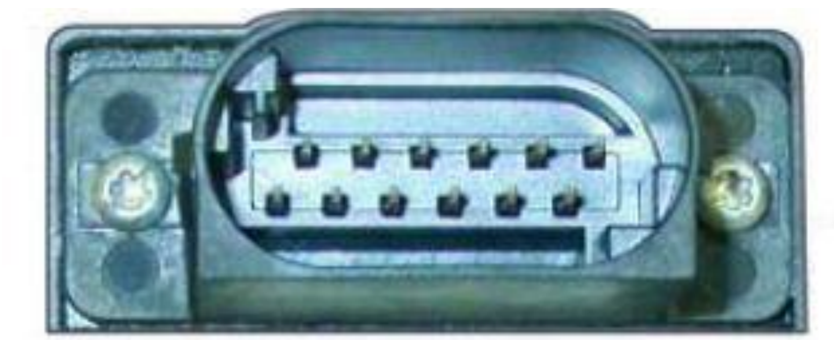

Fig. no.4: Night vision control unit.

The control unit is accommodated in the front Device holder behind the glove box. The control unit increases the image data from the camera from 320 x 240 pixels to640 x 480 pixels. Only one detail is shown in the control display. 640 x 240 pixels are displayed when the "Full screen" function is activated while 400 x 240 pixels are displayed for the split screen function. The diagnosis, programming and coding data are transmitted to the camera via the control unit. The camera and the front-lens heater are powered via the control unit. In addition, the control unit converts the symmetrical image data from the camera into a CVBS signal and, depending on the equipment specification, makes this signal available to either the Navigation system or the video module. The Night Vision control unit is accommodated in the front device holder behind the glove box. The camera-housing cover features a 12-pin plug connection.

3.3 BUTTON IN LIGHT SWITCH CENTRE

Fig. no.5: Switch button

The button for switching Car Night Vision on and off is integrated in the light switch centre. The following condition can exists: The rain/light sensor detects sufficient ambient light and driving lights are switched off; Car night vision is ready for operation approx. 2 seconds after the button in the light switch centre is pressed. The rain/light sensor detects insufficient ambient light and driving lights are switched on; Car night vision is ready for operation immediately after the button is pressed. In conditions of darkness (underground car park), the driving lights are switched off and the driving speed is less than 5km/h; Car night vision is ready for operation immediately after the button is pressed. Car night vision cannot be activated when:

- The driving lights are switched off,
- The sensor detects insufficient ambient light, and
- The driving speed is greater than 5km/h.

Once the night vision is activated, a message appears in the control display to the effect that the system cannot be used at night without driving lights

4 .PRINCIPLE OF OPERATION

The Car Night Vision camera is a thermal imaging camera, which converts thermal radiation into electronic signals and then into images visible to the human eye. The thermal image is converted first by the sensor into electrical signals and then with the aid of image-processing software into a visible image in the control display. The sensor elements alter the resistance in proportion to the temperature. The higher the temperature, the higher the electrical signal and the whiter the pixel will be shown. The sensor can generate a new image up to 60 times per second. This results in a softer and clearer image. Heat radiation is absorbed and dissipated by virtually every solid or liquid body. Heat radiation, however, is not visible to the human eye because it belongs in the long-wave infrared range. From a physical standpoint, this represents electromagnetic waves with a wavelength of 8 µm to 15 µm. This long-wave infrared radiation is known as Far Infrared (FIR). The advantage of utilizing radiation in the Far Infrared range is the greater range compared with Near Infrared systems with a wavelength of 0.7 µm to 1.4 µm. These systems require illumination with just this wavelength. Essentially, FIR systems consist of an optical element, a thermal imaging camera, a control unit and a display.

