Project Plan

3D Mapping of Outdoor Scenes Using Stereo Imagery

TSBB11 - Images and Graphics, Project course CDIO

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1 Introduction

This is a project plan in the course TSBB11 - Images and Graphics, Project Course CDIO at Linköping University (LiU). The project is called 3D Mapping of Outdoor Scenes Using Stereo Imagery. The project group consists of 5 students and the client is Bertil Grelsson at SAAB.

1.1 Specification

The aim is to accurately calculate the volume of an outdoor object using stereo imagery. The object is intended to be log piles, wood chip piles or other solid textured objects. SAAB provides a stereo camera rig and a laptop for controlling the cameras. The rig provides gray scale stereo image sequences, and IMU data containing incremental rotation of the rig. Using the stereo images, a 3D point cloud of the scene will be obtained. The goal is to estimate the real world volume of the object using the 3D model. The estimation shall be within an error margin of at most 10%.

1.2 Deliverables

The deliverables of this project are listed below.

- Project plan, specifications, and system design.
- Technical documentation describing the implementation of the system.
- A web page and a poster to present the results.

1.3 Project Management

The project will be managed using the SCRUM project model, which is suitable for software development. The requirements described in section 2 will be split into small tasks that are put in a backlog. During the development the team selects a number of tasks from the backlog which are solved in sprints. The role of the SCRUM-Master is to assure that the SCRUM model framework is followed. The Backlog manager is responsible for keeping the product backlog up to date and inline with customer requirements.

Mattias Carlsson	SCRUM-Master, Development Team
Max Gefvert	Development Team
Björn Kernell	Backlog manager, Development Team
Johan Lind	Development Team
Sebastian Parborg	Development Team

Table 1: Project group composition

2 Requirements

Below is a table containing the negotiated requirements.

1	The system shall create a 3D model of the object.
2	The system shall compute the volume of the object with an error margin of at most 10%.
3	The system shall meet condition 2 in uniform light condition, e.g. cloudy weather.
4	The system shall have a loop closure that fine tunes the 3D reconstruction.
5	The system shall compute 3D points using a using a non-bundled method.
6	The system shall satisfy the requirements above using rectified images from calibrated cameras.
7	The system shall have a graphical user interface for the system.
8	Validation of the volume measurement accuracy shall be done using manual measurements.
9	Technical documentation shall be provided for the system including all deliverables.
10	The system should create a polygon mesh of the object.
11	The system should compute the volume of the object with an error margin of at most 5%.
12	The system should be able to perform a 3D reconstruction of a 10x5x3 meter object within 15 minutes.
13	The system should meet all compulsory requirements in light conditions with high contrast, e.g. sunny weather.
14	A user manual for the system should be provided.

Table 2: Requirements

3 System Design

An overview of the system design is shown in the flowchart below in figure 1. A set of rectified stereo images and data from the IMU are the input to the system. The loop is over each view, that is each stereo image pair. Each module is described in more detail below. The green boxes symbolize functionality already existing in the stereo rig whose output will be used as input to the system. The blue boxes depict the design of the system.

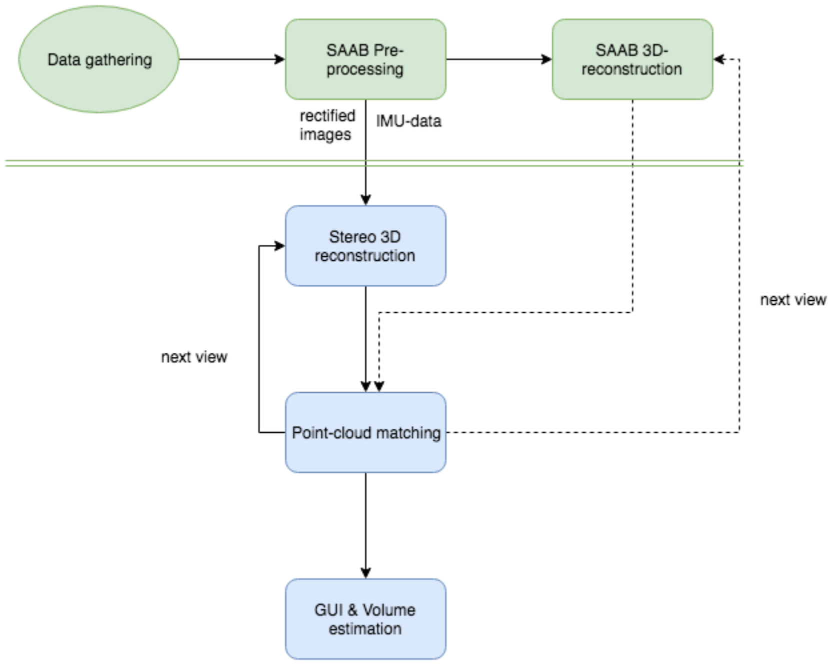

Figure 1: System design

3.1 Inputs

The inputs to the system consists of rectified images from a calibrated stereo camera rig provided by the client. The images are accompanied by IMU-data that tells the relative rotation between consecutive views. It's also possible to get 3D point-clouds generated from the rig as input.

3.2 Stereo 3D reconstruction

From a stereo view, a 3D reconstruction of the scene will be implemented by triangulating 3D points from 2D-correspondences.

3.3 Point Cloud Matching

The new 3D-points given from the stereo pair are then matched against the already existing 3D-points to estimate the position and rotation of the stereo rig. Data from the IMU can be used as an initial guess and/or plausibility check. The poses of the views and the positions of the 3D-points will be refined using loop closure, e.g. Bundle Adjustment, to minimize drift error.

3.4 GUI and Volume Estimation

The final 3D model will be used in a graphical user interface where the user can select which part of the model to measure. For instance, one can select three points lying on the ground who define a ground plane. Then the orthogonal distance from the plane can be integrated over the points defining the object.

3.5 Evaluation

When testing the system, a simple object will be used, e.g. a small house. Preferably something with a know volume, since manually measuring an object introduces a source of error. When that is not the case, the object will simply be measured manually as accurate as possible.

3.6 Language and Tools

The system will be implemented in C++. In addition, the OpenCV library will be used. Version control will be handled by GitHub and exported to SVN, if required by the course.