

“Virtual Musculoskeletal System” Case Studies for Gross Anatomy

Motivation:

Current anatomical instructional modes with tables or charts do not provide:

- **Interactivity** or **capacity** to create ‘**what if scenarios**’, e.g., what happens if muscle A is lost or provide only half of normal force.
- **Functional understanding** of muscle movements.

We wish to take advantage of the available biomechanically-accurate virtual musculoskeletal analysis tools which can:

- analyze entire high fidelity musculoskeletal systems completely within the computer.
- repeatedly run a wide variety of test suites involving users of all stripes at a fraction of time, space or cost.

Mission:

To create the architecture for scaffolded interaction with detailed virtual-human musculoskeletal models (“virtual musculoskeletal system”) to make varied “**what if**” type analyses and hypotheses testing possible.

Desired Outcomes:

- Incorporating **parametric interaction** capability to musculoskeletal models.
- Providing this parametric interaction capability to be accessible by lay users

Target audience:

Health-care professionals (Doctors, Nurses, Anatomists, Physiotherapists) without much computing experience.

Impacts and Benefits:

- Virtual Musculoskeletal Cadavers** framework seeks to :
- Allow “health science” students to learn aspects of Gross Anatomy through Structured Interactive Lab exercises.
 - Supplement the traditional lecture based classroom and the limited lab access to cadaver dissection tables for these large classes.
 - Provide exposure to students to real and realistic experiences with contemporary technology tools and methodologies.
 - Potential use in teaching a spectrum of end users – from the health care students to clinicians for:
 - **Quantitatively analyze** the role of muscles & joints
 - Selectively study the muscles and their effects on movements (at the individual or group levels)

Key technologies:

- Musculoskeletal computational models are constructed modularly using ANYBODY software and stored in a parametric library.
- **Instantiated models** from the library facilitate individualization of interactions to each user.
- A MATLAB GUI permits structured access to the ANYBODY musculoskeletal models, run the analyses and return the results.
- **Visualization** in a 3D interactive graphical virtual environment.

