# Interface for Monitoring and Interacting with Multi-Terrain Robot Teams

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**Abstract**

Previous research on human-robot interfaces has been mainly concerned with interaction between one person and one robot or software agent. Yet, there are many scenarios in which multiple human-multiple robot interactions are possible, such as with teams of rescue robots, combat robot teams, or surveillance robots. Our work seeks to turn a fast-paced interactive multi-agent system (Gamebots) into an interface where multiple researchers monitor and interact with teams of multi-terrain robots. Gamebots (figure 1) consists of a commercially developed 3D graphics engine Unreal Tournament (UT), which has been extended and enhanced to provide the important capabilities required for multi-agent research. It supports humans-as-agents, thus allowing multi-agent researchers to investigate scenarios involving human-agent competitions and collaboration.

## Developing Human-Robot Interfaces

To make human-robot interaction more effective when collaborating in tasks, both the user interface and the autonomous robots must be design to specifically handle the issues that arise when multiple human operators must interact with teams of robots to perform tasks, such as urban search and rescue (USAR). We are in the preliminary stages of developing a new interface that will allow multiple researchers the ability to simultaneously interact with multiple physical robots and software agents within a 3D virtual environment, Gamebots[Adobbati]. This ability will greatly facilitate collaboration between the robots and researcher. The task of USAR is very complex and dynamic, and interacting with the robots can be very challenging. In creating this interface, we face many challenges, such as, developing a method to combine the information gathered by all the agents about the actual physical environment in order to accurately represent it in the virtual environment.



Figure 1: screenshot of Gamebots' wizards 3D virtual world

## Gamebots System

Test environments and problems like chess, Phoenix [Cohen], and RoboCup [Kitano] have resulted in significant improvements to the sciences of artificial intelligence and multi-agent systems. Indeed, the usefulness of having a complex, dynamic multi-agent environment as a research infrastructure has been pointed out explicitly in [Gasser] and [Hanks]. Most existing infrastructures are designed to support specific tasks under a single environment, and rarely support human-as-agents in the environment.

Unlike other standard multi-agent systems, Gamebots allows multiple human players to interact with the agents in a 3D virtual environment, thus providing the opportunity to study human team behavior, and to construct agents that collaborate with humans. The core of the Gamebots project is a module for UT that allows characters in the game to be controlled via network sockets connected to other programs (see figure 2). The Gamebots server feeds

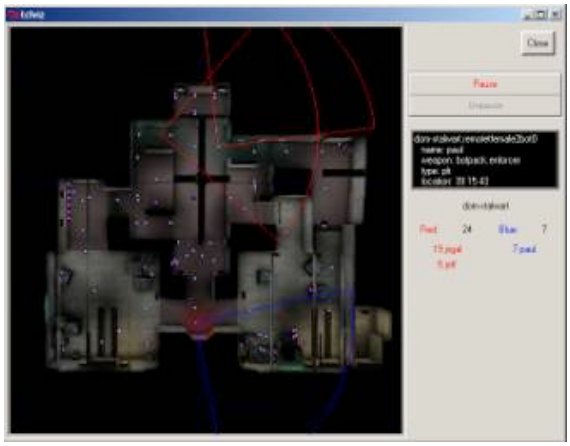

Figure 2: 2D auxiliary visualization tool

sensory information for the characters over the network connections. Based on this information, the client program can decide what actions the character should take and issues commands back over the network to the game to have the character move, shoot, or talk. Agent programs must display advanced AI and MAS capabilities to perform successfully -- they must plan paths, learn a map of their 3D environment, use resources available to them, coordinate and collaborate with their teammates, and engage in strategic planning which takes their adversaries into account.

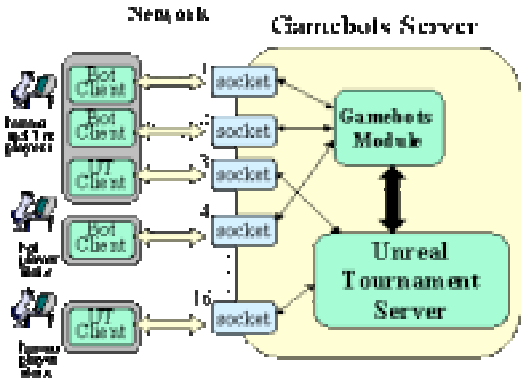


Figure 3: Gamebots architecture

Unreal Tournament falls into a category of video games known as first-person shooters, where all real time players (currently a maximum of 32) exist in a 3D virtual world with simulated physics and a variety of tools (often weapons) that give the players additional abilities. As implied by 'first person' in the genre's name, every player's senses are limited by their location, bearings, and occlusion within the virtual world. Developers can extend the existing games, or implement new ones using UnrealScript. UnrealScript is a C++ based scripting language that handles all game logic and object interaction under Unreal Tournament while the main game engine handles the hardcore work like ending scenes and simulating physics. UnrealScript can also be used to build small *mutator* scripts that implement small tweaks, such as adding or replacing world items, adjusting physics parameters, or changing item effects. Such mutators can be added at runtime to any existing game type, including the those for Gamebots. The Unreal Tournament server implementations exist for Windows, Linux, and Macintosh. Additionally, the use of an open network protocol means that client implementations are not bounded by platform and can often integrate easily with existing intelligence engines.

## Current Status

We are in the initial stages of this project to use Gamebots as an interface for monitoring and interacting with multi-terrain robot teams. Currently, we are in the process of interfacing Gamebots with a team of urban search and rescue robots consisting of four legged robots, one wheeled robot and two aerial robots. The team monitors the indoor environment of an office building. Other challenges will be to design the interface to allow researchers to adjust the autonomy of the agents, ranging from completely autonomous to teleoperation. We also plan to further enhance the 2D auxiliary visualization tools with new features, such as the displaying of vital task statistics for real-time analysis and planning.

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