

# NTU Robot PAL

## Team Description for RoboCup 2010

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**Abstract.** This team description paper describes the organization, research focus and ongoing work of the NTU Robot PAL team entering the RoboCup Standard Platform league in 2010.

### 1 Introduction

In 2009, we formed a small size team with only one faculty member and two students to participate in the RoboCup standard platform league (SPL) for the first time with Alderbaran Nao Robots. We made the quarter-final and the technical details of our 2009 team are available in [1]. The current team members consists of the following persons:

- *Chieh-Chih Wang* is an assistant professor in computer science and information engineering and the director of the Robot Perception and Learning Lab. He is the initiator of National Taiwan University RoboCup SPL activities since 2009. His research is in the areas of robot perception, computer vision and machine learning.
- *Shao-Chen Wang* is a master student in networking and multimedia. His research involves navigation, locomotion and localization. He had been a team member since 2009.
- *Chun-Hua Chang* is a PhD student in computer science and information engineering. His research involves SLAM in dynamic environments and tracking. He joined the team in 2010.
- *Po-Wei Wang* is an undergraduate student in computer science and information engineering. His research involves control, locomotion and planning. He joined the team in 2010.

The following sections describe the research focus and ongoing work.

## 2 Research Focus

Our scientific interests are driven by the desire to build intelligent robots and computers, which are capable of servicing people more efficiently than equivalent manned systems in a wide variety of dynamic and unstructured environments. We believe that perception and learning are two of the most critical capabilities to achieve our goals. The RobotCup Standard Platform League provides an excellent scenario for us to exploit and explore robot perception and learning.

### 2.1 Simultaneous Localization, Mapping and Moving Object Tracking

Simultaneous localization, mapping and moving object tracking (SLAMMOT) involves both simultaneous localization and mapping (SLAM) in dynamic environments and detecting and tracking these dynamic objects. Our SLAMMOT work [2, 3] provides a foundation for robots to localize themselves and to detect and track other teammates and opponents in the RoboCup scenario with a given map.

### 2.2 Probabilistic Structure from Sound

Microphone arrays are widely used for auditory perception in which the spatial structure of microphones is usually known or pre-calibrated. In practice, microphone array calibration can be tedious and other devices or means are required. The structure from sound (SFS) approach addresses the problem of simultaneously localizing a set of microphones and a set of acoustic events that provides a great flexibility to calibrate different setups of microphone arrays. Based on our recent work on probabilistic structure from sound using uncalibrated microphones [4, 5], the onboard microphones of the robots could be used not only for communication but also for localization.

### 2.3 Interacting Object Tracking

Interactions between targets can be used to solve the challenging occlusion problem in multitarget tracking, and to provide higher level scene understanding [6, 7]. It should be feasible to provide a means to recognize interactions among robots and higher level game strategies based on our interacting object tracking framework.

### 2.4 Navigation

Navigation plays a key role in RoboCup. The nearness diagram (ND) navigation method and the dynamic window approach (DWA) are two of the most popular navigation approaches in the literature. We have proposed a self-tuning ND navigation approach [8] to obtain smoother robot trajectories and a DWA\* approach [9] to determine the optimal control policies.

## 2.5 RoboCup SPL

Following the team report and code release 2008 of B-Human team [10], we got familiar with the Nao robots and incrementally constructed our software system. We constructed the ball and goal detection module, the robot pose estimator, the walking and kicking engine which are described in [1].

## 3 Ongoing Work

Based on our previous academic contributions and RoboCup SPL accomplishments in 2009, we are currently working on the following tasks.

### 3.1 Robot Detection

As collaboration is one of the most important factors to make the robot team more intelligent and efficient, the ability to detect and recognize robots, either allies or enemies, is critical. In addition to the ball and goal detection modules, the robot detection module is being developed.

### 3.2 Monocular SLAMMOT

Our previous work demonstrates the feasibility of SLAMMOT mainly using laser scanners. Recently, we have completed an augmented-state SLAMMOT system using a single camera in which 3D poses of the robot and moving objects, and 3D locations of stationary objects are estimated. With the detection results of field lines, goals, the ball and robots, we are modifying this monocular SLAMMOT system to accomplish the localization, and tracking tasks with the use of Nao's cameras in this competition.

### 3.3 Localization using Onboard Microphones and Speakers

In addition to vision-based localization, we are implementing sound-based localization using the onboard speakers and microphones based on our probabilistic structure from sound approach. Vision- and sound-based localization modules would be fused to provide more robust pose estimates.

### 3.4 Motion

While designing more effective and robust walking and kicking patterns, we are exploring the possibility of omnidirectional kicking and passing.

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