Virtual Cadaver System Framework

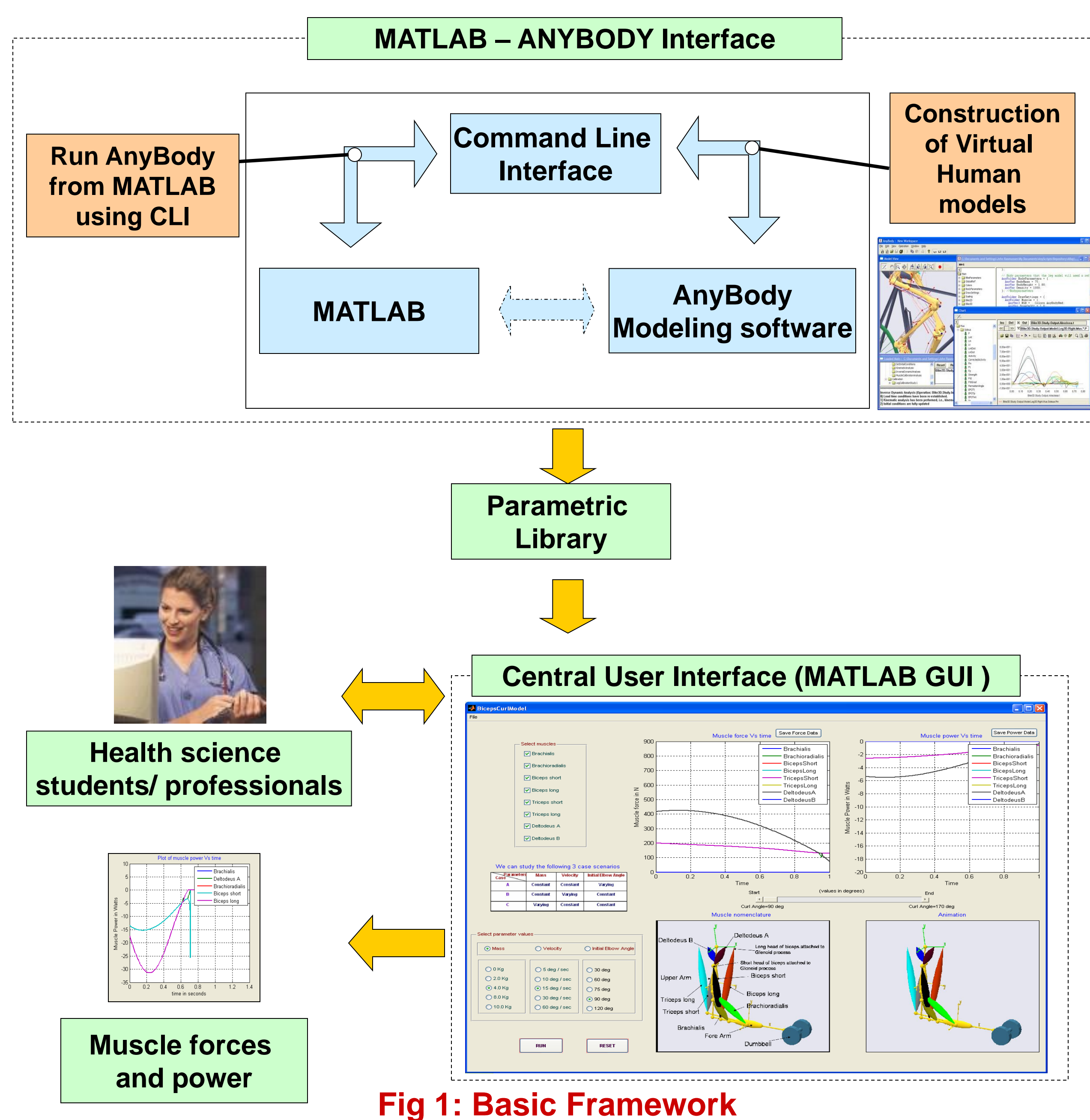


Fig 1: Basic Framework

Functionalities of Virtual Cadaver System:

- Labeled musculoskeletal model
- Visualization/animation of model movements
- Graphical representation of parameters of selective muscles- Force, Power.
- “What if” analysis:
 - Effect of **geometry, inertial properties, velocity**
- User **interactive** menus- File, Open, Save as Image, Save as Text, Print etc.

Sample Case Studies:

Performing “what if” type analysis:

“What if” type analysis can be performed by the user to study the effects of geometry, velocity and inertial properties on muscle parameters as shown below.

