Newsletter of the Robotics Society Of India

Vol. 1, No.3, 2013

Report on the 1st International Conference of Robotics Society of India:

ADVANCES IN ROBOTICS -2013

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Advances in Robotics or in short AIR-2013 was held during July 4–6, 2013 at R&DE (Engrs.), Pune, a premier laboratory of Defense Research and Development Organization, Ministry of Defense, Government of India. This was the first international conference of the Robotics Society of India (RSI) which was established in 2011. AIR-2013 had attracted 105 full papers, of which 59 made it to the final stage after rigorous peer review process. All the papers were categorized into "Oral" and "Short-oral-cum-poster." The final proceedings of the conference will be brought out by the Association for Computing Machinery (ACM), and would be available online in the ACM digital Library.

Figure 1: The entrance and inside view of Leonardo da Vinci Hall

On July 04, 2013, the conference begun with the registration in the morning at 08:30 hrs. The inauguration program started with the welcome address by Dr. S. Guruprasad, Director of R&DE (Engrs.) in the Leonardo da Vinci Hall (Figure 1). It was followed by the address of Shri Manjit Singh, President of the RSI and DS, Director-DM&AG, BARC, Mumbai. The Chief Guest was Dr. R Chidambaram, Principal Scientific Advisor to the Govt. of India.

During the conference, there were three keynote lectures. They were delivered by eminent academicians from the USA, Italy and Japan. Prof. Seth Hutchinson, University of Illinois, USA delivered the first keynote address during the inauguration session on "Visual Servo Control: The First Quarter Century." On the second day, Prof. Paolo Porta, University of Parma, Italy presented his talk on "Efficient Sensing for Autonomous Driving." On the third day, Prof. G. Obinata, Nagoya University, Japan presented his keynote address on "Human-centered Robotics."

The conference had exhibition stalls showcasing the latest technologies in the areas of robotics and automation in India. It was inaugurated by the Chief Guest, Dr. R. Chidambaram on the first day at 12:00 hours. Live demos of different robots of DRDO, IIT Delhi's Programme for Autonomous Robotics, and other industries attracted a huge crowd of participants (Figure 2).

Figure 2: Eminent dignitaries at the exhibition hall during live demos

During the three days of the conference, all the papers were divided into several sessions according to research areas such as kinematics, dynamics, control and simulation of robots, autonomous intelligent systems, etc. In between the sessions, there was excellent arrangements of high tea where people were found interacting and discussing with each other. Posters were displayed at the Exhibition Hall and each poster presenter was given 3 minutes to highlight the main points of their poster. At the end of the first day, there was a cultural program featuring the seven dance forms of India, followed by a grand banquet dinner (Figure 3).

Figure 3: Cultural program and banquet dinner at officers' mess

On the second day, i.e., July 5, 2013, there were technical sessions on vision and other non-contact sensory systems, active sensory processing and control, machine learning and artificial intelligence for robotics, and robotics related hardware and software. It was followed by a unique session, where different experts from R&D/industry presented their research activities. In the evening of the second day, the General Body Meeting of the RSI was held, the office bearers of the next conference AIR-2015 were elected. Dr. Prabir K. Pal of BARC, Mumbai was chosen as the General Chair and was assigned to coordinate the venue and the dates.

On day three, July 6, 2013, papers were presented in the technical sessions of medical and assistive robotics, tactile and other contact sensory technology, man-machine interface and integration, bio-mimetic and bio-inspired robotic systems. On this day, the interactive poster session was also scheduled where students from different institutions presented their work at the exhibition hall. Two best paper awards and two Special Mention awards were declared during the closing ceremony.

This conference contributed to highlighting the various research areas and projects going on in various labs in the country and also served as a forum for interaction between robotics researchers. It provided a platform to the researchers to share and learn. The flame lit during AIR 2013 will be carried forward by the RSI to AIR 2015. Hope to see you there.

