

# **Development of a Real-time 3D Mapping System using 2D/3D Cameras for Mobile Robot Applications**

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## **1. Abstract**

This paper presents an integrated 2D-3D vision system with highly accurate real-time tracking control for mobile robot simultaneous localization and mapping (SLAM). To achieve this, the rather new 3D Photonic Mixing Device (PMD) and 2D RGB color cameras are combined to generate visually realistic 3D maps. Visual input from the 2D camera delivers high resolution texture data but also enables the mobile robot to enhance the 3D data calculated from the range output of the PMD camera, which the PMD is able to measure depth with high precision in real time. This integrated system is more visual realism in images compared with typical 3D vision system such as Laser Range Finder (LRF). Data acquisition is automatically performed by an autonomous mobile robot mounting such cameras on board. The iterative closest point (ICP) algorithm is used for the registration of 3D geometric data. Experimental results that estimate camera trajectories and build the 3D maps are obtained for the demonstration of method.

## **2. Introduction**

The simultaneous localization and mapping (SLAM) is a very famous vital technology and used technique for self-localization of mobile robotics. SLAM is the process of building the map of environment while simultaneously using this map to provide localization information. For self-localization and mapping of the robot's environment, the precision and completeness of the acquired 3D data are the important points. Moreover, the real-time 3D computation of the scene in the moving direction of the robot is required to ensure obstacle avoidance and to mandate mapping and surveying tasks if environment dynamics are considered. Recently, the enhancements of PMD camera that enable 3D image grabbing within a few milliseconds give an important impulse in visual 3D sensing. This camera is capable of capturing reliable depth images directly in real-time. PMD is also compact and affordable, which makes it attractive for versatile applications including surveillance and computer vision. However, PMD-based device has still limited resolution and provide only gray scale information. In this paper, the combination of 2D-3D vision system is proposed to inundate this limitation, and to provide more realistic 3D color images instead of using LRF. The mobile robot TOM3D (Tele Operated Machine with 3D PMD-camera) is used for testing in 3D environment. Figure 1 shows a block diagram of 3D map building and robot localization process.

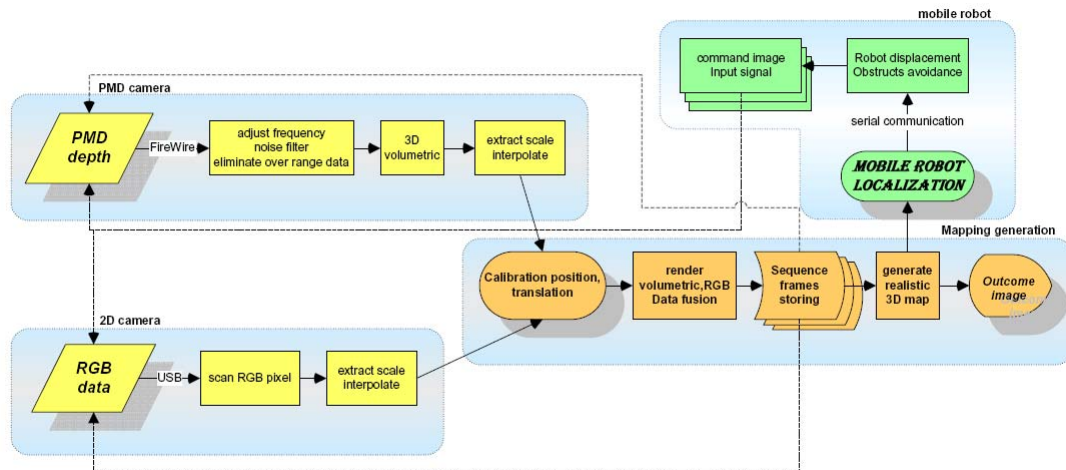


Figure 1 Block diagram of 3D map building and localization process

### 3. Mobile robot TOM3D

The mobile robot TOM3D (Tele Operated Machine with 3D PMD-camera) is used in a test platform. The robot is equipped with a PMD, 2D cameras, 16bit microcontroller, inclinometer sensor and embedded PC. The PMD camera is mounted on the top with a proper inclination angle and 2D camera on the below level. The inclination angle between 2 cameras is calibrated before combination process.

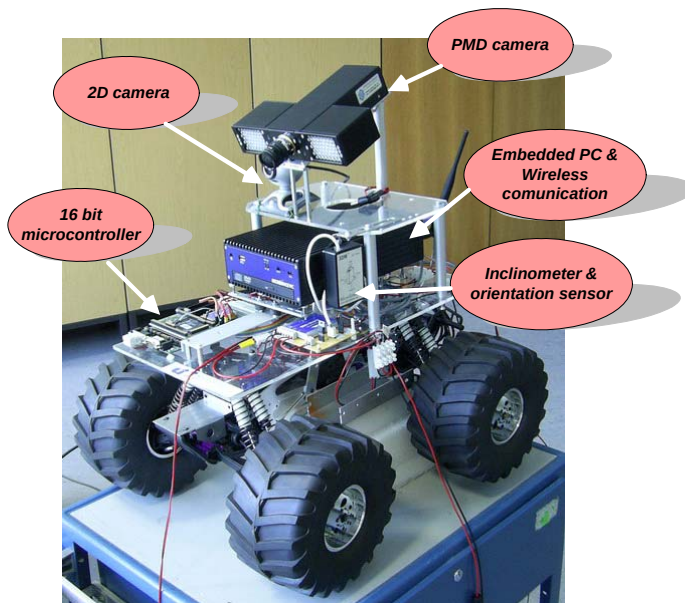


Figure 2 Mobile robot TOM3D