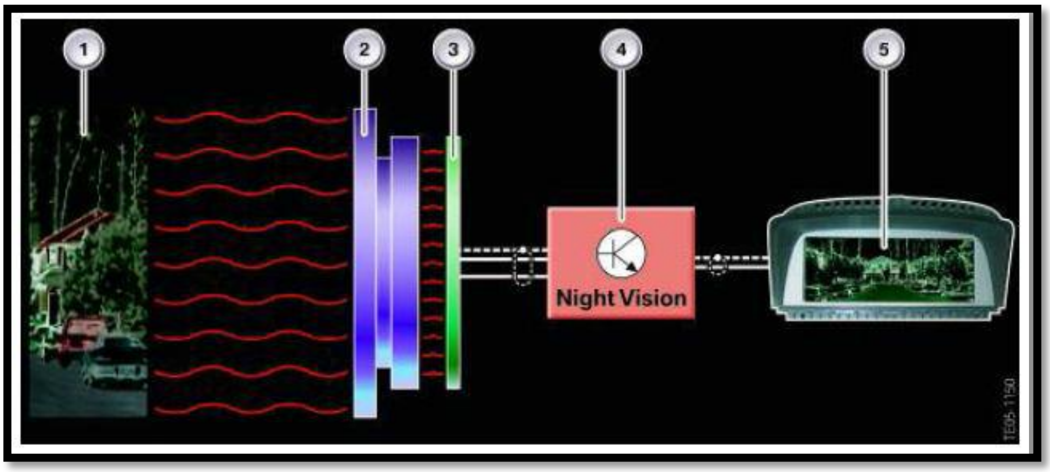

Fig. no. 6: Principle of Operation

Night vision technologies can be broadly divided into three main categories:
1: Image intensification
2: Active illumination
3: Thermal imaging

4.1. IMAGE INTENSIFICATION SYSTEM

Image intensification systems support direct observations by amplifying low levels of available light. They do not 'turn night into day' Nor do they overcomes the problems that affect vision in low light environments. The image intensifier is a vacuum-tube based device that converts invisible light from an image to visible light so that an object in the dark can be viewed by a camera or the naked eye.

4.2. ACTIVE ILLUMINATION

Active illumination technologies work on the principle of coupling imaging intensification with an active source of illumination in the near infrared (NIR) band. Infrared is used in night vision technology when there is insufficient visible light to see, active illumination involves conversion of ambient light photons into electrons which are then amplified by a chemical and electrical process and then converted back into visible light. Active infrared night vision combines infrared illumination in spectral range 0.7–1 μm. Due to which the scene, which appears dark to a human observer now appears as a monochrome image on a normal display device. Since active infrared night vision systems can incorporate illuminators that produce high levels of infrared light, the resulting images are typically higher resolution than other night vision technologies. The use of infrared light and night vision devices should not be confused with thermal imaging which creates images based on differences in surface temperature by detecting infrared radiation (heat) that emanates from objects and their surrounding environment

4.3. THERMAL IMAGING

In order to understand thermal imaging, it is important to understand something about light. The amount of energy in a light wave is related to its wavelength: Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the infrared spectrum.
Infrared light can be split into three categories:

1.Near-infrared (near-IR) - Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3microns, or 700 billionths to 1,300 billionths of a meter.
2. Mid-infrared (mid-IR) - Mid-IR has wavelengths ranging from 1.3 to 3 microns.
3.Thermal-infrared (thermal-IR) - Occupying the largest part of the infrared spectrum, thermal-IR has wavelength ranging from 3 microns to over 30 microns.

4.4. WORKING OF THERMAL IMAGING

A special lens focuses the infrared light emitted by all of the objects in view. The focused light is scanned by a phased array of infrared-detector elements. The detector elements create a very detailed temperature pattern called a thermo gram. It only takes about one-thirtieth of a second for the detector array to obtain the temperature information to make the thermo gram. This information is obtained from several thousand points in the field of view of the detector array. The thermo gram created by the detector elements are translated into electric impulses. The impulses are sent to a signal-processing unit, a circuit board with a dedicated chip that translates the information from the elements into data for the display. The signal-processing unit sends the information to the display, where it appears as various colour depending on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image.

