Visual Servoing of a Robotic Mine Detector Arm

Ali Musa Iftikhar, Hamza Anwar, Muhammad Furqan Afzal, Qasim Zafar
Mentor: Syed Muhammad Abbas **Supervisor:** Abubakr Muhammad
CyPhyNetS.lums.edu.pk

Overview

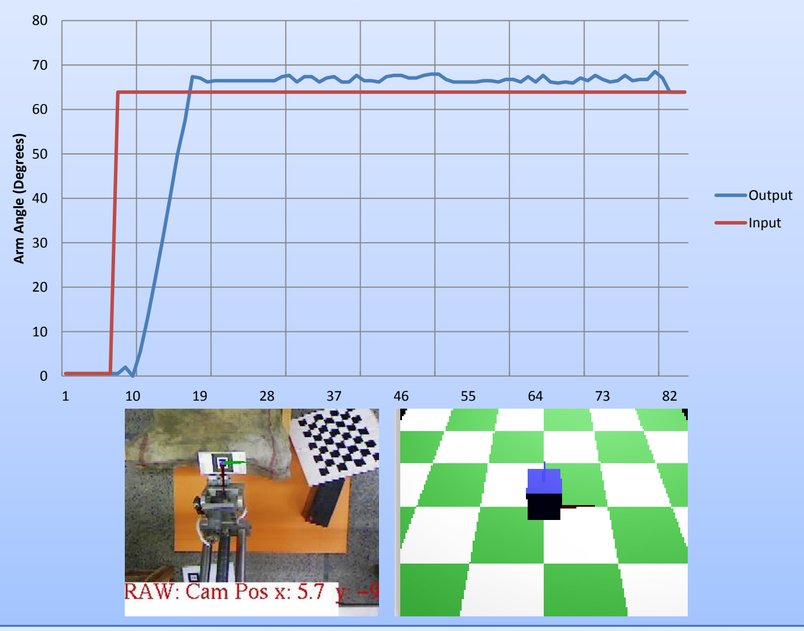
Landmine-detecting systems are crucial in demining hazardous abandoned minefields. The most crucial task is to ensure an optimal distance of the detector from the terrain for the best possible detection. We aim to use stereo vision for accurate 3D profiling of different types of terrains and then servo the robotic sensor arm over it to guarantee perfect surveillance of the terrain.

Related Work

Marwa, a low cost robot for rough terrain landmine detection [1], was developed by CyPhyNetS LUMS for NI mine detection robot design contest. Our project aims to extend and improve its visual servoing for maximal precision in detection.

Marwa in Lebanon (2011)

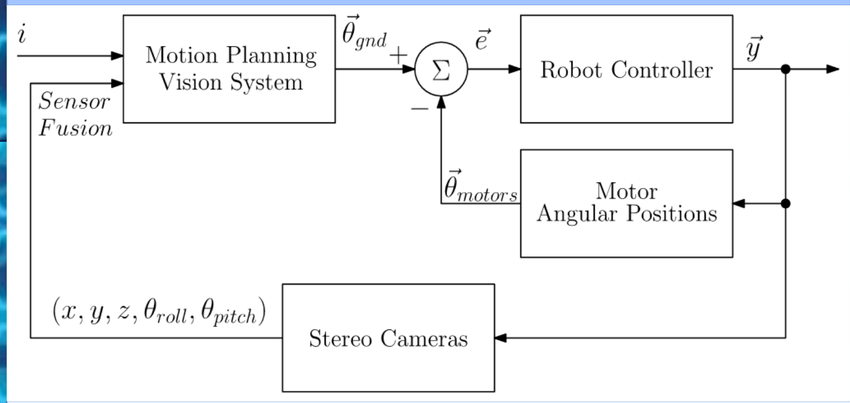
Design and Simulation Results



Visual feedback for end-effector 3D pose detection (ARToolkit)

Proposed Approach

- 5 DOF robotic manipulator arm.
- Stereo camera pair for 3D reconstruction of rough outdoor terrains.
- Rasterized planar segmentation of scanning area.
- End-effector motion planning.
- Visual feedback for minimizing actuation error.

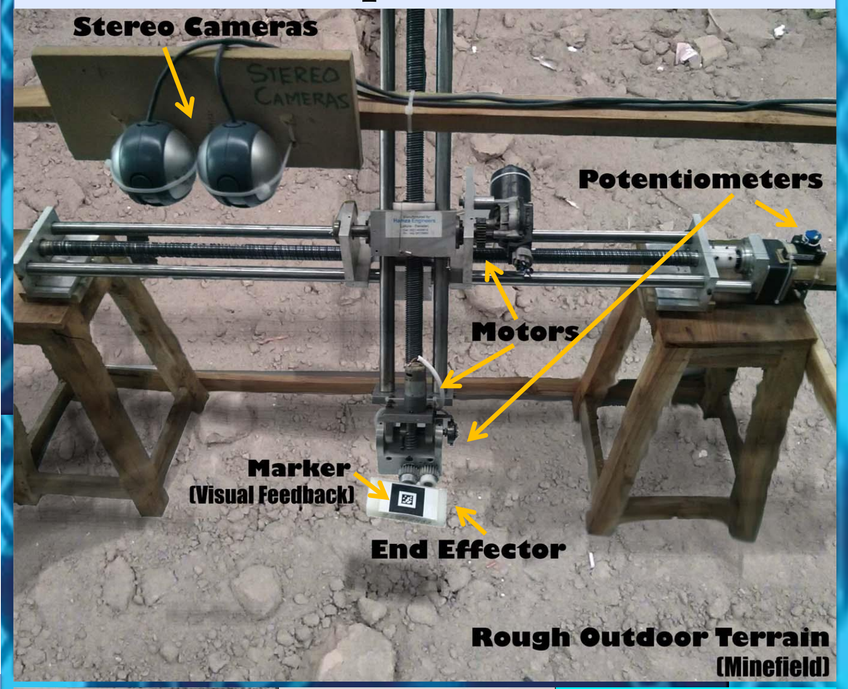


System Diagram

Design Methodology

The stereo camera pair generates the 3D map of the terrain to be scanned for landmines. We use stereo's semi-global matching technique because of its robustness to outdoor radiometric differences in light. The generated 3D point cloud (shown depth color-coded in adjacent figure), is segmented into planes of uniform size. RANSAC is used for plane-fitting, and then, a 3D trajectory of the robotic arm is planned for maneuvering closely over these planes. After the one-time planning step, the Arduino controller (via serial communication) sets the five motors to their desired angular positions step-by-step to complete the trajectory. Sensors used here are free-running potentiometers. Cameras are again used for end-effector position and orientation sensing, to apply visual correction over planning. This part uses open-source Augmented Reality (AR) Toolkit.

Hardware Setup



Scene snapshot | Disparity map | 3D Point cloud

Future Work

In future we plan to carry out noise modelling for a more theoretically developed fusion of camera and potentiometer sensors for the end-effector's 3D pose detection. We may even employ efficient path planning so as to ensure obstacle avoidance dynamically. The long-term aim is to ensure efficient tracking of different types of terrains not necessarily flat.

References: [1]. T. Manzoor, A. Munawar and A. Muhammad. Visual Servoing of a Sensor Arm for Mine Detection Robot Marwa. 7th German Conference on Robotics (Robotik), Munich, Germany, 2012. {Ref: http://cyphynets.lums.edu.pk/images/ViServRobotik2012.pdf}

Department of Electrical Engineering, 3rd floor SBASSE Complex, Lahore University of Management Sciences, Opposite Sector U, DHA, Lahore – 54792, Pakistan