

EVALUATION OF GAME-BASED CONTROLS FOR ROBOT OPERATIONS

Objectives

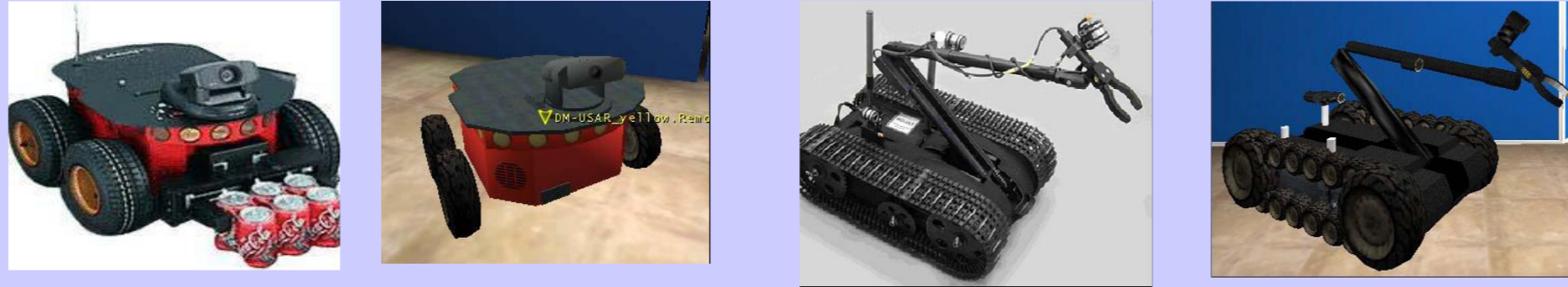
The objective of this project is to investigate the effectiveness of using game-based modes of controls for robots in an Urban Search And Rescue scenario with a virtual test bed. The three modes include direct input from the keyboard, point-and-click via a virtual control panel, and direct input from a gamepad controller

Virtual Test-Bed

A virtual test-bed in the form of computer simulation was used to model USAR robots and environments. The virtual test-bed was developed using USARSim, a high fidelity mobile robot teleoperation simulation software that employed the Unreal game engine, provided a highly realistic visual rendering and physical modeling.



The Robots



Industrial and Systems Engineering

Supervisors:
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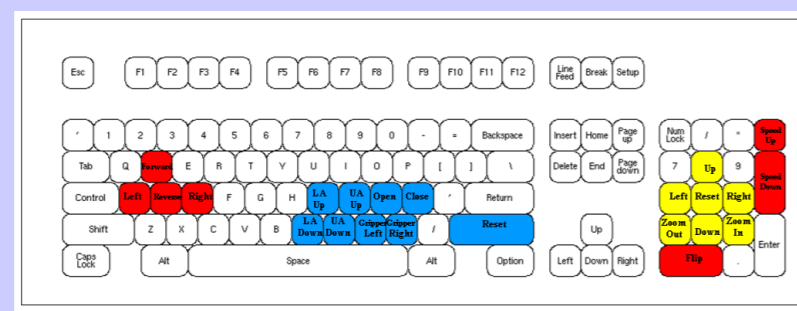
Members:
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Modes of Control

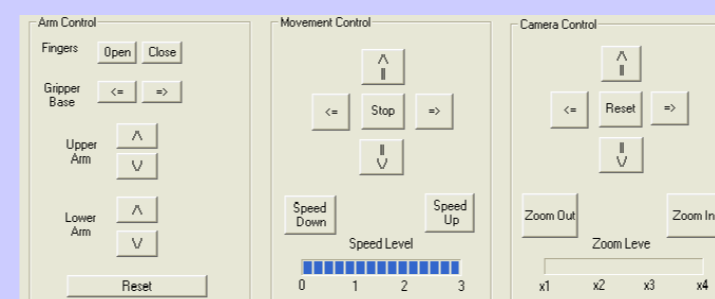
Direct Input from Keyboard

Operators could control the robot's functions by depressing selected keys on the keyboard. The choice of keys to be used was obtained by gaining inspiration from a variety of popular first-person shooter computer games.



Mouse Control via Point-and-click on a Virtual Console

A virtual console was incorporated into the control program to enable control of the USAR robots using a mouse by clicking on the virtual buttons. Such a mode of control is often used in strategy games, where gamers use only mouse functions to play.



Gamepad

Logitech Dual Action 2 gamepads were chosen as such gamepads are widely used in video game consoles. In particular, these gamepads are commonly used in simulation games, as their design allow gamers to control a wide variety of functions from a single device.