5. WORKING OF AUTOMOTIVE NIGHT VISION SYSTEM

In car night vision system, during low light, the infrared projectors project the IR rays on the field of driving. The infrared LEDs emits photons towards the field, these rays are reflected by the surrounding. These reflected rays are captured by the night vision camera in the car and is detected by IR sensors. The signal is then converted to image signals and which is displayed through the display unit.

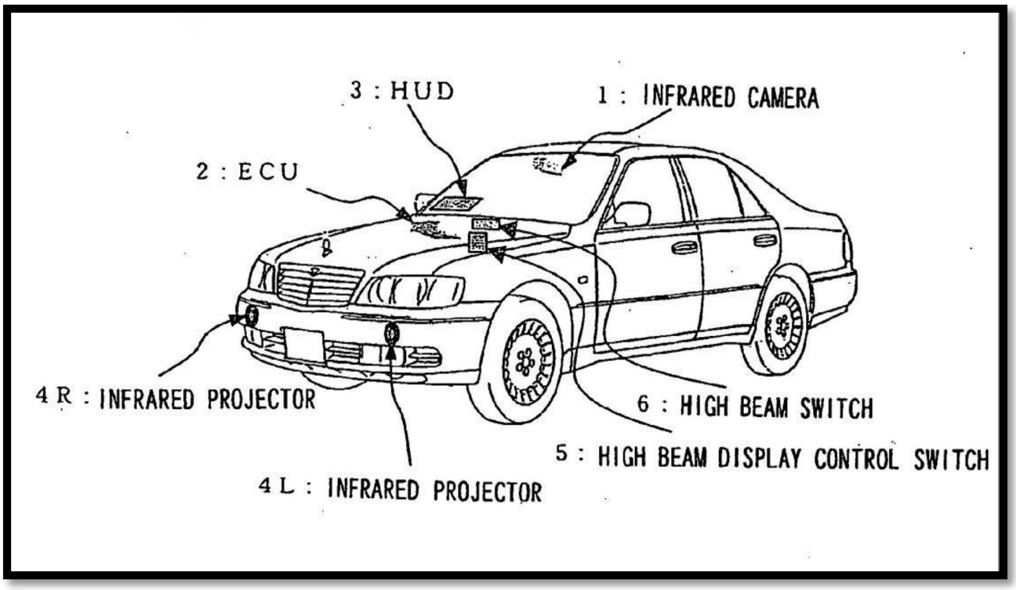

Fig.no.7:Night vision system in a car.

Systems use an LCD that's mounted on the dash, in the instrument cluster, or integrated into the head unit. The front thermo graphic sensors detects the heat and processes the thermo grams to display images on LCD.The IR sensor attached in vehicle's grille illuminates very high beam.

6. ZOOM ANGLE VIEW OF CAMERA

When the "Zoom" function is activated, BMW Night Vision automatically switches to a 1.5 times enlargement of the display at speeds in excess of 44 mph (70 km/h). The cameras angle of view is reduced to 24° here. Zoom is activated automatically again when the speed drops below 37 mph (60 km/h). The camera's angle of view reverts to 36°. Zoom is calculated by the camera.

