LOCALIZATION AND MAPPING ON A QUADRUPED ROBOT

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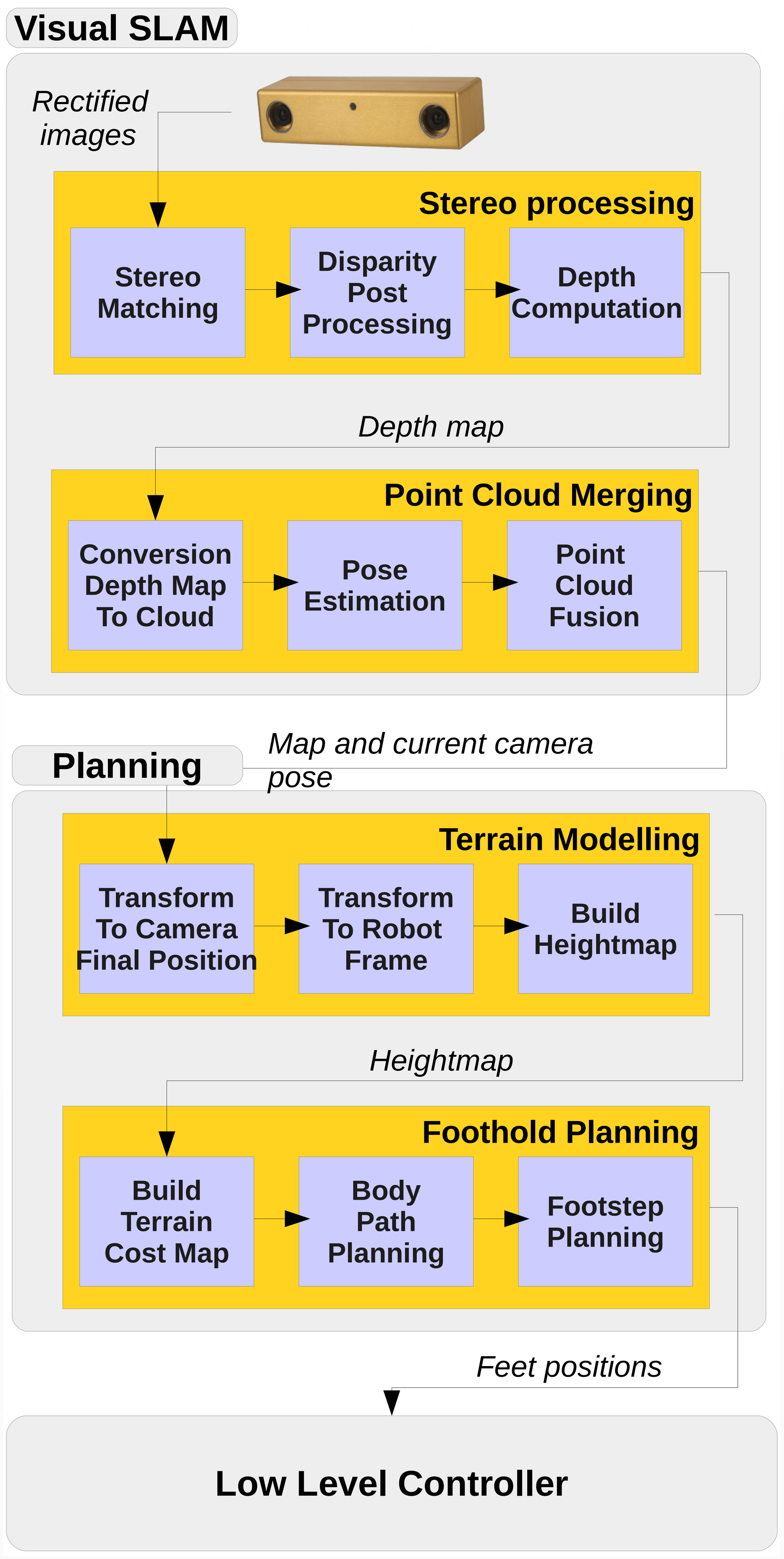
Abstract

Legged robots are expected to have superior mobility on rough terrain than wheeled robots. The main reason is that legged locomotion is more adaptable to a wide range of terrain types as the robot can decompose its path into a sequence of footholds and can use different locomotion strategies. In order to accomplish most of the locomotion tasks the robot requires high level control (*i.e.*, to adjust the locomotion parameters and to choose optimal footholds) which depends on real-time localization and accurate terrain mapping [1].

