abstract
The construction industry is very mundane and tiring for workers without the assistance of machines. This challenge has changed the trend of construction industry tremendously by motivating the development of robots that can replace human workers. This thesis presents a computed torque controller that is designed to produce movements by a small-scale, 5 degree-of-freedom (DOF) robotic arm that are useful for construction operations, specifically bricklaying. A software framework for the robotic arm with motion and path planning features and different control capabilities has also been developed using the Robot Operating System (ROS). First, a literature review of bricklaying construction activity and existing robots’ performance is discussed. After describing an overview of the required robot structure, a mathematical model is presented for the 5-DOF robotic arm. A model-based computed torque controller is designed for the nonlinear dynamic robotic arm, taking into consideration the dynamic and kinematic properties of the arm. For sustainable growth of this technology so that it is affordable to the masses, it is important that the energy consumption by the robot is optimized. In this thesis, the trajectory of the robotic arm is optimized using sequential quadratic programming. The results of the energy optimization procedure are also analyzed for different possible trajectories. A construction test bed setup is simulated in the ROS platform to validate the designed controllers and optimized robot trajectories on different experimental scenarios. A commercially available 5-DOF robotic arm is modeled in the ROS simulators Gazebo and Rviz. The path and motion planning are performed using the Moveit-ROS interface, and are also implemented on a physical small-scale robotic arm. A Matlab-ROS framework for execution of different controllers on the physical robot is described. Finally, the results of the controller simulation and experiments are discussed in detail.