DOI 10.5162/SMSI2025/D7.1

Recognising Wild Animals on Roads: Radar-based Sensor Systems for Accident Avoidance

Michael Schneider[1], Hubert Mantz[1], Thomas Walter[1],
Mike Montoya-Capote[2], Jonas Berger[2], Andreas Reichel[2], Nils Hollmach[2]
[1] Ulm University of Applied Sciences, 89081 Ulm Germany,
[2] tecVenture, 04177 Leipzig Germany
michael.schneider@thu.de

Summary:

The objective of this study is to evaluate the potential of a 60 GHz radar system as a roadside wildlife detection system. The system can be integrated into a delineator, allowing roadside monitoring and the possibility of warning against wildlife accidents. This system is compared to a low-cost image-resolving thermal array sensing system. IR array sensors have limited range and are highly dependent on the environment, with a maximum distance of 18 m in cold environment.

Keywords: wildlife accident, radar system, IR-array sensor, range-doppler evaluation, sensor fusion, moving target indicator, wildlife protection, driver assistance

Introduction and Motivation

The increase in traffic on Germany's roads is contributing to a rise in the number of accidents involving wild animals. In order to assist drivers in avoiding accidents, car developers are turning to driver assistance systems [1]. Several pilot projects demonstrate how drivers can be actively warned. An electronic wildlife warning system has been tested and developed by the Forestry Testing and Research Institute in Baden-Württemberg, Germany, since 2007. This system involves the installation of a fence alongside the road to guide wild animals (e.g. deer) to a crossing area. At this point, infrared sensors detect the presence of an animal, and a sign then warns the driver [2]. The defining characteristic of existing sensor systems is that they monitor only short segments of road, typically between 5 and 7 m, with the remainder of the road secured by a fence. The system presented in this study employs the use of radar sensors to monitor the entire space between delineators. The range of a sensor mounted on a delineator covers an area within a maximum distance of 30 m as illustrated in Figure 1. They are capable of detecting wild animals as they approach the road. This sensor system monitors the entire area adjacent to the road, obviating the necessity for an additional barrier such as a fence.

Sensor Systems

The sensor system has been subjected to rigorous testing and validation in a portable measurement box.

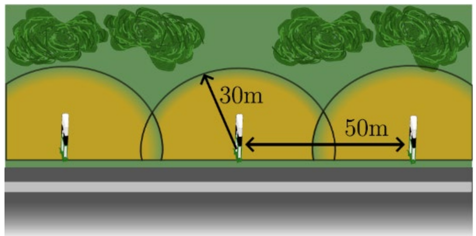

Fig. 1. The provided schematic depicts a road with integrated sensors within the delineator. The distance between the delineators is 50 m, and the sensing radius of the sensors forms a 30 m half circle radius around a delineator.

This box contains both the radar sensors developed in-house by TecVenture and a set of reference sensors. The radar sensors operate at frequencies of 60 GHz and 24 GHz, respectively. These comprise a 60 GHz radar sensor from RFbeam Microwave, referenced in [3], in addition to infrared measuring technology. This sensor type is based on the Infineon BGT60UTR11AIP. A custom-designed lens was constructed with the objective of limiting the field of view to a maximum of 60°. Additionally, a sensor with a frequency of 24 GHz, based on InnoSenT's SMR-334, was developed with the objective of extending the range of evaluation. Furthermore, a Moving Target Indicator (MTI) [4] was integrated into the radar developed by TecVenture, which is already capable of detecting motion. In order to more accurately assess the capabilities of the Boson 640 thermal camera [5], a comparison is made with IR measurement technology. This is used for thermal validation of wildlife and to determine the maximum range of the camera in the context of existing systems. For this purpose, an IR array HTPA60x40d with a field of view (FoV) of 92° x 60° from Heimann Sensor is employed [6].