Case Study 1: Biceps Curl Model

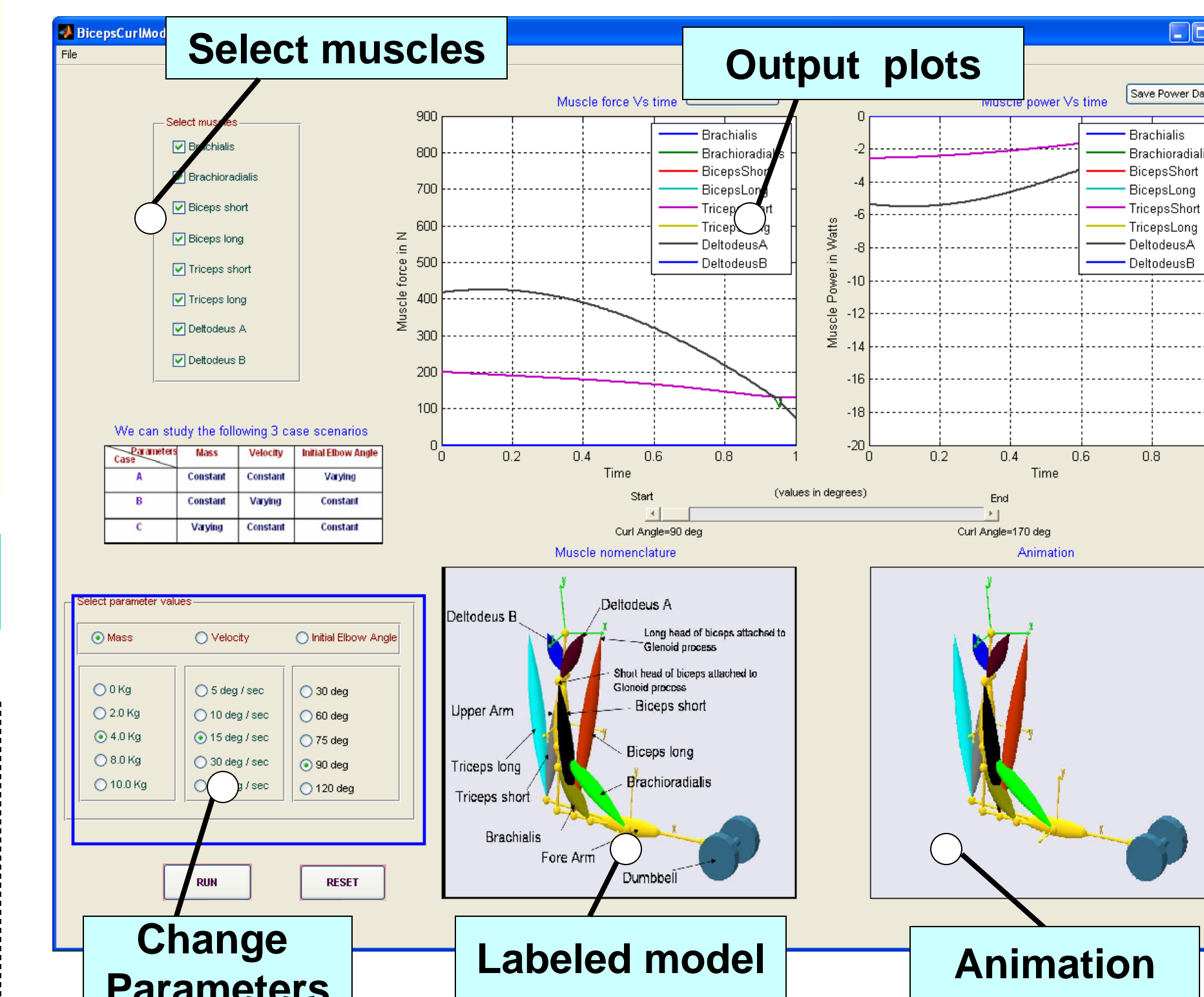