Mobile Robotics Laboratory (MRL) at the Department of Aerospace Engineering, Indian Institute of Science, Bangalore

D Ghose, IISc - bangalore

The Mobile Robotics Laboratory (MRL), which is a part of the larger Guidance, Control, and Decision Systems Laboratory (GCDSL), located at the Department of Aerospace Engineering, Indian Institute of Science, has been engaged in research on mobile robotics for the last Eight years. The focus of the laboratory is mainly on designing and implementing algorithms for multi-agent systems to be used in collective robotic applications. The ultimate objective of many of these algorithms is to make them suitable for use in a swarm of autonomous micro-aerial vehicles. However, as a first level implementation we use a mobile robotics platform. The following are the major contributions that have emerged from the work in MRL. Each contribution is followed by a single reference which is representative of several other publications on that topic.

Formations of Minimalist Mobile Robots

In order to take mobile robots closer to their biological counterparts, there is a need to further simplify the manner in which they currently perceive their surroundings, communicate with their neighbors, and compute their actions. The objective of this research work was to address the problem of synthesizing simple rules and local interactions at the individual robot level l so that pre-specified complex behavior emerges at the group level of a collection of autonomous mobile agents. This emergent collective behavior is used to perform certain spatial group-tasks. Specifically, we consider self-assembling of a group of mobile robots into grid, line, and wedge patterns. We introduce the notion of local-templates in which each mobile agent – capable of simple forward/backward movements and a clock-wise/counter clock-wise spin – actively encodes distinctive information into multiple non-overlapping regions of the surrounding environment in order to form pose-specific virtual links with similar minimalist agents in a local neighborhood. The resulting local patterns around each agent lead to the desired global formation. We built a robotic platform consisting of four wheeled-mobile robots, designed and built in MRL, that

are christened as Kinbots. They are similar in principle to Braitenberg vehicles and use simple perception/ interaction/ actuation techniques to achieve individual vehicle complexity and produce effective group behavior through cooperation. To validate the proposed approach, we demonstrate a column-formation task in computer simulations and physical experiments. The experiments done with kinbots are representative of various prominent stages in a group-formation task such as formation-achievement, maintenance, and response of formation movement to the presence of obstacles.

K.N. Krishnanand and D. Ghose: Formations of minimalist mobile robots using local-templates and spatially distributed interactions, *Robotics and Autonomous Systems,* Vol. 53, pp. 194-213, 2005.

Glowworms and Robots

We address the problem of multiple signal source localization where robotic swarms are used to locate multiple signal sources like light, sound, heat, leaks in pressurized systems, hazardous plumes/aerosols resulting

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Photo Gallery AIR 2013, Pune

Inauguration by Dr. R. Chidambaram, Principal Scientific Advisor to Govt. of India

Dignitaries on dais

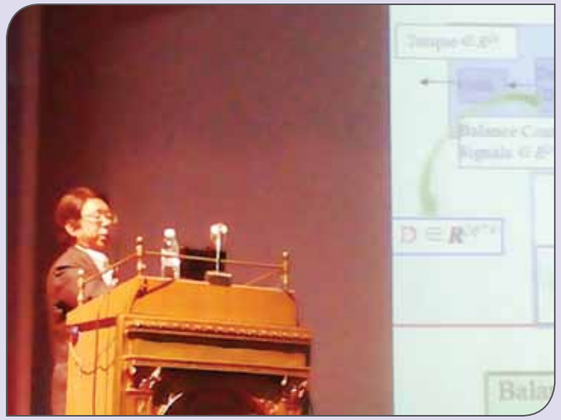
Shri Avinash Chander, Secy. Dept. Of Defence R&D, DGR&D and Scientific Advisor to Defence Minister

President of RSI: Mr. Manjit Singh delivering his address.

