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Night Vision System in BMW

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Abstract

A night vision system must increase visibility in situations where only low beam head lights used today. As pedestrians and animals have highest risk increase in night time traffic due to darkness, the ability of detecting those objects should be the main performance criteria, and the system must remain effective facing the headlights of the oncoming vehicle. Thus BMW has applied the Night vision system in its vehicles to avoid accidents which can cause the deaths.

In the paper, the performance of night vision camera (NVC) is evaluated. The night vision camera is produced by Autoliv for BMW. The paper results not only depended knowledge on performing NVC, but also the understanding the complex product that involves knowledge about engineering involved in it.

An Automotive night vision system is system to increase the vehicle driver's perception and seeing distance in darkness or poor weather beyond the reach of vehicles head light. They are currently offered as optional equipment on certain premium vehicles the camera is connected to the front grill of automotive. It senses the images in the form of electronic signal and then sends it via cable to the LCD screen which helps the driver for his convenience.

The next generation of automotive night vision system will likely to continue to display to the driver enhanced images of forward driving scenes.

In some display there may also be highlighting of pedestrians and animals, which has been argued to be the primary safety goal of night vision system.

Keywords: NVC, autoliv, LCD.

1. Introduction

In fall 200, BMW introduced Night Vision on series – 7.This system processes far infrared radiation, which minimizes non-essential information placing a greater emphasis on pedestrian and animal, allows for a range of 300 meters or nearly 1,000 feet, and avoids "dazzle" from headlights, road lights and similar intense light sources. In fall of 2008, on the redesigned 7-series, BMW added a pedestrian detection system which flashes a caution symbol on navigation / information screen and head up display when it detects a pedestrian. The objective of the pedestrian warning algorithms is to accurately detect pedestrian and provide the driver with informative warning. In eyes of the driver, the end product of the good system provides the timely warning and possibly, additional information such as the position of the pedestrian or an overlaid on the night vision display. There are two different technologies in the market for night vision system. Far infrared (FIR) also called passive infrared And Near infrared (NIR) also called active infrared.

- **What is Night Vision System?**

The Bmw 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).BMW 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.

- **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 BMW system is distinguish 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 recognisation 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.

A far infrared camera in the grill, just over an inch in diameter, senses the temperature of everything in front of the vehicles. A computer then converts the data into an image that appears on the navigation display unit into the dashboard. Warmer objects (a pedestrians, an animal) appears white; cooler objects (parked cars, detritus) appears black. When the car exceeds 25 mph, the system scans specifically for pedestrians by scanning the road up to 100 yards ahead of the vehicle. A pedestrian appears with the yellow tint.

Fig. 1: Image obtained on screen.

2. Literature Survey

Pre 1940's flares and spot lights were used for operations at night. Due to the nature of this early night vision device (NVD), they gave away tactical positions. Military scientists began to think of improve night vision to gain a strategic advantage. The first night vision device (NVD) was created during the world war- 2.Functioned by placing an infrared filter over a search light. Fighters would use special binoculars to see using the light from this night vision method. Infrared light is used to visualize the things in the dark.

Accident scientists show that the driving at the night represents a significant potential danger. In Germany, some 50 percent of the fatal car accidents happen at night, although an average of the 75 percent of all driving is during a day. A similar situation is found in a US. With a 28 percent share of all driving, 55 percent of all fatal accidents occur at night. Accidental statistics throughout Europe as a whole also justify intensive consideration of the issue of nocturnal driving. According to estimates, approx. 560,000 people injured in the dark and 23,000 are killed. Over 25,000 accidents per year involving pedestrians and cyclists occur during the night in the Germany. The reason are obvious; poor or significantly limited sight conditions on highways and country roads, obstacles or narrow bends which are recognised too late with low beam, inappropriate judgement of the speed or distance due to lack of the orientation for the eye, driving into the "black hole" of the head lights of oncoming traffic, possibly exacerbated by wet, reflecting road surface. Our eyes are the first line of the defence against the hazards So, the recent innovation to help driver see better at night and in most diverse weather conditions, is the “Night Vision System” The core of this system is FLIR system thermal imaging camera.BMW is the first European premium car manufacturer that started to implement the technology in the cars.