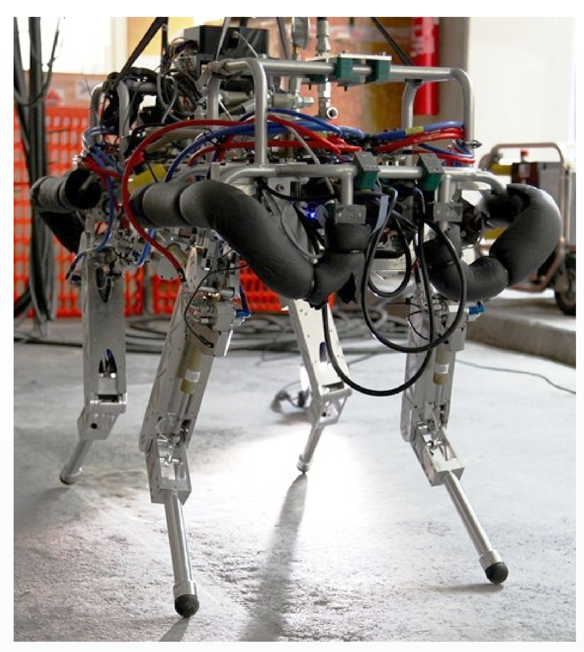
Pipeline

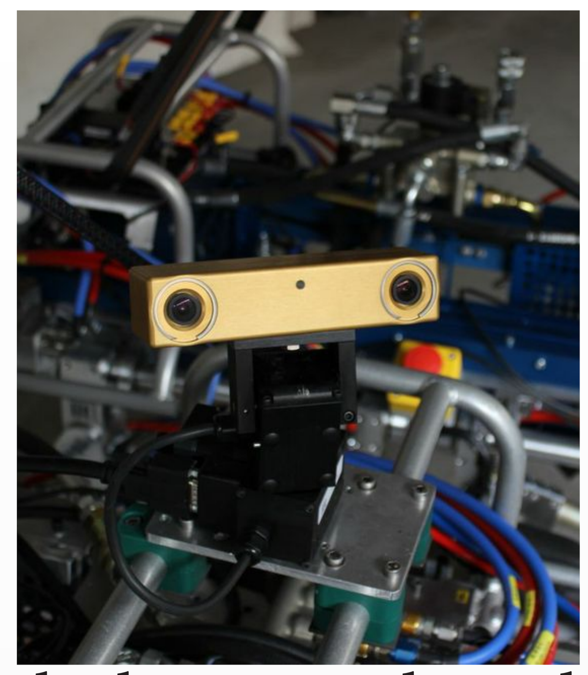


The HyQ Robot

HyQ is a versatile hydraulically actuated machine that weighs 80 kg, is 1 m long and 1 m tall and has upper and lower leg segments of 0.35 m in length. The robot's legs have three degrees of freedom each, two joints in the sagittal plane (hip and knee flexion/extension) and one joint for hip abduction/adduction. It is equipped with a PC104 for actuation control at 1 kHz.

HyQ Setup





The equipment include as on-board vision system a Pointgrey Bumblebee Camera and a FLIR D46-17 PTU

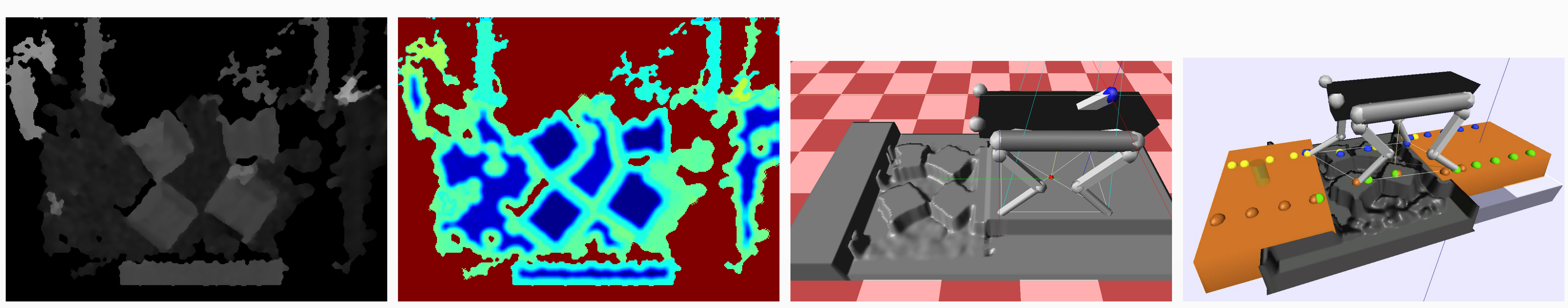
Future Works

- Reduce SLAM failures by integrating the IMU measurement in the SLAM pipeline;
- Improve the disparity computation rate by adding FPGA computation.

From SLAM to foothold planning

1. Modified version of the Kinect Fusion (KinFu) Large Scale algorithm fed with filtered depth map from Bumblebee
2. Mapping is improved with mechanical motion compensation provided by PTU Controller;
3. Map is reprojected in 2D to obtain height map;
4. We associate a cost to each cell of the height map. The cost map penalizes:
   - High frequencies (*i.e.*, discontinuities on the morphology, such as the edges of a rock);
   - Small uniform areas (*e.g.*, holes or small flat rocks), since the robot has a non negligible foot area and it could miss such foothold;

   The cost is proportional to both direction and intensity of the gradient and is linearly combined to the original height map to consider the height of the cells (dark cold colors = low cost, dark warm color = higher costs).
5. The planner use the cost map plus other information (*e.g.*, kinematic constraints) to compute foot-holds.



References

[1] S. Bazeille, M. Camurri, et al. "Terrain mapping with a pan and tilt stereo camera for locomotion on a quadruped robot". In: *ICRA14 Workshop on Modeling, Estimation, Perception and Control of All Terrain Mobile Robots (WMEPC14)*. 2014.