Technology Robotix Society

Technology Students' Gymkhana
IIT Kharagpur

Autonomous Campus Bot

A MakerSpace Initiative

Project Aim

The ultimate goal of this project is to have an autonomous outdoor robot that can tour the campus on it's own without any human intervention. It should also be able to navigate safely avoiding people and other obstacles. A real life application of this robot would be to deliver objects autonomously from one place to another.

Motivation

This project directly focuses on achieving long-term vision based autonomy for mobile robots. Most autonomous outdoor robots rely heavily on costly sensors for autonomous navigation. Our goal is to use only two cameras as a stereo setup to perform autonomous navigation. In the world of robotics, achieving long-term autonomy is an active research goal, and we think this project would be a perfect start for the MakerSpace initiative and boost the culture of robotics in campus.

Research Areas

1. **Localization:** The first task of the robot is to localize itself on campus. Initially we plan to use GPS and wheel odometry (integrated using a particle filter) to achieve the same. After that we plan to move to a completely vision-based localization approach.

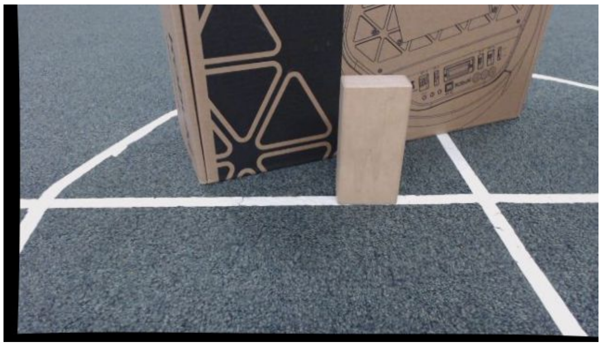
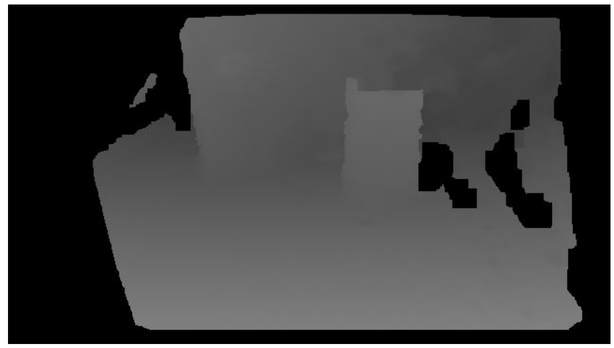
2. **Obstacle Avoidance:** We plan to use a stereo vision based approach to perform obstacle avoidance. Local 3D reconstruction can be achieved from stereo cameras in real time and this would enable us to detect obstacles in front of the robot.

3. **Navigation and planning:** Localization and obstacle avoidance would be integrated to enable the robot to move autonomously. A higher level path/task planning needs to be done on a campus map before sending commands to the robot.

Completed Work

A lot of work on real time obstacle avoidance using stereo vision has already been done. Using two cameras as a stereo system, depth information can be extracted from images captured by the cameras. These depth information are stored in maps called disparity maps, which are basically images storing the relative shift of each pixel in rectified stereo images. These disparity values can be converted into depth, as they have an inverse relationship. Hence one could reconstruct a 3D point cloud from these stereo images. After the reconstruction step, an obstacle scan is performed on the 3D point cloud, to find obstacle points in the scene. This step is essentially making the stereo system virtually act like a laser scanner. Using the points found by the obstacle scan, a local planner is used on the robot to avoid the obstacle.

3

Left Image	Disparity Map
	

Live 3D reconstruction:
https://drive.google.com/open?id=0B2cJaMD4iwIkWU5KeFNNRlFaRTg

GitHub repo: https://github.com/sourishg/jackal-navigation

Project Requirements

S.No.	Product	Quantity	Price (Rs.)
1.	ArduPilot Mega + GPS (http://www.amazon.in/APM2-6-ArduPilot-Flight-Controller-NEO-6M/dp/B01GFQ58TU/ref=sr_1_2?ie=UTF8&qid=1471967810&sr=8-2&keywords=ardupilot+mega+2.6)	1	4800
2.	Chassis (inc. motors, gears, wheels)	1	20000
4.	Intel NUC (http://www.amazon.in/Intel-BOXNUC5i5RYH-Computing-NUC5i5RYH-Bluetooth/dp/B00SD9IS1S/ref=sr_1_3?s=computers&ie=UTF8&qid=1471967659&sr=1-3&keywords=intel+nuc)	1	27300
6.	LiPo Battery 4 cell (14.2V, 8000mAh) (http://www.hobbyking.com/hobbyking/store/__11940__Turnigy_nano_tech_6000mah_4S_25_50C_Lipo_Pack.html)	2	8000
7.	XBOX 360 wireless controller (http://www.amazon.in/Microsoft-Xbox-Wireless-Controller-Receiver/dp/B00HJQZS3M/ref=sr_1_2?ie=UTF8&qid=1472010418&sr=8-2&keywords=xbox+360+controller+wireless)	1	3425
8.	3D printing + Misc.		6000
		Subtotal	69525