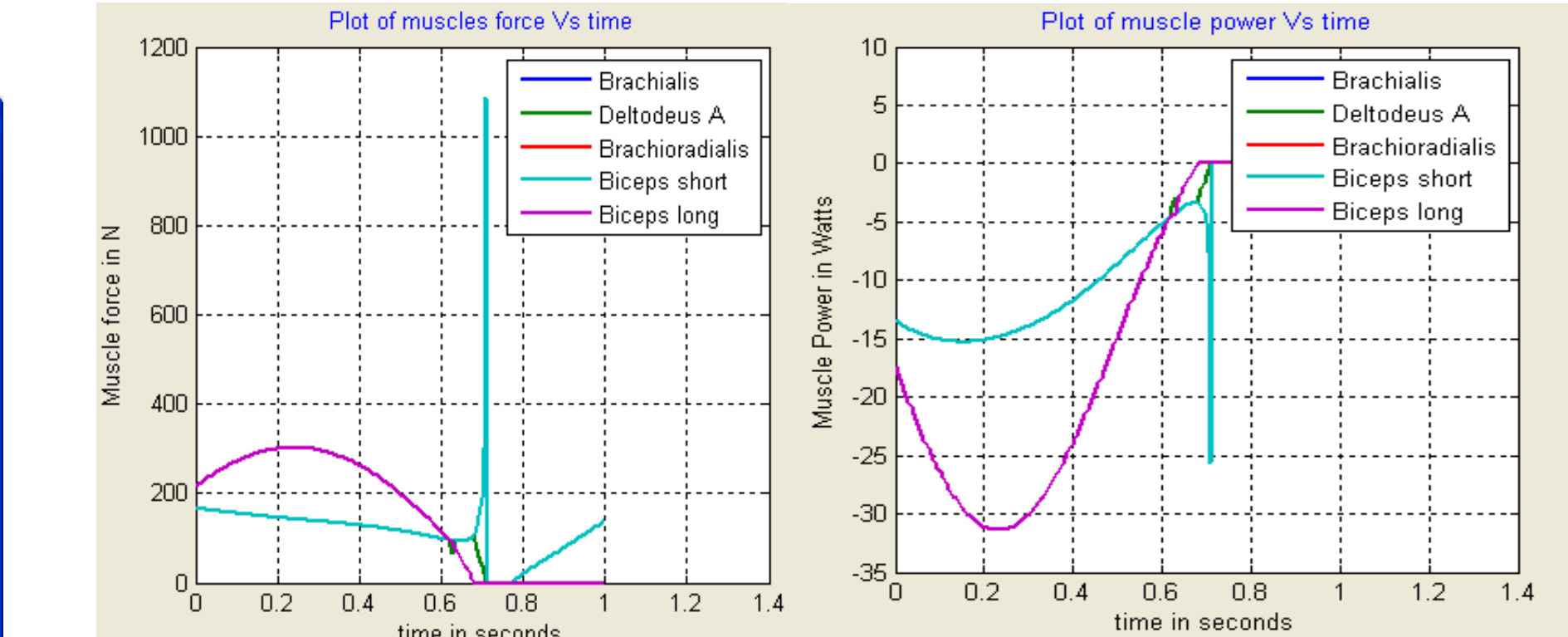