Dr. P. Porta of VisLabs during his keynote address

Dr. R. Chidambaram during his inaugural address

Prof. Seth Hutchinson delivering his Keynote address



Prof. G. Obinata during his keynote address

Audience during the opening ceremony

Exhibition hall, DRDO Pune

Speakers and Organizers

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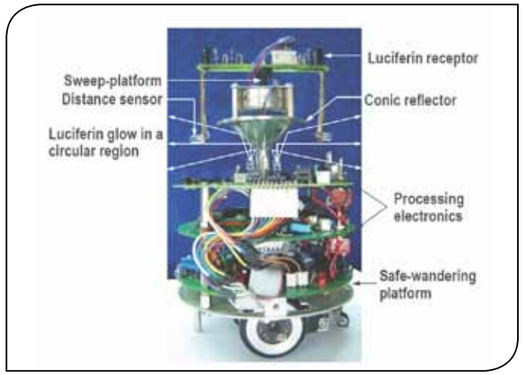
from nuclear or chemical spills, fire-origins in forest fires, hazardous chemical discharge in water bodies, oil spills,



deep-sea hydrothermal vent plumes, etc. We present a multi-robot system that implements a modified version of the glowworm swarm optimization (GSO) algorithm, which was inspired by the behaviour of glowworms and was originally developed in MRL to solve multimodal function optimization problems, for this purpose. The GSO algorithm uses a leapfrogging behavior for the basic search capability and an adaptive decision range that enables the agents to partition into disjoint subgroups, simultaneously taxis towards, and rendezvous at, multiple source locations of interest. Transition of agent behaviors from simulation to real-robot-implementation needs modifications to certain algorithmic aspects mainly because of the point-agent model of the basic GSO algorithm and the physical dimensions and dynamics of a real robot. Realization of each sensing-decision-action cycle of the GSO algorithm requires the robots to perform subtasks such as identification and localization of neighbors, selection of a leader among current neighbors, updating of the associated local-decision range, and making a step-movement towards the selected leader. Experiments in this regard validate each robot's capability to perform the above basic algorithmic primitives. Real-robot-experiments are conducted in the context of light source localization in order to validate the GSO approach to localization of signal sources.

K.N. Krishnanand and D. Ghose: A glowworm swarm optimization based multi-robot system for signal source localization, *Design and Control of Intelligent Robotic Systems (Eds. D. Liu, L. Wang, and K.C. Tan),* Studies in Computational Intelligence, Vol. 177, Springer-Verlag, pp. 49-68, 2009.

Collision Avoidance in 3-Dimensional Space

Avoidance of collision between moving objects in a 3-D environment is fundamental to the problem of planning safe trajectories for autonomous flying vehicles in dynamic environments. This problem appears in several diverse fields including robotics, air vehicles, underwater vehicles and computer animation. Most of the existing literature on collision prediction assumes objects to be modeled as spheres. While the conservative spherical bounding box is valid in many cases; there are other cases, where objects operate in close proximity, and a less conservative approach that allows objects to be modeled using analytic surfaces that closely mimic the shape of the object, is more desirable. We use a collision cone approach (previously developed only for objects moving on a plane) to determine collision between objects, moving in 3-D space, whose shapes can be modelled by general quadric surfaces. Exact collision conditions for such quadric surfaces are obtained to derive dynamic inversion based avoidance strategies.

A. Chakravarthy and D. Ghose: Generalization of the collision cone approach for motion safety in 3-D environments, *Autonomous Robots,* Vol. 32, pp. 243–266, 2012.

Broadcast and Rectilinear Decision Domain based Consensus Strategies

The aim of this work is to develop a computationally efficient decentralized rendezvous algorithm for a group of autonomous robots. The algorithm generalizes the notion of sensor domain and decision domain of agents to enable implementation of simple computational algorithms. Specifically, it uses a rectilinear decision domain (RDD) as against the circular decision domain assumed in earlier work. Because of this, the computational complexity of the algorithm reduces considerably and, when compared to the standard Ando's algorithm available in the literature, the RDD algorithm shows very significant improvement in convergence time performance. Analytical results to prove convergence and supporting simulation results and experimental results using LEGO robots are also obtained.

K. Das and D. Ghose: Multi-agent rendezvous algorithm with rectilinear decision domain, Trends in Intelligent Robotics (Eds. P. Vadakkepat and J.-H. Kim), Communications in Computer and Information Science, Vol. 103, Springer Verlag, pp. 162-169, 2010.

