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Optical Oracle based Scheme to Understand Radar Data

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Summary

Using machine learning algorithms is tough if the data we are handling are not perceivable by human-beings. For example CT-scans or radar-images. These images depict response of objects in bands which are not perceivable by human sensory organs. In this innovation (which has been filed as a British Patent (Application No: GB1803585.7)), we describe a scheme in which an oracle sensor (which is a human-perceivable sensor; e.g. optical sensor) guides a radar sensor. This scheme will make it possible to develop AI algorithms which can help us understand signal and images from sensors, like radar, which are not directly perceivable by human beings.

1 Introduction

One of the major challenges in using the data generated from radars is the fact that mostly these are not labeled. And even when they are labeled the process needs experts which makes the process costly. Unlike optical images non-optical images are not the way common human beings perceive their world. Hence, it takes years of training and experience to understand the different artifacts in non-optical images. For example, it is easy to show that if there is a break in the road the radar image of it will have an artifact. However, given an artifact it is extremely challenging to predict what it represents.

It should be understood that understanding radar or such non-optical signal by human-experts can never be complete. Because we still are using our eyes to understand something that has not been generated for the eyes.

This is where we can try to understand how does human brain deal with non-optical signal. Vision is the primary sensor in mammals and is used during the early development of infants to understand other sensory signal like auditory signal[1]. Inspired by this cognitive paradigm, we propose an oracle based learning system where the non-optical sensors get trained using the labels generated by the optical image understanding blocks.

Deep neural network has been taken as the machine learning algorithm of choice. Figure 1 shows the block diagram of the proposed system when the non-optical sensor is getting trained. This phase is assumed to be taking place when the conditions are right for the camera to generate good quality images. For example, let us take consider a vehicular application where both optical and radar sensors are used. In such a case, the optical sensors would be working perfectly during day time when the weather conditions are good. Under such a condition the radar sensor's image is not of much use and this condition can be used to train the radar. The signal from the camera and the radar are time-stamped as well as location-stamped. By location stamp we mean that the image and the radar signal has been processed to a spatial coordinate. Then the optical image is processed through optical image understanding tools, for example Google Cloud Vision API[2]. This generates labels for many objects in the scene. Depending on these labels and their locations, the non-optical data can be segmented and labeled. So by using the optical oracle we are able to generate labeled data during run-time and in a large quantity. These data can be used to fine-tune the deepNN for the understanding of the non-optical signal.

Figure 2 displays how the system would work when the non-optical sensor is being used. Taking our previous example of a vehicle with optical and radar sensors this might be during poor lighting or weather conditions when the optical sensors are limited in terms of their usability. The radar can be used to generate labels which can then be embedded (or fused) with the optical image to generate a richer image which can be understood by a common person driving the vehicle.

We should note two major novelties of the proposed system. And it can be noted that both of these are inspired by how human cognition works. Firstly, the optical sensor is used as the oracle to train the non-optical sensors. This is what happens in most mammals. And human mind follows this strategy to enriched the non-optical sensory signal and generates a holistic perception of the environment. Similarly in our system the final thrust is on generating a holistic understanding of the environment. Secondly, human cognition is an ongoing process and that is why we are so apt at adapting to new environments. Our system also learns in an ongoing manner. Every time the lighting conditions are good the optical oracle is used to bolster the deepNN for the non-optical sensor understanding.

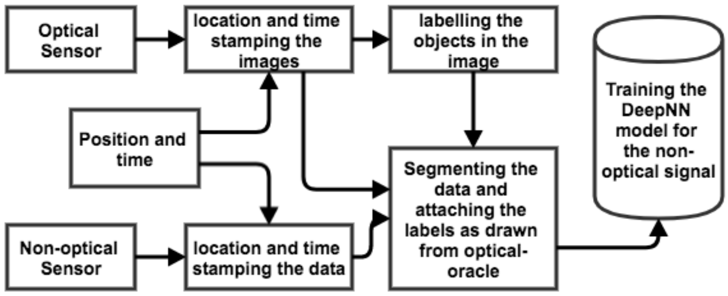

Figure 1. System block diagram when the non-optical sensor is getting trained. This phase uses the optical sensor's image-understanding block as the oracle which generates labels which can be used to train the signal from the non-optical sensor.

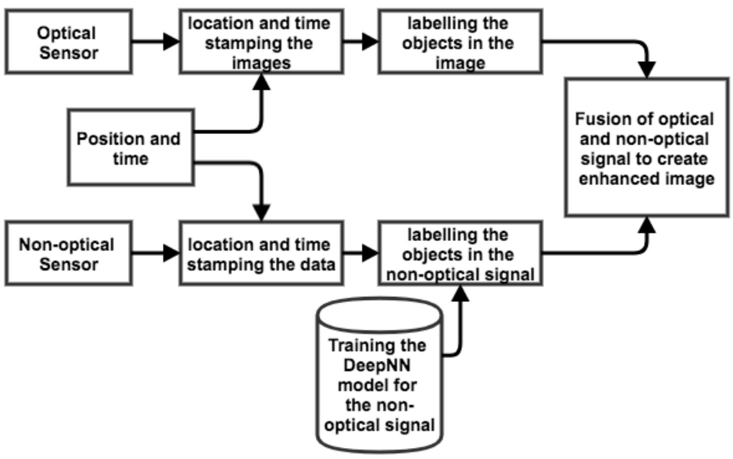

Figure 2. System block diagram when the non-optical sensor acts along side the optical sensor. The non optical sensor usually gathers information which can be used to enriched the optical images. The labels generated by the non-optical sensor is used to enhance the optical image.

References

[1] A. Fernald, “Chapter two hearing, listening, and understanding: Auditory development in infancy,” *Blackwell handbook of infant development*, p. 35, 2008.

[2] “Gogle cloud vision API,” https://cloud.google.com/vision/, accessed: 2017-11-20.