I. Intent to Participate

The Spelman College SpelBots intend to participate in the RoboCup 2007 Atlanta Four-Legged Competition if selected by the technical committee.

In 2006, we were grateful to compete in the RoboCup 2006 Four-Legged Competition in Bremen, Germany. Our team improved upon its performance from 2005 and in 2007 we are ready to make a much greater improvement. Our improvement last year is most noted in the point differential from 2005 to 2006. Last year we only missed winning our intermediate round match by a score of 0:1 after making some improvements to our vision system and improving the speed of our gait. We hope that the further improvements outlined in this technical application and the posted video will demonstrate to the RoboCup 2007 Technical Committee our ability to be even more competitive and allow us to compete in this year’s tournament to be held in our hometown of Atlanta, Georgia, USA. We also anticipate planning to compete in future Legged RoboCup competitions based on the new robot platform that is yet to be announced.

II. Team Information

The SpelBots were formed to give Spelman undergraduates the opportunity to learn robotics and artificial intelligence while participating in research. Spelman College is a historically black, all-women undergraduate college located in Atlanta, Georgia USA. The SpelBots involvement in RoboCup has helped generate interest within our community in robotics and artificial intelligence. The SpelBots conduct their research in the AI, Informatics and Robotics (AIR) Lab in the Department of Computer and Information Science at Spelman College.

The SpelBots team members are as follows:
1. Primary Contact: Andrew B. Williams, Ph.D. Director,
Spelman College SpelBots
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2. Andrea Roberson, Captain, Email: Roberson.andrea@gmail.com
3. Ashley N. Johnson, Co-Captain, Email: anjohnson1@gmail.com
4. Melissa Blakey, Member, Email: Melisa.2b@gmail.com
5. Katrina Stewart, Member, Email: kstewart@spelman.edu
6. Whitney O'Banner, Member, Email: wobanner@gmail.com
III. Technical Report – Statement of Research Interests and Results
   A. Broader Research
   The SpelBots RoboCup efforts are linked to our broader research in multi-
   agent/multi-robot teamwork (Thomas, Howard, Williams 2005) and multi-agent ontology
   learning (Williams 2004). Briefly, we are researching using an auction-based system
   with intelligent bidding to allocate tasks efficiently among robots in the multi-robot
   routing domain. Multi-robot routing domains are a class of problems in which a team of
   robots must visit a given set of locations so that their routes are optimized based on
   certain criteria. Our use of cognitive robotics based vision primitives will be used to
   extend our research in multi-agent ontology learning in which we plan to have our robots
   learn visual concepts based on learning from example concepts within a multi-robot
   system. The rest of this report describes our short term research goals directly related to
   the Four-Legged RoboCup competition.

   B. Localization
   This year we have made progress in implementing localization using dead reckoning
   and a particle filter. First, we have implemented a method to track and display its
   position by creating a behavior called DeadReckoning.h. This code allows the AIBO to
   record its current position and update its new position every half a second. In order to
   track the positions, it first records parameters in the locomotion events including the
   forward velocity (x), sideways speed (y), turning speed (a), and the time that elapsed
   since the last event. It then stores the information from the current readings and the
   previous readings. The distance moved for each the x and y values are calculated in the
   formula:
   \[
   \text{Distance moved} = \frac{(\text{current time} - \text{previous time})}{1000.f} \times \text{prevx} \text{ or prevy};
   \]
   The distance moved for both the x and the y are used in a formula to create a specific
   point.

   Next, the robot makes use of a C++ class we are implementing called, Locate.h.
   Locate makes use of a particle filter to track its position within the robot’s world. The
   particle filter that we are using is a new feature in Tekkotsu that allows the robot to detect
   its position within a world based on its movements as well as what it sees. Locate also
   calls a class in Tekkotsu called MapBuilder and creates a world map (i.e. the entire
   environment) and a local map (i.e. the robot's range of sight). Modifications and
   adaptations are required to the current implementation of the MapBuilder for use in real-
   time soccer. The robot uses Locate.h to combine all these features along with
   DeadReckoning to track and map its position in an environment. The world map is
   created in code and remains static. The local map is dynamic and updates as the robot
   changes its position. The robot tracks its movements and updates its position on the world
   map as it moves.

   C. Robot Vision
   We are continuing to use Tekkotsu for low level vision and adding our own high level
   vision and decision making. We are utilizing the dual coding vision representations that
   uses CMVision to extract regions before translating them into dual-coding data
structures. Our high-level vision takes advantage of these new dual-coding primitives to represent and recognize markers, goals, and the ball, while filtering out the noise from the surrounding environment. In RoboCup 2006, we began to use the new dual coding vision representations and will take advantage of their use for improving our localization. We plan to take advantage of new Tekkotsu vision related classes such as the new MapBuilder. However, we need to adapt it to be used in a real-time soccer environment since Tekkotsu is only a general purpose robot programming framework.