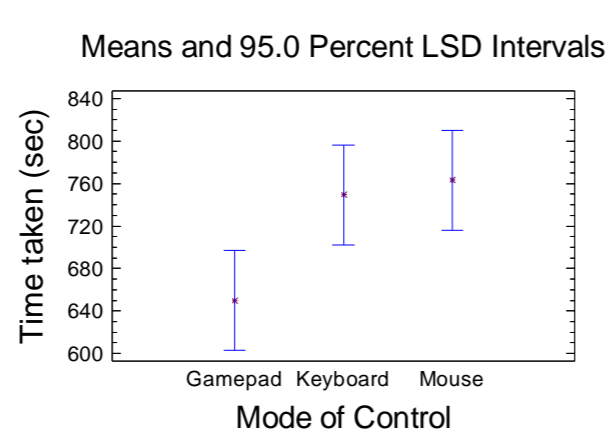


Experiments

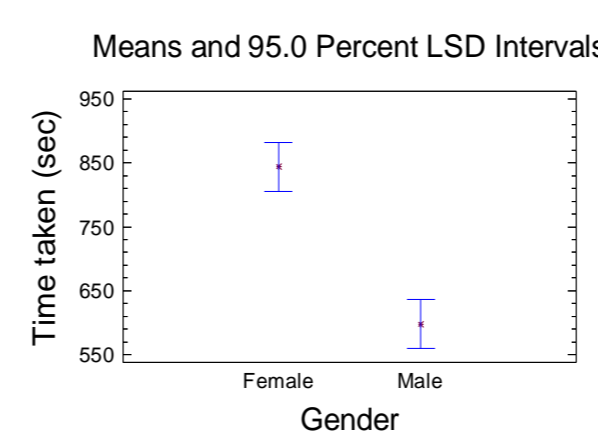
The 60 test subjects were divided into 3 equal groups, with each group using one of the 3 control modes to be tested. The experiment was conducted at the IBM On Demand Supply Chain Solution Centre of the Industrial and Systems Engineering Department at the National University of Singapore. The participants were also asked to complete a questionnaire before the experiment to obtain some background information and also to assess their level of gaming experience.

Experiment 1

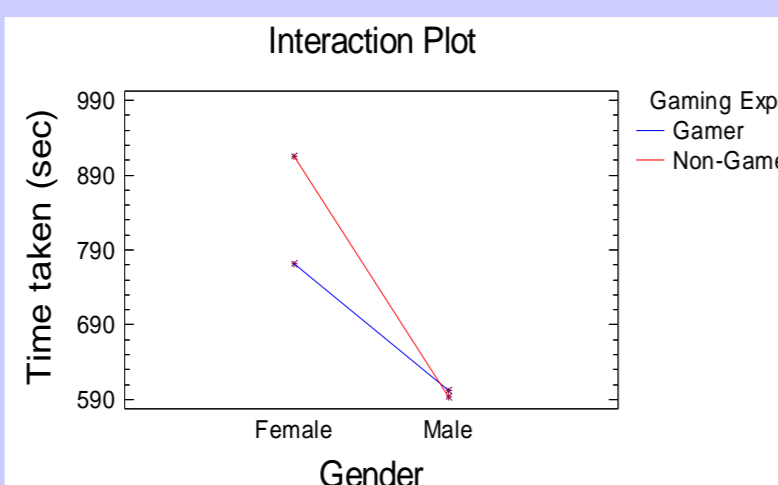
The USAR scenario for the P2AT mission attempts to re-create a disaster scene in a building, with collapsed walls, numerous obstacles, dim lighting and bodies of casualties. This mission required subjects to maneuver the P2AT through the disaster environment, identifying casualties and indicating their locations on a blueprint of the area provided to them. The disaster area was designed such that there was a unique path that subjects would take, and every subject would have to negotiate the same obstacles along this path.



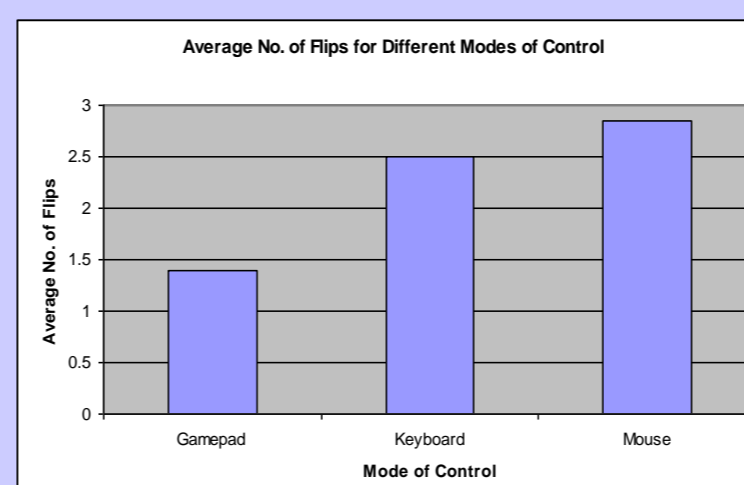
Gamepad produced significantly better results than keyboard or mouse, which were insignificantly different from each other.



Males fared significantly better than females.