Fig 2: Biceps curl model GUI

Dumbbell mass=2 kg Curl Velocity = 120 deg/s Initial position of forearm= 60 deg



Dumbbell mass=2 kg Curl Velocity = 120 deg/s Initial position of forearm= 120 deg

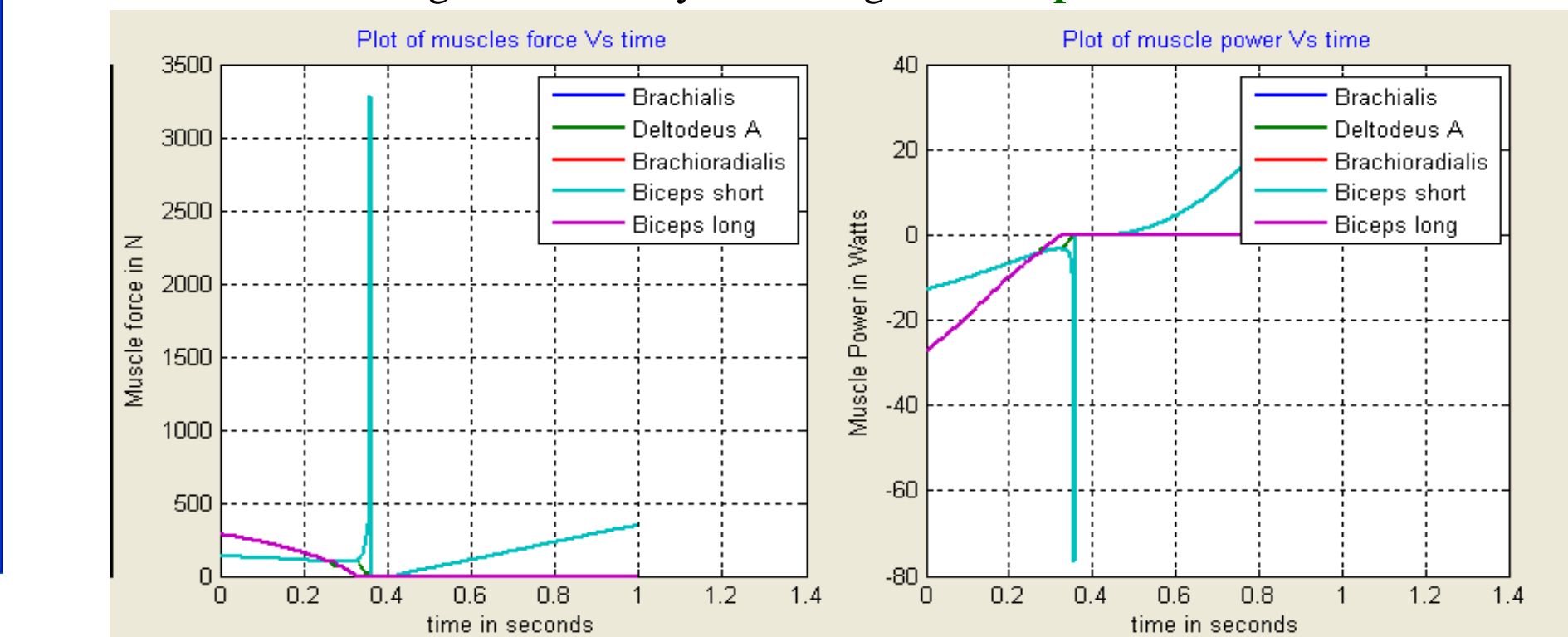


Fig 3: “What If” type analysis: Biceps Curl model

Case Study 2: Bike Model

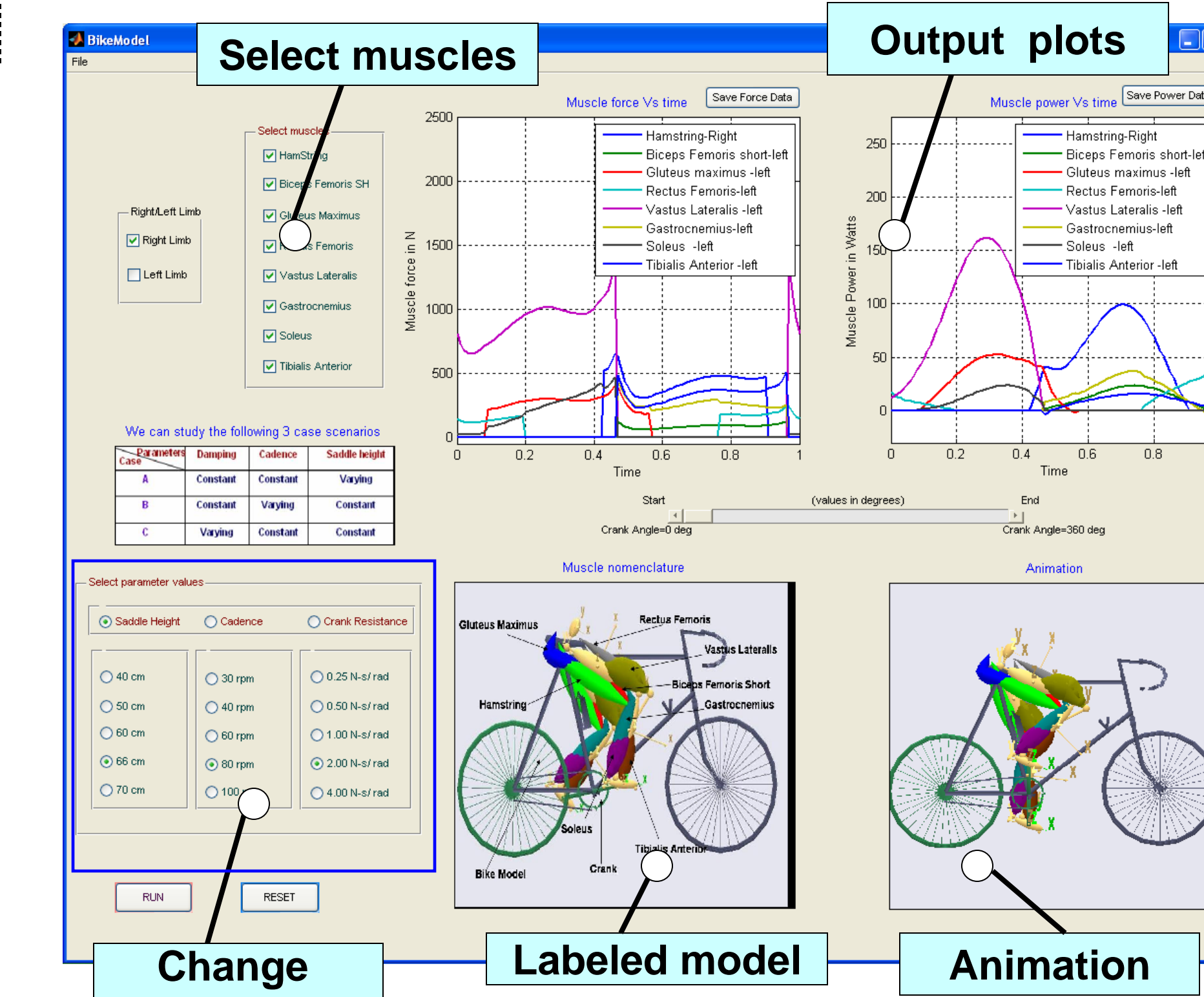
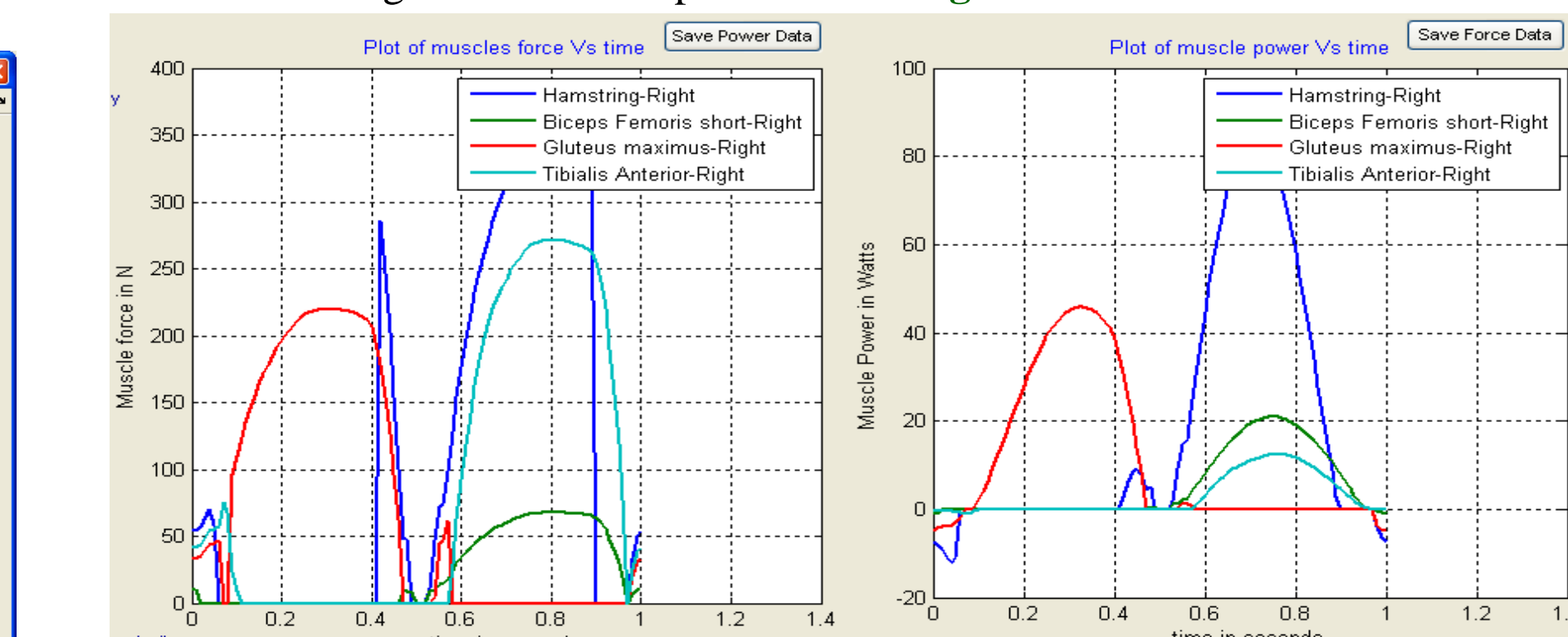


