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EXTENDED ABSTRACTS

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Preface

The concept of CAST as Computer Aided Systems Theory was introduced by F. Pichler in the late 80's to encompass those computer theoretical and practical developments as tools for problems in System Science. It was thought as the third component (the other two being CAD and CAM) that will provide for a complete picture of the path from Computer and Systems Sciences to practical developments in Science and Engineering.

Franz Pichler, of the University of Linz, organized the first CAST workshop in April 1988, which demonstrated the acceptance of the concepts by the scientific and technical community. Next, the University of Las Palmas de Gran Canaria joined the University of Linz to organize the first international meeting on CAST, (Las Palmas February 1989), under the name EUROCAST'89 and proved to be a very successful gathering of systems theorists, computer scientists and engineers from most of European countries, North America and Japan.

It was agreed that EUROCAST international conferences would be organized every two years, alternating between Las Palmas de Gran Canaria and a continental Europe location, being later decided to celebrate them in Las Palmas. Thus, successive EUROCAST meetings took place in Krems (1991), Las Palmas (1993), Innsbruck (1995), Las Palmas (1997), Vienna (1999), Las Palmas (2001), Las Palmas (2003) and Las Palmas (2005), in addition to an extra-European CAST Conference in Ottawa in 1994. Selected papers from those meetings were published by Springer-Verlag Lecture Notes in Computer Science nos. 410, 585. 763,1030, 1333, 1798, 2178, 2809, and 3643 and in several special issues of Cybernetics and Systems: an International Journal. EUROCAST and CAST meetings are definitely consolidated, as it is shown by the number and quality of the contributions over the years.

EUROCAST 2007, to be held in the Elder Museum of Science and Technology of Las Palmas, February 12-16, continues with the approach tested in last Conferences as an International computer related Conference with a true interdisciplinary character. There are different specialized Workshops which, in this occasion, are devoted to 1.-Systems Theory and Simulation, chaired by Pichler (Linz) and Moreno Díaz (Las Palmas); 2.-Computation and Simulation in Modelling Biological Systems, chaired by Ricciardi (Napoli); 3.-Intelligent Information Processing, chaired by Freire (A Coruña); 4.-Computers in Education, chaired by Martín-Rubio (Murcia); 5.-Grid Computing, chaired by Volkert (Linz); 6.-Applied Formal Verification, chaired by Biere (Linz); 7.-Cellular Automata, chaired by Vollmart (Karlsruhe); 8.-Computer Vision, chaired by Álvarez (Las Palmas); 9.-Heuristic Problem Solving, chaired by Affenzeller (Hagenberg); 10.-Signal Processing Architectures, chaired by Huemer (Erlangen) and Müller-Wipperfürth (Hagenberg); 11.-Robotics and Robotic Soccer, chaired by Kopacek (Vienna); 12.-Cybercars and Intelligent Vehicles, chaired by Parent (Paris) and García-Rosa (Madrid) and 13.-Artificial Intelligence Components, chaired by Chaczko (Sidney).

XIII. Artificial Intelligent Components

Comparison of WiFi Map Construction Methods for WiFi POMDP Navigation Systems

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Abstract. The framework of this paper is the robotics navigation inside buildings using WiFi signal strength measure. In most cases this navigation is achieved using a Partially Observable Markov Decision Process (POMDP). In the localization phase of this process the WiFi signal strength is used as observation. The localization system works in two stages: map construction and localization stage. In this paper we compare three different methods for obtaining the WiFi map in the construction stage. The methods have been tested in a real environment using two commercial robotic platforms.

1 Introduction

For surveillance robots navigation over huge indoor environments design, in which the objective is to guidance the robot to a goal room using some low level behaviours to perform local navigation, a topological discretization is appropriate to facilitate the planning and learning tasks. A POMDP model provides solutions to localization, planning and learning in this robotic context. These models use probabilistic reasoning process to deal with uncertainties, very important in the case of WiFi localization sensors.

WiFi localization systems take advantage of the boom in wireless networks over the last few years. The WiFi networks have become a critical component of the networking infrastructure. Therefore the localization stage can determine the device location without any extra hardware in the environment. It makes these systems attractive for indoor environments where traditional techniques, such as Global Positioning System (GPS), fail.

In order to estimate the robot location, we propose to measure the WiFi signal strength of received packets in wireless Ethernet interface. This measure depends on the distance and obstacles between wireless access points (AP) and the robot. Unfortunately, in indoor environments, the WiFi channel is very noisy and the RF signal can suffer from reflection, diffraction and multipath effect, which makes the signal strength a complex function of distance [1]. To solve this problem, it can be used a priori WiFi map, which represents the signal strength of each AP at certain points in the area of interest. These systems work in two phases: map construction and estimation of the position. During [illegible] ways. In the estimation phase, the vector of samples received from each access point is compared with the WiFi map and the "nearest" match is returned as the estimated robot location. In this paper we compare three methods to obtain this WiFi signal strength map.

2 Implementation and Results

The Test-Bed environment was established on the 3rd floor of the Polytechnic School building, concretely in the corridor number 4 of the Electronic Department. We used two robots based on the 2AT platform of Activmedia Robotics.

First, the WiFi map was calculated using a typical loss path propagation model, this method required only a few seconds and it needed a slightly workman. Then, we used the manual training method by mean of positioning the robot along the several states in a manual mode, the robot took the WiFi signal samples to calculate the mean value at each state. This needed 9 hours and a half of an intensive man-work. Finally, we used an automatic training method based on a robust local navigation task to carry out the robot centred along the corridor and using a modified Expectation-Maximization algorithm proposed in a previous work [2]. The user only needed to launch the local navigation application with a slightly supervision during about 2 hours to ensure that the task was carried out correctly by the robot.

The three maps was used in the localization stage of the POMDP for testing the error percentage in this phase. The comparison of these methods is shown in Table 1.

Table 1. Comparison of WiFi Map Construction Methods

Method	Training Time	Man-Work (%)	Error Percentage(%)
Propagation model	< 30 sec	5	98
Manual	9 h 30 min	100	24
Automatic	2 h	10	8

References

1. P. Bahl and V. Padmanabhan, "Radar: A, in-building rf-based user location and tracking system," in *Proc. of the IEEE Infocom*, 2000, pp. 775–784.
2. M. Ocaña, L. Bergasa, M. Sotelo, R. Flores, E. López, and R. Barea, "Training method improvements of a wifi navigation system based on POMPDP," in *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2006)*. Oct. 2006, pp. 5259–5264.