D. Team Strategy
The team strategy for the SpelBots this year consists of four key points: teamwork and communication, maintaining balance on the soccer field (i.e. no intra-team interference), automatic placement of the dogs using localization, and setting plays, or strategic patterns, in order to score goals. Communication is a crucial part of our strategy; we are aiming to have the robots to function as a unit, or actual team, as opposed to functioning individually as we have had in the past. We are working to implement a simple agent communication language to allow our robots to communicate with each other in order to ensure better and more accurate passing, be aware of each other’s placement on the field, and react to their teammates’ positions on the field. The latter leads to the second part of our strategy, which is to maintain balance on the field.

Since it is essential that our robots remain spread out so that we can use the open areas of the field to our advantage we are making this part of our strategy. When all of the robots are spread out, it is easier for them to cover all positions on the field, as opposed to being cluttered in the center of the field where they will not be able to react as quickly if the ball moves towards the corners or sidelines.

Localization is key because we would like for the robots to be able to initiate their positions on the field without us having to physically position them. This is a small but important part of our team strategy because we would like for the robots to be able to know where they should be starting the game and also be able to begin the game closer to their opponents’ goal. The final part of our four-point strategy is to set up plays in order to have more stability and consistency with scoring. If we can establish set plays or routine patterns that are effective for scoring, the robots can execute these plays repeatedly and hopefully score more goals during the actual competition. Routine plays are important because they will greatly improve the robots’ consistency if they are executed correctly and effectively.

E. Motion
To improve our robot’s kicking ability, we will be in experimenting with new motion sequences. We are adjusting and improving the timing of the kicks using a combination of vision and infrared sensors to make more effective kicks. We are experimenting with using a variety of kicks in different game situations to be able to score more frequently.

F. Locomotion
We are continuing to make use of the University of Pennsylvania walk engine to overcome our gait speed limitations we had a couple of years ago. Tekkotsu currently provides the walk engine of the UPennalizers. No new innovations in our locomotion are planned for this year’s RoboCup.
IV. Statement on Code Reuse
The SpelBots have developed their code on top of the Tekkotsu platform (www.tekkotsu.org), which originated from Carnegie Mellon University’s CMPack’02 software developed by Dr. Manuela Veloso’s group. The Tekkotsu platform is a general robot programming framework and is not a robot soccer platform. To our knowledge, the SpelBots were the only team to use Tekkotsu in RoboCup 2005 and probably RoboCup 2006.

V. Relevant Publications


VI. Video Submission
The video submission of the SpelBots for the RoboCup 2007 Qualification can be found at http://www.spelman.edu/~spelbots/SpelBotsRoboCupQual2007.mov or http://www.spelbots.org/SpelBotsRoboCupQual2007.mov (we are currently experiences problems with our College’s server so we are posting this in two locations). This video is best displayed using Quicktime http://www.apple.com/quicktime/download. Please contact Andrew Williams at jayhawkeye@gmail.com if you experience any technical difficulties when viewing this video.

What you will see in the approximately two-minute long video illustrates several improvements from a year ago:
• Improved goalie reaction to the ball and goal defense.
• A turn-and-shoot maneuver that we are working on perfecting.
• More effective attacker scoring.
• Scoring via teamwork.

VII. Code Comparison
We are re-using only the walk engine from the U. Penn 2004 RoboCup team and therefore we are not doing a DIFF for the entire U. Penn code and SpelBots code.

VIII. Travel Support Commitment
Please find attached a letter of commitment for funding support for RoboCup 2007 from Spelman College President Beverly Daniel Tatum. Spelman College receives funding from the NASA Jet Propulsion Lab, The Boeing Company, and General Electric.
Transmission via electronic mail

February 13, 2007

International RoboCup 2007 Four-Legged Robot League Technical Committee

Dear Members of the Technical Committee:

It is my pleasure to provide this letter of commitment to support the participation of our Spelman College SpelBots team to compete in the International Four-Legged RoboCup Competition, July 1-10, 2007 in Atlanta, GA. Since RoboCup 2007 is being held in Atlanta where Spelman College is located, no international travel support is required if the SpelBots are selected to compete this year.

At Spelman College, we continue to enthusiastically support our SpelBots' participation in RoboCup and we are excited about their improved performance in the 2006 RoboCup in Bremen, Germany last year. We hope that they will have an even greater performance in front of our local community in Atlanta, Georgia if selected to compete.

In the event that our SpelBots team is selected to compete in Atlanta at RoboCup 2007, the College will cover the costs of registration fees, meals, and local transportation as needed for our two Spelman College faculty members and six Spelman students.

Thank you for your consideration for our participation in the 2007 RoboCup Atlanta Four-Legged RoboCup competition.

Sincerely,

Beverly Daniel Tatum, Ph.D.
President
btatum@spelman.edu