RADAR AND PHOTOMETRIC SENSOR FUSION FOR 3D RECONSTRUCTION

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Robotic operations in harsh environments require sensors that provide information about the scene geometry with sufficient resolution and accuracy under a wide range of environmental conditions. No single sensing modality, however, is able to cover all requirements. Photometric sensors provide data with high spatial resolution but need intensive computation to yield depth and are sensitive to environmental conditions such as fog, darkness or highlights. Laser range finders deliver high-resolution accurate depth information but are adversely affected by dust, snow or reflective surfaces. Radar range finders are robust to most of such environmental conditions but provide inaccurate low-resolution depth information. Combining several sensing modalities into one device has the potential of widening the set of operating conditions and achieving increased data reliability by exploiting the redundancy present in the sensed data.

In this paper, an integrated range-photometry sensor is presented. The developed sensor relies upon the strengths of two modalities: radar range sensing, and high-resolution dynamic photometric imaging. While radar data has low resolution and depth from motion in photometric images is susceptible to poor visibility conditions, the integrated sensor compensates for the limitations of the individual components.

The integration of the two modalities (range and photometry) is achieved by using two complementary methods: a 3D reconstruction method based directly upon the range data and a shape-from-motion approach based upon the photometric data. An edge detection fusion technique is performed, first, in both sources of information in order to locate photometric edges due to depth discontinuities. This edge map constrains the next steps of the process. The range data reconstruction is based upon a robust formulation of the data interpolation problem and a Markovian model. The shape from motion algorithm is based upon the robust estimation of the optical flow. This estimation is constrained by an initial model computed from the available range data. Results with both synthetic and real data illustrate the improvement brought about by this approach.