Pasargad Team Description Paper
Rescue Virtual Robot – Robocup 2012

Yaser Abbasi[1], Ebrahim Bararian[2], Simin Jahangard[2], Saeed Shiry Gheydari[2]

[1] Department of Mathematics and Computer Science, Amirkabir University of Technology, Tehran
[2] Robotics Institute, Amirkabir University of Technology, Tehran

{yas.abbasi, ebrahim.bararian, s.jahangard66}@gmail.com
{shiry}@aut.ac.ir

Abstract. After experiencing some International Competitions in Virtual Robot League, some rescue problems has been identified such as Victim/Humanoid Detection, Multi-Agent, HRI[1], Exploration and SLAM[2]. We achieved new approaches to solving it that some is discussed in this paper. In order to developing and testing the algorithms simply is made a new base code by Pasargad which it will be released after Mexico Competition for public use in the robotic community. This new base code has get up some developing complication. This year Pasargad has focused on Victim Detection and Multi-Agent by aerial, legged and wheeled vehicle robots such as AirRobot, NAO and P3AT. In following will describe the new approaches to Virtual Robot.

Keywords: Robocup, Virtual Robot, USARSim, Victim Detection.

1 Introduction

Research efforts in urban search and rescue robotics have grown substantially in recent years. Robotic search and rescue would be ideally tested in real an environment; however since most research labs do not have the space or resources to create arenas which are similar.

Virtual (simulated) versions of NIST's Reference Test Arenas for Urban Search and Rescue Robots were developed to provide the research community with an efficient way to test algorithms independently of the costs associated with maintaining functional robots and traveling to one of the permanent arena sites for validation and practice.

[1] Human Robot Interaction
[2] Simultaneous Localization And Mapping

Urban Search and Rescue Simulation (USARSim) [1] is a high-fidelity open source simulator of robots and environments based on the Unreal engine that provides a high resolution, physics based environments simulation of robotic platforms and models of several common robotic platforms and sensors as well as sample worlds. USARSim has validated the sensors and environments simulator in these papers [2, 3] and others papers.

Some approaches did not change or they are in progress, and then you can find them in last Pasargad TDP [4] or will update later.

Team members and roles are as follows:

Yaser Abbasi	:Multi-Agent Exploration, Air Robot Controller, 2/3D GUI, Map Creator
Ebrahim Bararian	:Victim Detection, Wheeled Vehicle, NAO Controller-Walking, Image Performance
Simin Jahangard	:Victim Detection and Air robot mapping
Saeed Shiry Gheydari	:Advisor

Pasargad team has created many maps in USARSim/UT3 Platform and in future will prepare some USARSim/UDK maps.

More information about the maps and download links are provided here:

http://www.pasargadrobotic.com

2 New User Friendly Base Code

Robotics researchers needs to test own algorithms before implemented on Real models for increasing maintenance cost. So simulator such as USARSim can help them. The USARSim able simulate real world, robots and sensors and show us results of simulation. But there must exist middle ware to connect algorithms to USARSim. New Pasargad Base Code can play this role with simple method to deploy and user-friendly features. One of these features is easy way to implement a robotic algorithm such as A* path planning, just exchange “path planning algorithm” line with the algorithm Java class name which is “AStar” in the Configuration File.

The base code has basic communication to USARSim, Image Server, WSS and primary algorithms for every problem in Robotics such as SLAM, Path Planning, Obstacle Avoidance, Multi Agent Exploration, Basic Robot Controller(NAO, Air Robot, P3AT), NAO Walking, Object Detection, Victim Detection, Voice Recognition, Autonomous/Semi-Autonomous and other famous robotics algorithms.

Pasargad Base Code will be completed to Mexico Competition and publicly available for all robotics researchers particularly Virtual Robots Competitors.

3 Victim Detection

One of the goals through which, we can move to full autonomous system is victim detection with an AI approach. Besides, it is possible to use victim detection in a semi-autonomous style when you control a robot, other robots will alarm the operator if they see a victim in the image they have received. There are multiple methods to reach this goal. Each one has some benefits and problems. A HOG[3] feature based method, A SURF[4] feature based method and motion detection have used here.

A HOG feature based method which is introduced in [5] is a good way to detect victims in upright positions. It is fast in computation but can't be sure that victims are in upright positions. It rarely can happen. In this method HOG descriptors extracted from the upright victims and non-victim images fed to a linear SVM[5] and in result the classifier get trained to distinguish between victims and other objects.

To achieve more robust method to detect victims, we chose to use SURF feature as it is invariant to rotation and scaling and also fast to compute [6]. In computing this feature's descriptor first it is needed to compute the key points. A linear SVM is trained with 64 dimensional features extracted from victim and non-victim images. Then, we can extract image features and using the SVM, it is checked if it is a victim SURF point or not. To eliminate the false positives in deciding if it is a victim, a graph is made out of the key points distinguished as victim's ones in which there is one node for each key point and two nodes are neighbor if their Manhattan's distance is less than a threshold. Then a flood fill algorithm is used to state the graph components. Finally if the ratio of the rectangle's area which surrounded each component to the number of its key points is larger than a threshold it would be decided as victim. To increase the algorithm's speed the GPU-based SURF computation would be helpful[7] in comparison with HOG feature based method, it take much time to compute. In figure 1 the key points near the victims are detected. Also there are some false positives.