Night vision camera is assembled in the United States, installed in BMW in Germany and then distributed worldwide. After its utilization, it goes to waste (End of life) and then mostly recycled. Manufacturing of raw materials takes place all over world and transported to Autoliv.

3. System Componants and Description

The BMW 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.

Fig. 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. 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 for the "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 is incorporated on the inside of the camera-housing cover to prevent the optical element from misting over or freezing up. The heater is activated when the Rain/light sensor detects precipitation or at temperatures below 32°F (0°C). A night vision device (NVD) is a device comprising an image intensifier tube In rigid casing, commonly used as military forces. Lately, night vision technology has become widely available for civilian use. For example, Enhanced Vision System (EVS) have become available for aircraft to help pilots with situational awareness and avoid accidents. These systems are included in the latest avionics packages from manufacturers such as Cirrus and Cessna.

3.2 Night Vision Control Unit

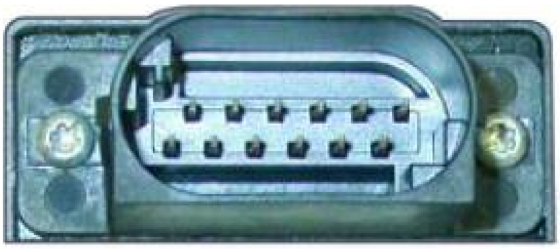

Fig. 4: Night vision control unit.

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 to 640 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.

The night vision electronics doubles the image created by the night vision camera from 320 x 240 pixels to 640 x 480 pixels. Only section is shown on the display. When “Full screen” is selected, 640 x 240 pixels are displayed. The split screen display uses 400 x 240 pixels. The night-vision camera is actuated via the LIN bus, e.g. for diagnosis. The night-vision electronics convert the symmetrical video signals from the night-vision camera into FBAS signal.

3.3 Button in Light Switch Center

Fig. 5: Switch button.

The button for switching BMW Night Vision on and off is integrated in the light switch center. The following condition can exists: The rain/light sensor detects sufficient ambient light and driving lights are switched off; BMW 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; BMW 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; BMW night vision is ready for operation immediately after the button is pressed. BMW 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.

3.4 Principle of Operation

The BMW 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.

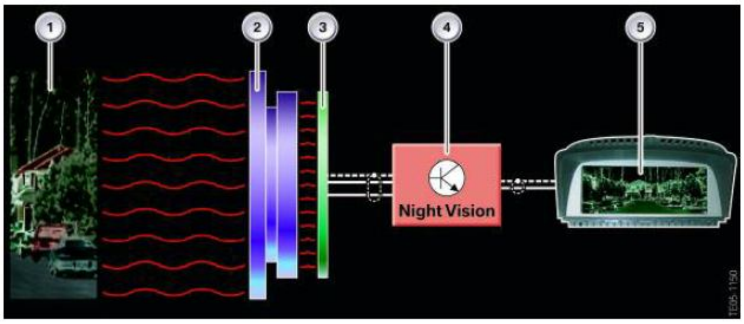

Fig. 6: Principle of Operation.

No	Explanation
1	Environment ahead of vehicle
2	Optical element
3	Thermal imaging sensor
4	BMW night vision control unit
5	Central information display

3.5 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.

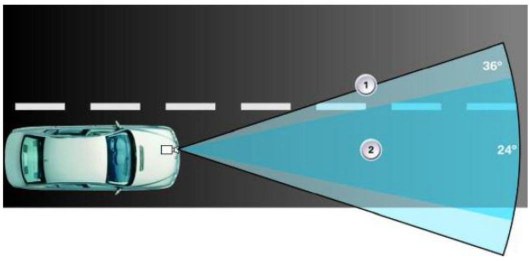

Fig. 7: Zoom angle view.