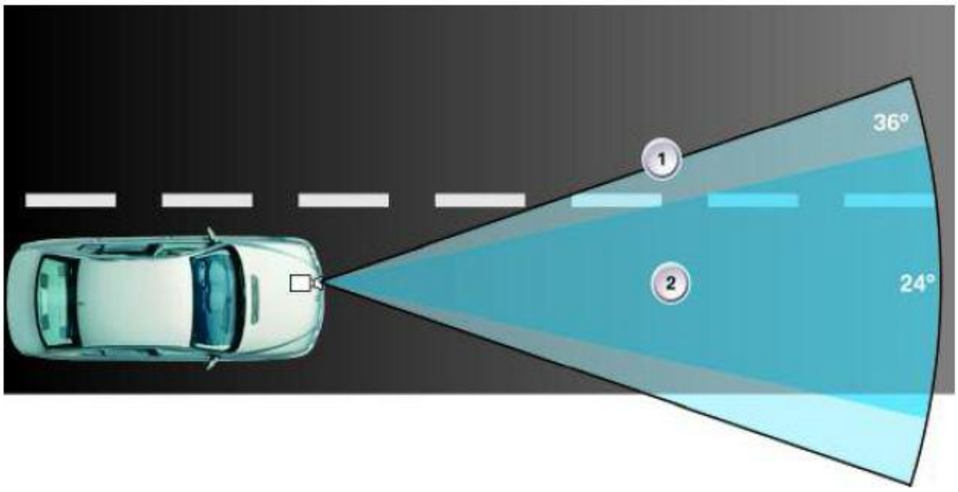

Fig.no.8:Zoom angle view

No.	Explanation
1	Angle of view of 36° of zoom
2	Angle of view of 24° of zoom

7. VISIBILITY

Normal driving-light illumination is approximately 328 ft (150 m). The use of Car Night Vision enables heat emitting objects to be detected up to a distance of approx. 984 ft (300 m). This specified distance is dependent on weather factors. For example,heavy fog or rain reduces visibility.

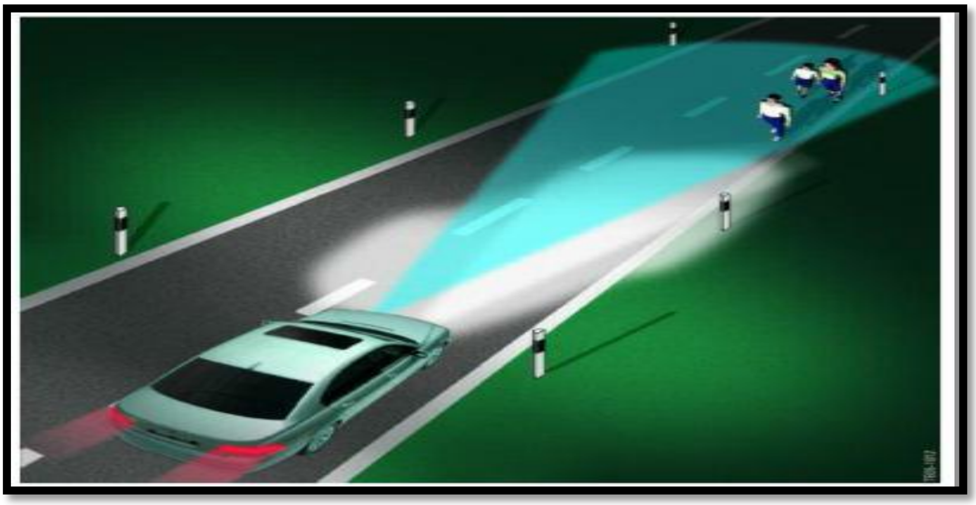

Fig.no.9: Comparison of Car night vision visibility with different vehicle head light