Presence of interaction effect between gaming experience and gender is shown. Gaming experience only results in significantly different performance for the females participants and not for males



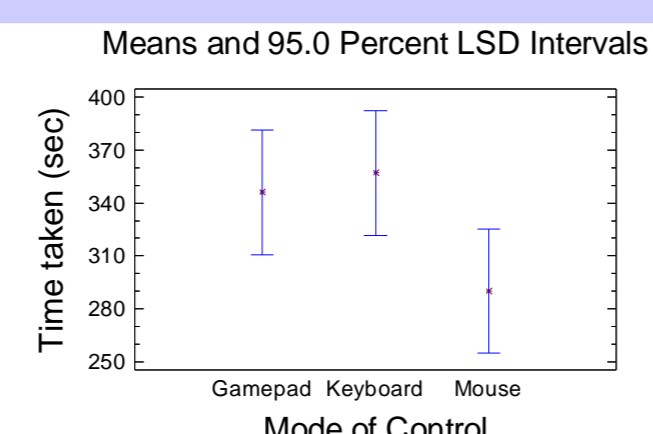
Game pad resulted in the least number of rollovers



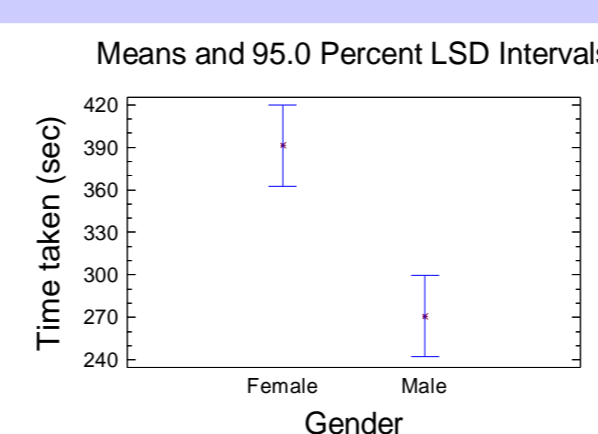
Results

Experiment 2

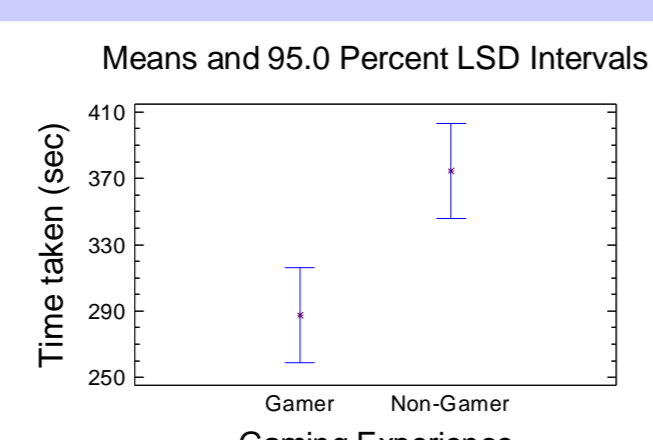
This scenario consisted of a wall with an aperture between the robot and a casualty in a disaster scenario, and subjects were required to control the arms of the Talon such that the camera on its grippers could be inserted into the aperture to view the situation on the other side. The subjects were then asked to describe the casualty.



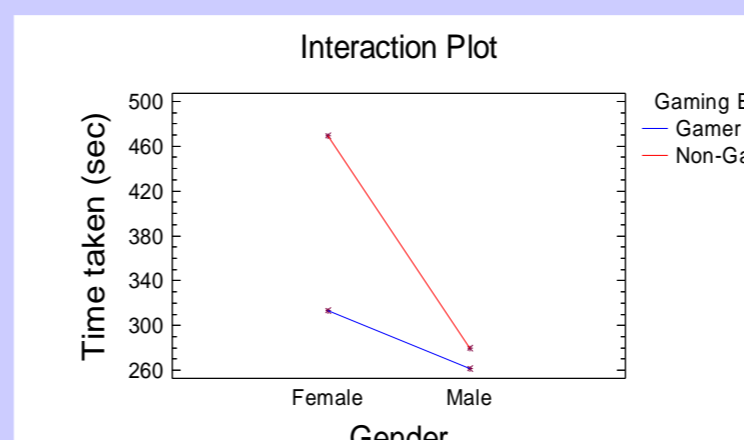
Insufficient evidence to suggest there is significant difference in the results produced by the three modes



Males fared significantly better than females



Participants with gaming experience performed significantly better than those without



The difference between male gamers and female gamers is not as pronounced as the difference between male and female non-gamers



Observations

The game pad allows the users to utilize both hands for the purpose of navigation and negotiating obstacles as opposed to the mouse which allows only one input at a time. The keyboard presents potential for confusion as there are too many keys adjacent to the important ones. As such, the game pads produce generally better results for experiment 1.

The nature of experiment 2 requires only 1 input command at 1 time. As such, there were no significant advantages harnessed by using either controls.

The effect of gender has been very significant in both experiments. Further work should be carried out to explore these effects.