Vision for Robotics

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Abstract

Robotics includes a very broad range of potential computer vision applications, including autonomous navigation, manipulation, and human/robot interaction, and a very broad range of operating domains -- land, sea, air, or space. Estimating motion of the robot and perceiving the 3-D structure of the robot's environment are core problems in most of these applications, but inferring material properties of the scene, recognizing specific objects in the scene, and estimating motion of objects in the scene can also be important.

This lecture will start with a brief survey of vision applications in robotics, then present an introduction to sensors and sensor modeling for robotics, including cameras, multispectral sensors from visible through thermal infrared, range sensors including lidar, structured light, and radar, and inertial sensors. This will include a short treatment of the physics and noise characteristics of the sensors. The lecture will then introduce methods for fusing measurements from visual, inertial, and other sensors for robot motion estimation, introduce several choices of data structures to represent the 3-D environment of robots, and illustrate how to update such representations for typical examples of robot 3-D sensor suites. We will touch on topics in terrain/material classification for robotics and on trends in computing architectures for real-time robot vision. Finally, we will examine some case studies of robot perception systems for off-road land navigation on Earth and Mars, flying vehicles/landers on Earth and Mars, and mobile manipulation systems. There will be an emphasis throughout on issues involved in making vision fast and reliable in real-world applications.

Keywords
robotics, embedded vision systems, range sensors, state estimation, mapping, radiometry, noise modeling

Syllabus
Overview of robotics applications (land, sea, air, and space), sensors and sensor modeling for robotics (cameras, multispectral, lidar, radar, inertial), sensor fusion for robot motion estimation, 3-D modeling for robotic mobility and manipulation, introduction to computing architectures for robot vision, case studies

About the speaker
Larry Matthies obtained his PhD in Computer Science from Carnegie Mellon University in 1989 and has been at the Jet Propulsion Laboratory since then, where he currently supervises the Computer Vision Group. His research has focused on perception systems for autonomous navigation of

unmanned vehicles, including for land, sea, air, and space. All of the Mars rover miisions to date have used vision algorithms from his group. He also lectures on vision-based navigation at Caltech and is adjunct at the University of Southern California. He is a Fellow of the IEEE and a co-recipient of the IEEE Robotics and Automation Award for contributions to robotic Mars exploration.