GRAVEL Seed Grand Proposal

Investigating the Use of Computer Game Technology in Robot Training

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January 14, 2005

Introduction

Virtual environments have been shown to be capable of accurately representing many real world scenarios. This is a proposal to investigate the use of virtual environments created using commercial gaming technology in the training of robot operators. Many problems associated with robot operator training can be reduced or eliminated using a virtual approach and many new opportunities may be offered by this system. While they may never fully replace real life training, we believe that games simulating robotic use can become an important tool for training robot operators.

Description

In order to take advantage of the capabilities offered by robots, operators must learn a completely new set of skills. These skills include understanding the robots condition by interpreting sensor data, adapting to the view provided by a tele-operated robot, and recognizing the capabilities and limitations of the robot they are operating. Even these basic skills can be difficult and counter intuitive. Currently, these skills are taught as part of a multi day training course taught by a professional instructor. More specific or advanced training occurs at one of a few specialized robot training courses around the country.

The training mentioned above can be improved by the use of simulation games. Many of the skills described are similar to those used in common computer and video games. Computer games often give players limited knowledge of their surroundings due to limitations in the interface. This includes limited field of view, resolution and image quality. These are similar to the difficulties involved with interpreting the view provided by a tele-operated robot. In order to supplement this view and give the operator a better understanding of the robot's condition and environment, a variety of sensors are used. Interpreting this data is similar to reading graphics for health, energy, resources or movement found in computer games. In computer games, players are often required to utilize unique skills and abilities (like the ability to fly) in order to overcome obstacles, in other situations, players must find a way to overcome difficulties caused by their limitations with how they may interact with their environment (like the inability to climb a chain link fence). Because of the similarities between robot operation and computer games, we believe that game simulations can be effective in training robot operators.

Virtual training provides several benefits over traditional instruction. The first is that virtual training is free of the dangers to both people and equipment associated with operating a robot. This means that a novice user can gain experience before operating an actual robot, and an adept user can practice more risky scenarios without any real risk. Virtual training also allows users to easily train in a variety of scenarios. Even the most bizarre and unlikely scenarios can be created in a virtual environment and rehearsed as often as the user wants. Real world locations and obstacles can also be simulated using a game. Previously, robot operators would have to use the equipment or facilites available, or visit a specially designed training center. With a simulation, these real world locations can be recreated down to almost the smallest deateal at only a small fraction of what was spent to build them in the real world. With virtual robot simulations, robotic training can occur at any time in any place and very cost effectively. We feel that the ideal situation to test this would be a factory setting. Robots have attained widespread use in modern factories. Therefore, there will be a number of unique applications to use for testing, and any advancements will have significant benefits to the industry. In addition, the factory setting is more straight forward than other robotics applications. Because there are fewer unpredictable events in the factory setting, a factory robot simulator would be easier to accurately create. The effectiveness of robot operation games for training can be more quantitatively evaluated. Finally, there is a good possibility of attracting additional sponsors to further this research.

With today's commercial gaming technology, common robot environments can be accurately simulated using only a personal computer. Games such as “Half Life 2” not only incorporate powerful rendering engines to generate realistic looking graphics, but have powerful physics engines to make them feel real when played. This means that the view an operator sees can be made to look almost exactly like the view seen from a tele-operated robot. In addition, objects the user interacts with behave like they would in real life. Objects in game behave as their real life counterparts do by adhering to the laws of momentum, energy and friction. In order to provide this level of realism, “Half Life 2” as well as 28 other titles which debuted in 2004 use the Havok Game Dynamics toolkit. This allows game developers to incorporate high level physics into their games. These powerful tools are available to researchers through a variety of editing tools packaged with the game. Though originally provided to create new game levels, these tools give researchers direct access to powerful physics and rendering capabilities until now only available as part of complex simulation programs.

Broader Potential

We hope to expand this project to deal with other robotics applications. One field of particular interest is search and rescue operations. It can be difficult to train in real life for all the different scenarios a search and rescue robot may encounter. Unlike the factory setting, search and rescue can be highly unpredictable. There is no guarantee that the ground is stable, or that the structure will not further collapse. These hazards can be modeled using existing game technology but creating events that are truly unpredictable will be difficult to accomplish. In addition, this situation introduces hazards which are especially dangerous to robots. Water and radio black out zones can damage the robot or make it act unpredictably if these situations are not planed for in advance. These situations will be difficult to simulate because they depend on electrical and electro magnetic characteristics of the robot and its environment rather than the physical characteristics current physics engines are designed to simulate.

This system could also be expanded for use in testing robot designs. Once an operator has become proficient at robot control, the design of the robot can be modified and evaluated. By changing the mechanical properties of the robot, it can be optimized to accomplish a specific task with greater efficiency. The specifications of the robot can be quickly changed in a virtual game environment by altering the parameters of the model used by the game. The effectiveness of this design can then be evaluated, and further modifications can be made.

Additional game elements can be added to the training simulation. Obstacles can be made non-random so that they specifically follow the user or appear at the worst possible times. This is important because the events many users will train for will be the random obstacles which are difficult to consistently recreate in a real world setting.

We hope this research will show that commercial gaming technology can have many valuable uses outside outside of entertainment. By harnessing the technology used to create today's high end games, researchers can easily gain access to powerful physical and graphical rendering tools. Training simulations can be created using these tools which would allow users to safely train in a wide variety of scenarios. By studying the effectiveness of these simulations, we can evaluate the use of commercial gaming technology in research and industry.

Budget

The total amount requested is $2500. $2000 will be used to hire a researcher for this project. In addition, $500 will be used to purchase or upgrade a computer to be used in this research as well as to purchase the needed software.

References:

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