Frontier-Based Goal Seeking for Robots

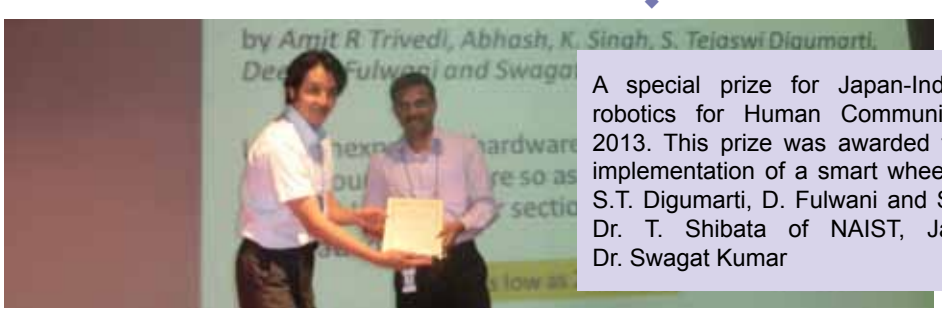
In this work, the problem of goal seeking by robots in unknown environments is considered. A frontier based

algorithm is proposed for finding a route to a goal in a fully unknown environment, where only the information about the goal region (GR), that is the region where the goal is most likely to be located, is available. The concept of frontier cells, which are on the boundary between explored space and unexplored Space, is used. A "goal seeking index" is defined for each frontier cell and used to choose the best among them. Modification of the algorithm is proposed with altered choice of frontier cells when wall like obstacles are encountered or when the robot falls in a "trap" situation, to further reduce the number of moves toward the goal. The algorithm is tested extensively in computer simulations as well as in experiments and the results demonstrate that the algorithm effectively directs the robot to the goal and completes the search task in minimal number of moves. The solution to the problem of local minimum is also addressed, which helps in easy escape from a dead-end or dead-lock situation. It is shown that the proposed algorithm performs better than the state of the art agent centered search algorithm RTAA*.

V. R. Jisha and D. Ghose: Frontier based goal seeking for robots in unknown environments, *Journal of Intelligent and Robotic Systems,* Vol. 67, Issue 3-4, pp. 229-254, September 2012.

Miscellaneous Work

Apart from the above, several other mobile robotics related work has been carried out or is under progress. Notable among them is to simulate swarming behaviour of rotorcrafts under a cyclic pursuit strategy using small toy helicopters controlled through laptops, and obstacle avoidance, target-following and swarming using quadrotors. Some work on vision-only based collision avoidance has been done using the concept of dynamic histogram switching and the work has been patented for use in robotic wheel chairs. A patent on using the GSO algorithm on robots operating in nuclear spill areas has also been proposed. Also, at present work on making a quadrotor pass through a jagged and irregularly shaped hole in the wall is under progress.



A special prize for Japan-India Friendship with a focus on robotics for Human Community was also presented in AIR 2013. This prize was awarded to the paper entitled 'Design and implementation of a smart wheelchair by A.R. Trivedi, A.K. Singh, S.T. Digumarti, D. Fulwani and Swagat Kumar. The picture shows Dr. T. Shibata of NAIST, Japan presenting the award to Dr. Swagat Kumar

Upcoming Events

"The 3rd Joint International Conference on Multibody System Dynamics (IMSD 2014) and The 7th Asian Conference on Multibody Dynamics (ACMD 2014)will be held on June 30 – July 3, 2014 at the Busan Exhibition and Convention Center (BEXCO) in Busan, Korea.

Important Dates

- Extended Abstract Submission Deadline: November 29, 2013
- Notification of Acceptance/Rejection: February 21, 2014
- Full Paper Submission(optional) Deadline: March 28, 2014
- Deadline for Early Bird Registration Fee: April 11, 2014
- IMSD 2014 - ACMD 2014: June 30 - July 3, 2014

Amongst many sessions related to multibody dynamics there will be sessions on Robotic Systems, Control and Mechatronics, and High Performance Computing. Readers of RSI newsletter are encouraged to submit papers and represent India in S. Korea!"

For further Information Please contact:

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