הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Thursday, December 7 2023 at 13:00, D. Dan and Betty Kahn Building, Room 217.

Design, Simulation, and Experiments in Push Manipulation of Aggregates and Manipulator Geometry Analysis for Autonomous Construction Site Preparation

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Autonomously controlled vehicles are growing in popularity in the field of construction. Research on autonomous control of construction vehicles aims to enhance efficiency, safety, and productivity by developing technology that allows machines to intelligently navigate and execute tasks without constant human intervention. One area in the construction field that has seen little research in the way of automation is site preparation. This includes tasks such as the removal of debris and vegetation, earthwork to level the terrain, and excavation of the structure foundations. Leveling the site terrain generally requires the movement of aggregates such as soil. This is typically accomplished using large vehicles that produce motion by push manipulation using a front-mounted shovel.

In current construction sites, these machines are typically driven and controlled by humans. As the aggregates are pushed by the vehicle's shovel, the shape and orientation of the shovel also needs to be controlled in addition to the movement of the vehicle itself. While some research has been done to automate the process, not much exists relating to path planning for the movement of these aggregates. This research seeks to develop a model predicting the way in which the motion of aggregates is affected by the movement of the vehicle as well as the shape and orientation of the shovel. With this knowledge, a controller can be developed to intelligently move aggregates to a desired location by controlling the movement of the vehicle and shovel.

In order to develop this model, experiments are run in small scale using scaled aggregates and shovels, controlled by a commercial 6 Degree of Freedom robot. Different shovel shapes and paths are investigated in order to determine their effect on the aggregate movement. Pictures of the aggregates are captured before and after the shovel passes, and image recognition is applied to track their motion. From the results of these experiments, a physics-based simulator is developed.

Using this simulator, trials can be run in bulk and more variables can be examined to determine their effects on the movement of the aggregates. These variables include among others the curvature and length of the shovel's path, and the size and density of the aggregates. With the relationships determined in the simulations, a model is created which successfully predicts the aggregate movement in significantly less time than using the physical simulator, allowing for a path planning algorithm to determine the needed motion of the vehicle in a much shorter amount of time.

Seminars Coordinator: Assoc. Prof. Gal Shmuel.