[3] Histograms of Oriented Gradients
[4] Speeded Up Robust Features
[5] Support Vector Machines

Fig. 1. Victim detection using SURF feature

Finally, one of the basic and fast ways for detecting victim that moves is subtraction [8]. According to this method two images that one of them taken in time 't' and the other one taken in time't+1' subtracted from each other . The nonzero areas will show the victims area. A threshold helps to avoid image's noise effects. Although this is a fast approach but it is helpful in static situations of the robots which needs the environment and other robots have no movement and a little movement of the victims Figure 2.

Fig. 2. Victim Detection Using Motion Detection

4 Air Robots Formable Objects Detection to Guide Robots On The Ground

There are some common objects in our daily life which their shape obey regular rules. This helps us considering algorithms like Hough transform [9] to find circular and rectangular objects. Air robots can prepare the ground robots useful information by finding these kinds of objects like tables which can be used by the ground robot in collision avoidance algorithms. See figure 3 for the Hough transform results.

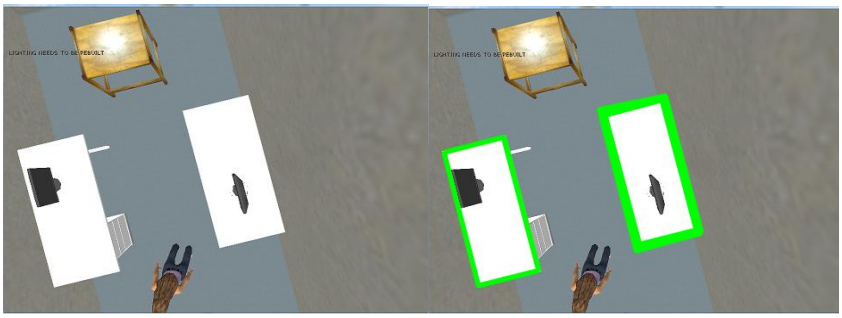

Fig. 3. Rectangular Object Detection

5 Image Enhancements

In some situations, low contrast of the images due to smoky or foggy environment, makes the understanding of the image hard. To solve this problem, we considered to expand the color range of the image using histogram equalization. The result is shown in figure 4.

Fig. 4. Image enhancement using histogram equalization

Also, we used sharpness mask to increase the sharpness of the image. In this approach each pixel value increased or decreased according to its difference to neighboring pixels. Radius of neighbor pixels, measure of pixel value change according to the contrast

6 NAO - Bipedal Walking

There are different methods to develop walking algorithm including IK[6] and Fourier. IK has some disadvantages like being robot model-dependent and that it needs much complicated computations that makes this method slow. As the walking is a repeating process, Truncated Fourier Series can be used to generate a pattern for walking. It results in some formulas in Sagittal, Frontal and Transverse planes for legs joints.

Also hand movements have great effect on stability of the agent. Formulas for the hand and leg movements get together and the parameters for the final formula get optimized using genetic algorithm. The details of the algorithms are described in [10].

7 Future Aspect

In this paper has be described some new Pasargad approaches and some algorithms are in progress.

References

[1] Jijun Wang, Stephen Balakirsky, Stefano Carpin: USARSim: a robot simulator for research and education, Proceedings IEEE International Conference on Robotics and Automation(2007), pages 1400-1405, April 2007

[2] Formsma, O., Dijkshoorn, N., van Noort, S., Visser, A.: Realistic simulation of laser range finder behavior in a smoky environment. in "RoboCup 2010: Robot Soccer World Cup XIV", Lecture Notes on Artificial Intelligence series, volume 6556, p. 336-349, Springer, Heidelberg, March 2011.

[3] B. Balaguer, S. Carpin: Where Am I? A Simulated GPS Sensor for Outdoor Robotic Applications. Proceedings of the First International Conference on Simulation, Modeling and Programming for Autonomous Robots. (2008)

[4] Abbasi, Y.,et al.:.Rescue Simulation League - Virtual Robots 2011, Pasargad Team Description Paper – Robocup 2011. In: Proc. CD of the 15th RoboCup Intrnational Symposium. (2011)

[5] Dalal, N.; Triggs, B.; , Histograms of oriented gradients for human detection, Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on, vol.1, no., pp.886-893 vol. 1, 25-25 June 2005

[6] Herbert Bay, Andreas Ess, Tinne Tuytelaars, Luc Van Gool SURF: Speeded Up Robust Features, Computer Vision and Image Understanding (CVIU), Vol. 110, No. 3, pp. 346--359, 2008

[7] Cornelis, N.; Van Gool, L.; , Fast scale invariant feature detection and matching on programmable graphics hardware, Computer Vision and Pattern Recognition

[6] Inverse Kinematics

Workshops, 2008. CVPRW '08. IEEE Computer Society Conference on, vol., no., pp.1-8, 23-28 June 2008

[8] Gonzales and R. Woods Digital Image Processing, Addison wesley, 1992, pp 47 - 51, 185 – 187

[9] Bhaskar, H.; Werghi, N.; Al Mansoori, S.; , "Combined spatial and transform domain analysis for rectangle detection," Information Fusion (FUSION), 2010 13th Conference on , vol., no., pp.1-7, 26-29 July 2010

[10] Shafii, N.; Javadi, M.H.S.; Kimiaghalam, B.; , "A Truncated Fourier Series with genetic algorithm for the control of biped locomotion," Advanced Intelligent Mechatronics, 2009. AIM 2009. IEEE/ASME International Conference on , vol., no., pp.1781-1785, 14-17 July 2009