



Dynamic Predictor Improves Machine Control

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WARF: P130307US01

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method for predicting machine joint motion that is particularly suitable for stiff dynamical systems.

Overview

Articulated mechanisms, such as walking robots or robotic arms, can be understood as a set of rigid links connected to each other by joints. The joints are put into motion using motors, sensors that indicate joint position and passive components like springs.

To effectively control these mechanisms, it helps to be able to mathematically predict their movement in response to commands. To this end, a UW–Madison researcher previously developed a motion or ‘kinematic’ predictor that works by solving kinematic differential equations (see WARF reference number P100351US02).

In many systems, such as vehicle suspension systems (whether they are ‘passive’ or are of the ‘active’ variety where actuators are used to apply forces) or walking robots of a type where the ‘gait’ is controlled on similar principles to active suspensions, motion is only partially specified by controlling the angles of selected joints in the system. Controlling the movement of such devices requires a dynamic predictor that determines motions resulting from the influence of inertial, spring, actuator and other forces. However, when dealing with mechanisms having ‘stiff’ springs (like rubber bushings), solving differential equations by the term expansion used in the kinematic predictor can be problematic, involving a large number of terms in the expansion and small time steps to achieve stable and accurate results.

The Invention

The researcher now has developed a new dynamic predictor that rapidly and accurately calculates the motion trajectory of a system that is only partially constrained by joint inputs. This dynamic predictor achieves stable and accurate results for stiff systems. To do this, the predictor applies conditions achieving such results at both a first and second joint position at the start and end of a motion time step.

More specifically, the relationship between joints is described as a differential equation to be solved by the predictor. The predictor parameterizes the motion of the unconstrained joints in such a way as to match the conditions the solution needs to satisfy at both the start and end of a motion time step. As this parameterization is expressed by polynomial coefficients, motions of the remaining joints are readily determined by the kinematic predictor.

Applications

- Machine control
- Modeling control mechanisms for design purposes

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Key Benefits

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- Determines control parameters on an automatic basis
- Method is rapid and precise.
- Suitable for stiff dynamical systems
- Improves control

Additional Information

Related Technologies

- [WARF reference number P100351US02 describes the researcher's motion predictor for non-stiff articulated mechanisms.](#)

Tech Fields

- [Engineering : General engineering technologies](#)
- [Information Technology : Computing methods, software & machine learning](#)

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