Description

Title of the Invention: System and Method for Multipath Auto-labeling in High-Resolution Radar Point Cloud

In this patent, a comprehensive method and system is devised to automatically label the multipath points in radar point cloud with the help of images collected by a camera system that is synchronized with the radar.

This method consists of three main components. The first component aims to pre-process the point cloud which is called point cloud segmentation. In this stage, the radar point cloud is segmented into static and dynamic points. The segmentation can be achieved by evaluating the doppler distribution of the point cloud. The second component is designed for image segmentation. During this step, the objects in the image are classified into two broad categories, i.e., static objects and dynamic objects. Each category may consist of many classes. For example, the static category may include classes such as roads, traffic signs, poles, trees, grass, etc. that are relevant to the car-driving or other applications. Dynamic category in general consists of all the objects that can move around such as cars, trucks, buses, pedestrians, cyclists, animals, etc. The third component conducts the automatic labeling wherein first, the radar point cloud will be overlapped with the camera image. Then, the dynamic multipath is classified according to the overlapped results. Finally, the static multipath is classified according to physical constraints, which depends on the relative geometry between the radar and its surrounding environments.

Brief Description of the Drawings

Details on Fig 1 : System for auto-labeling of multipath points in the point cloud domain are mentioned as below:

Component-01 stands for the sensor dataset that is used for multipath labeling. Component 01 in general consists of radar point cloud 102 to be labeled and images 100 from camera.

Component 02 is image segmentation. Image segmentation amounts to providing each pixel of the image a class label. In this invention, we consider the following classes: background, vehicle, and pedestrian.

Component 03 is radar point cloud segmentation. In radar point cloud segmentation, a flag of dynamic target or static target will be assigned to each point. This is achieved by fitting the relative motion model to the DOA and angular information of each point.

Component 04 is radar point cloud and camera image overlay. This is to project the 3D radar points into a 2D image and then overlap the 2D point cloud image with radar camera image. To do so, one need the camera intrinsic calibration information to project the 3D points onto 2D image and then the extrinsic calibration information between radar and camera to overlay them.

Component 05 is the multipath labeling on the dynamic points. The basic rule here is that any dynamic point in the radar point cloud will be labeled as MP if it is not overlapped with any dynamic object in camera image. Meanwhile, to cover MP due to multiple bounce, there is a different rule to determine whether a dynamic point is MP.

Component 06 is MP labeling for static point. This stage aims to labeling the MP points due to static points. The basic rule is that any point behind another point, i.e., having similar DOA but larger range, will be labeled as MP.

Claims

Claim 1: A system and method for auto-labeling of multipath points in the radar point cloud is designed as depicted in Figure -1, consisting of sub-systems which processes point clouds and camera images, along with labeling of multipath points

Claim 2: The point cloud processing system of claim 1 conducts the segmentation of dynamic points and static points by evaluating the distribution of Doppler velocity.

Claim 3: The image processing system of claim 1 conducts point cloud overlay with the image after image segmentation.

Claim 4: The multipath labeling system of claim 1 makes use of the overlapped point clouds and the images to label each and every point.

Claim 5: The system of claim 4 first labels the dynamic multipath based on whether the dynamic point in the point cloud is overlapped with any dynamic object in the image domain.

Claim 6: The system of claim 4 thereby the system labels the static multipath based on physical constraints that any static point behind another point is a multipath point.