Improved Recursive Dynamics Simulator (ReDySim) for Multibody Systems

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Abstract

There has been significant growth in the application of multibody dynamics in the domains of the automotive, aerospace, defence, agriculture and many more. This has fuelled research activities in the field of multibody dynamics in the above-mentioned domains in industry and academia. This has resulted in the demand of multibody dynamics solvers which are numerically stable, computationally efficient, customisable, scalable and free. Recursive Dynamics Simulator (ReDySim) [1, 2] is one such multibody dynamics solver based on MATLAB. ReDySim uses Decoupled Natural Orthogonal Complement Matrices (DeNOC) based dynamics formulation [3] which is proven to be numerically stable and computationally efficient. The solver has been developed in MATLAB keeping in mind ease of usage and accessibility of MATLAB in many academic institutions.

The solver was developed originally for research community keeping in mind requirements of the ease of access to state variables, and the inclusion of trajectory and control algorithm. The solver takes inputs in the form of modified DH parameters [3], mass, the location of center-of-mass and mass moment of inertia. Therefore, it does not require developing and integrating CAD model as required in commercial software. There is provision for performing both inverse and forward dynamics using ReDySim. The basic version of ReDySim lacked Graphic User Interface, which can be immensely helpful the beginners in the field of Multibody dynamics. Another limitation was that the original version had provision for including only revolute joint. Substantial improvements are made in ReDySim from its initially released version keeping in mind user's perspective. This paper will mainly focus on the newly added features of ReDySim.

The improved version of ReDySim has a GUI as shown in Fig. 1, which can provide ease of access to various inputs and outputs to the beginners, whereas the advanced users can directly access the library of functions and customize them as per their requirements. The present version of ReDySim can also include prismatic joint. Various new modules have also been added in ReDySim as given below:

- Fixed-Base Systems: This module can be used to perform inverse and forward dynamics for fixed-base open- and closed-loop multibody systems. It can model both rotary and prismatic (sliding) joints.
- Floating-Base Systems: This module can be used to perform inverse and forward dynamics of free-floating systems such as space robots.
- Legged Robots: This module can be used to perform inverse and forward dynamics of floating-base systems interacting with an environment such as legged robots. It uses penalty-based approach for contact modelling.
- Symbolic Calculation: This module can generate equations of motion for open-loop fixed- and floating-base systems in symbolic form.

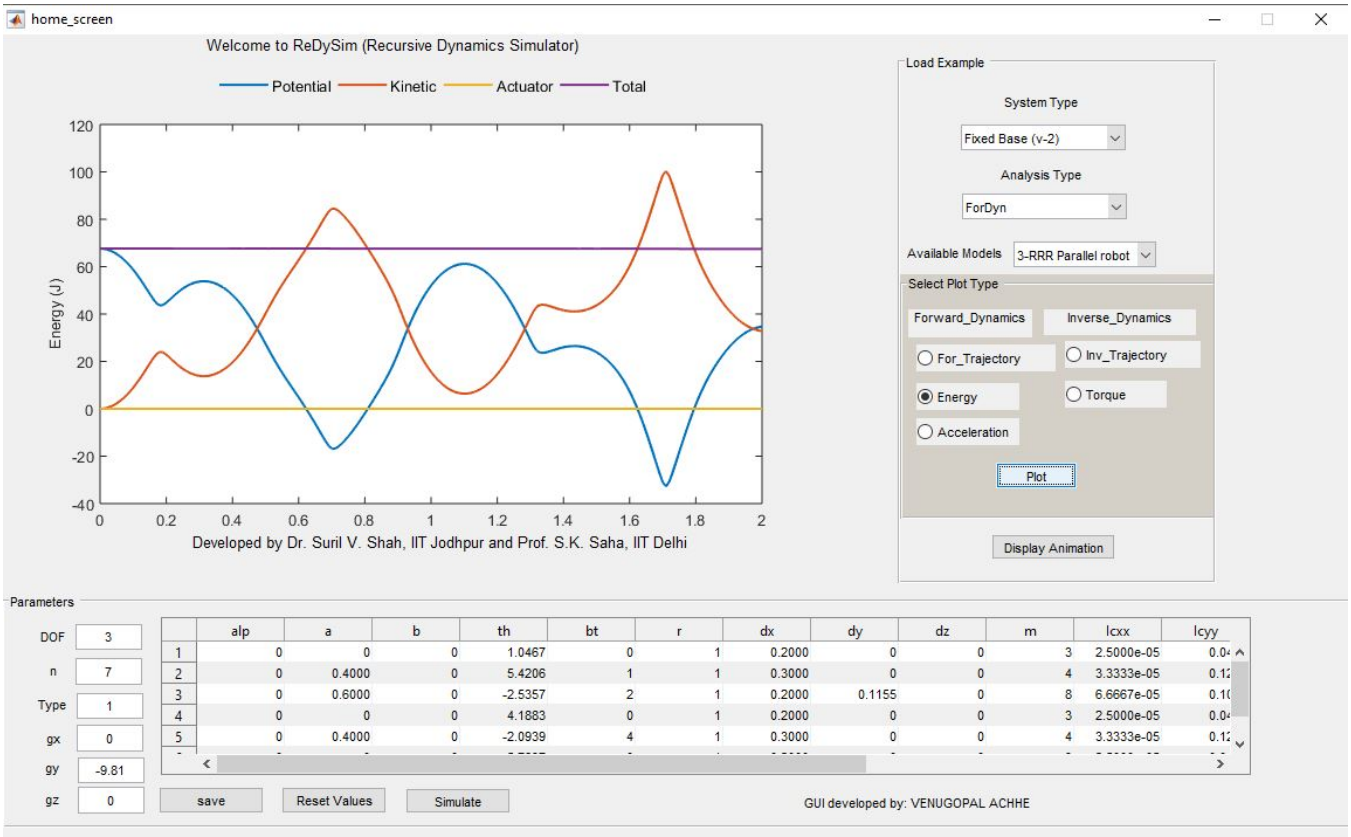

Fig. 1: Snapshot of the GUI developed for ReDySim

An exhaustive set of ready to solve demonstrating examples have been added in all of the above-mentioned modules to help the end users. In addition to the above, functions such as Jacobian and Generalized Inertia Matrix (GIM) have also been made available to the end-users. ReDySim has the capability to incorporate any control algorithm and trajectory planner with utmost ease. These abilities provide flexibility to user/researcher in incorporating their customized algorithms with ease. ReDySim showed considerable improvement over commercial software such as ADAMS, RecurDyn, and algorithms available in literature in terms of the computational time, accuracy and numerical stability.

References

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[3] http://redysim.weebly.com (Alternate link: http://www.redysim.co.nr/)