BIOGRAPHICAL SKETCH

Stephen Zuccaro was born in Winchester, Tennessee on December 20, 1991. He moved to Lynchburg, TN where he spent the majority of his childhood and adolescence. In 2014, he graduated with his Bachelor's Degree in Mechanical Engineering from Tennessee Technological University in Cookeville, TN. He is presently a graduate student researching the kinematics and dynamics of mobile robots. He will graduate with a M.S. in Mechanical Engineering from Tennessee Technological University in May of 2017.

EDUCATION

B.S. Mechanical Engineering

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The Department of

Mechanical Engineering

Announces the Dissertation Defense

Of

Stephen Zuccaro

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FIELD OF STUDY

MASTER OF SCIENCE

Mechanical Engineering

DISSERTATION TOPIC

POWER CONSUMPTION OF SKID-STEER MOBILE ROBOTS BASED ON DYNAMIC PREDICTIONS OF SLIP

EXAMINING COMMITTEE

Dr. Stephen Canfield, Chairperson

Dr. Steven Anton

Dr. Kwun-Lon Ting

ABSTRACT

Skid steer mobile robots (SSMR) provide a robust and simplistic mechanical drive platform making them useful in many applications. SSMRs are well suited for climbing applications and can be used for manufacturing tasks such as welding, cutting, surface treatments, and inspection. When considering the kinematics and dynamics of SSMRs, it has been established that the motion constraints are functions of the dynamics. When performing a manufacturing task power consumption is an important consideration because of the slipping and corresponding friction that induce large loads on the drive system. The slipping behavior is generally characterized through instant centers of rotation of the contact patches and it has been established that these are functions of the system dynamics. However, the existing SSMR power models usually treat these constraints at the kinematic level by assuming constant slip rates taken from empirical data. This thesis will demonstrate a method to evaluate SSMR power consumption based on slip parameters that are calculated directly from the equations of motion. This method evaluates constraint forces through a friction model and is therefore most appropriate for applications in which the operating surfaces can be characterized with predictable properties. The dynamic power model is validated and then implemented on two practical manufacturing applications. The applications show that the dynamic instant center model plays a significant role in estimating power requirements. The results further demonstrate that the power and energy requirements for a given task depend significantly on the payload and motion along the task in a non-linear fashion, for example showing that the minimum payload does not necessarily correspond to the minimum energy use. This outcome suggests that dynamic effects can be used to find optimal trajectories to minimize power or energy requirements.