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

4. Visibility

Normal driving-light illumination is approximately 328 ft (150 m). The use of BMW 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.

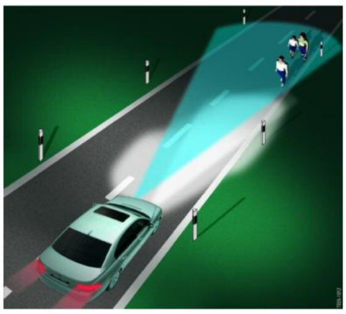

Fig. 8: Comparison of BMW night vision visibility with different vehicle head lights.

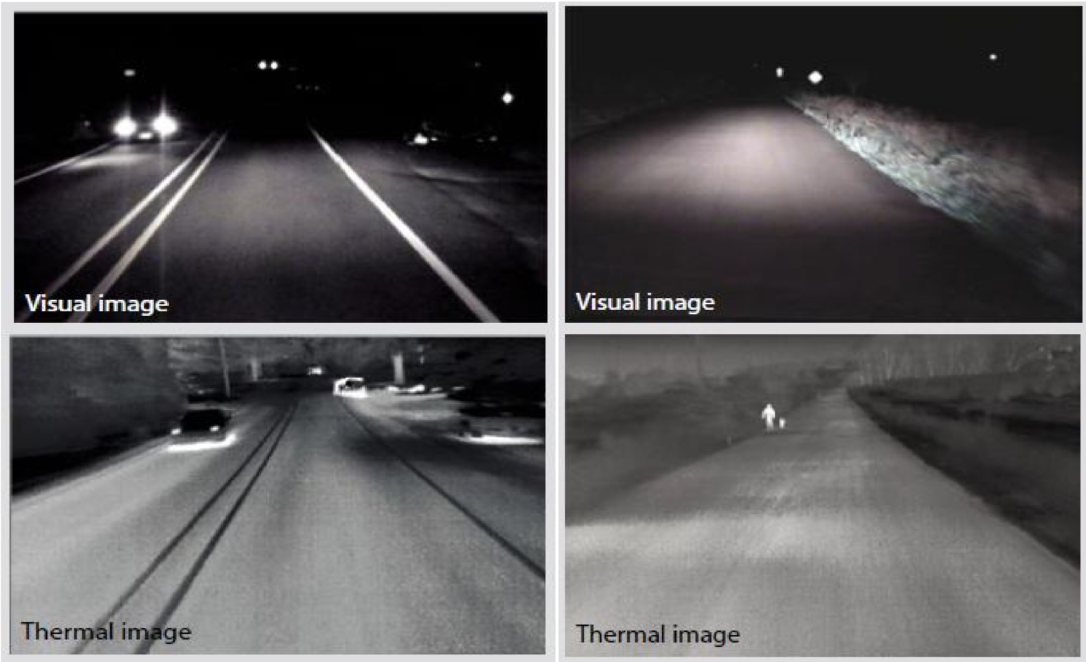

Fig. 9: The visual and actual Images.

5. Advantages and Disadvantages

5.1 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

5.2 Disadvantages

1. The objective of the pedestrian warning algorithm is to accurately detect pedestrians and provide the driver with informative warnings. In the eyes of the driver, the end product of the good system provides a timely warning and possibly, additional information such as position of the pedestrians or an overlaid icon on night vision display.
2. Although generic image processing algorithms have been addressing similar goals for many years, there are several problems that are unique to image

processing in automotive application. For example, 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.

3. 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.

6. Conclusion

In the paper we studied and learnt about the NIGHT VISION SYSTEM OF THE BMW which gave us the knowledge about the whole system. By the study of the paper we got familiarize with the technology used in BMW NIGHT VISION SYSTEM. Also understood that how to utilize the BMW NIGHT VISION feature. Finally, we came to know the benefits to having this technology in the vehicle which can be used to avoid the accidents. On the basis of that we conclude that automatic pedestrian warning, in the form of highlighting the pedestrians on the night vision display, is generally helpful in increasing detection distance and accuracy.

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