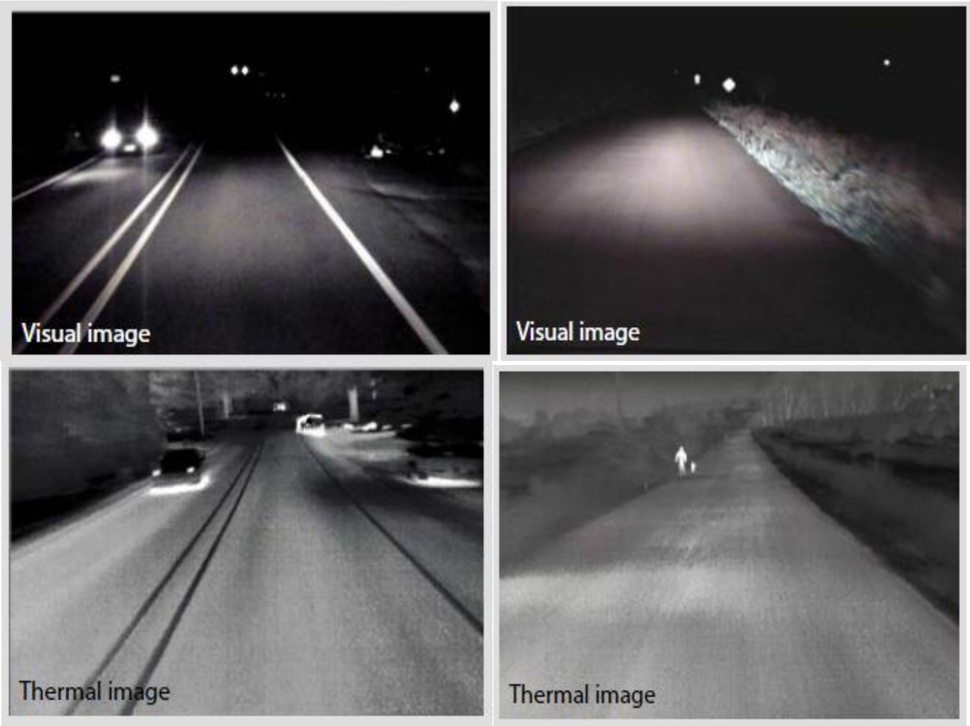

Fig. no.10: The visual and actual Images

8. APPLICATION

Common application for night vision includes:

- Hunting Military
- Wildlife observation
- Security
- Navigation
- Hidden-object detection
- Entertainment

9. ADVANTAGES AND DISADVANTAGES

9.1 ADVANTAGES

1. Improved vision conditions of dusk and darkness.
2. No dazzling by head lights of the oncoming vehicles.
3. Highlighting of illuminated, heat-emitting objects as pedestrian, cyclists, deer, etc
4. Better overview of the driving situations.
5. The zoom functions of the object in the far distance at high speeds.
6. Illumination of the bends/curves (pivoting of image details)
7. Illumination of dark courtyard and garage entrances.
8. Superior image quality.
9. Uninterrupted image.
10. Immune to dynamic thermal environment

9.2 DISADVANTAGES

1. It is difficult to distinguish between objects in the foreground and the background of the image the entire image is continuously changing and because pedestrians vary in scale based on their distance to the viewer.

2. The probability of true warnings (i.e. when the driver is about to hit the pedestrian) is low, as it often is in reality, then the odds of the true alarm, can be quite low even for very sensitive warning systems with very high hit rates and low false alarm rates

10. CONCLUSIONS

With the night vision function, drivers achieve a better driving experience at night. The real time road sign detection and headlight tracking features can provide more information of the road to the user. With the aid of this system, the chance of missing the information of a road sign can be reduced and, therefore, driving in dark can be safer than before. The extra functions such as road sign recognition and rear camera can ease the driving task. The detailed design and implementation of IVAN are also presented. An overview of the hardware configuration and software architecture of the system are shown. We also discuss the implementation procedures and algorithms involved in our system. The experimental results have demonstrated the feasibility of the proposed system. The road sign recognition rate is around 67% and the average false alarm per minute is 0.4. The system can be further improved in two aspects: hardware an software. For example, fish eye view cameras can be used to provider wider field of view and cameras with optical zoom capability can help to increase the resolution of the road sign so that higher recognition rate can be achieved. In the software part, applying optical flow algorithm into the road sign tracking process may improve the reliability of the road sign detection. We believed that driving can be an enjoyable task. With the advance of technology, automobiles equipped with embedded system are expected to be a trend in future. IVAN can be regarded as a pioneer prototype to improve driving experience and enhance driving safety in the dark.

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