Results

The results of measurements conducted at a wildlife park indicate that deer can be detected at distances of up to 22 m using a radar-based detection system with a frequency of 60 GHz. Figure 2 illustrates the range Doppler map of the 60GHz radar sensor, indicating the presence of a target at a distance of 18m and a radial velocity of 0.8 m/s. A target of the same amplitude does also appear at 4 m. This is a radar artefact and not an object. It is of greater consequence to consider the radar and IR-array results in conjunction with the thermal camera data. The measurements presented were obtained at 08:00 on October 2024. The ambient temperature was recorded at 9°C. This resulted in a high degree of contrast relative to the deer's body temperature. As illustrated in Figure 3, the deer can still be detected by the IR array at a distance of 18 m. By the time the afternoon had elapsed, the ambient temperature had already reached 15 °C. Consequently, the detection capability of the IR array was reduced to a distance of 14 m. The thermal camera detects deer at any temperature, even from far away.

Discussion and Conclusion

The findings indicate that detection with the 60 GHz sensor is feasible at a distance of 22 m. During the measurement, no deer passed at a greater distance, which would have required a more comprehensive evaluation of the 24 GHz sensor. The configuration of the lenses and the orientation of the 60 GHz radar sensor permit the estimation of the direction from which the animal is approaching. Range-Doppler mapping techniques estimate the velocity of approaching animals, assessing their potential hazard to road traffic. However, the MTI cannot detect static or slow-moving targets. A mean value filter could enhance detection. Furthermore, the detection area was traversed by an agricultural machine, which demonstrated that the radar cross section signature can be employed to differentiate between animals and other targets. The evaluation of IR-array sensing technology has demonstrated that the detection range is significantly influenced by ambient temperature. This indicates that animals can be detected with greater efficacy and at a greater distance in the winter than when the ambient temperature is the same as the body temperature. The evaluation of the boson-thermal camera has demonstrated that an enhanced resolution results in a notable improvement in distance resolution. This is attributed to an elevated thermal energy per pixel. The camera has thus demonstrated its potential as a valuable instrument for validation. Subsequent series of measurements will be conducted to further investigate the random occurrence of game in the detection area. Additionally, the project entails the miniaturization of the system for integration into a delineator and the interface for the warning.

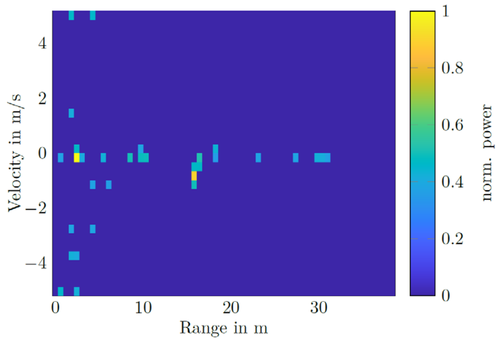

Fig. 2. The range-Doppler map of the 60 GHz Tecventure sensor in the absence of an MTI is presented herewith. The target is a deer situated at a distance of 18m and exhibiting a radial velocity of 0.8m/s.

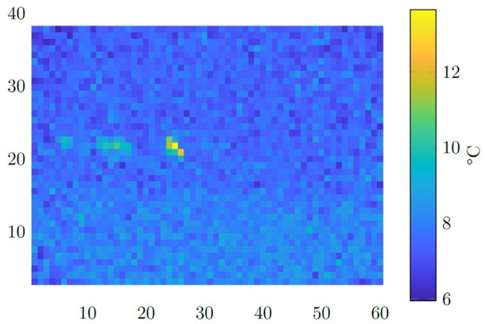

Fig. 3: The IR array image, captured concurrently with the data presented in Figure 2, reveals a thermal contrast at pixel (25,20) attributable to the presence of a deer at a distance of approximately 18 m.

References

[1] Kauer/DJV, "Wildunfallstatistik," 2023. https://www.jagdverband.de/,18.10.2024.

[2] FVA, "Pilotprojekt Elektronische Wildwarnanlage B292 bei Aglasterhausen" ,July 2008.

[3] "Md3-radar-transceiver," 2024. https://rfbeam.ch/product/v-md3-radar-transceiver/, 17.10.2024.

[4] E. Tohidi et al., "Compressive sensing in mti processing," in 2015 3rd International Workshop on Compressed Sensing Theory and its Applications to Radar,Sonar and Remote Sensing (CoSeRa), vol. 1, pp. 189–193, IEEE, June 2015.

[5] flir, "Boson640," 2024, https://www.flir.de/products/boson/ ,18.10.2024.

[6] "Heimann sensor," 2024. https://www.heimannsensor.com/, 20.10.2024.