Fig 3: Bike model GUI

Crank load=2 kg Cadence= 80 rpm Saddle height=60 cm



Crank load=2 kg Cadence= 80 rpm Saddle height=70 cm

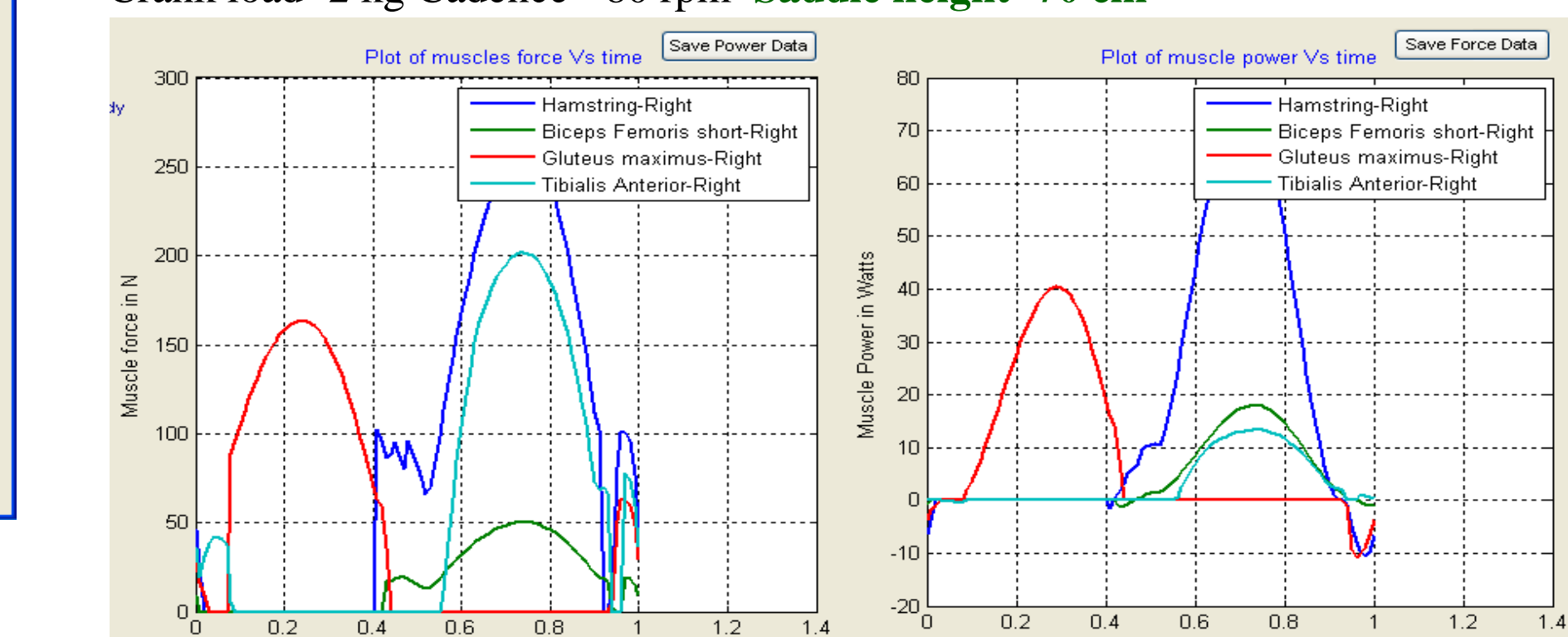


Fig 5: “What If” type analysis: Bike model

Future Work:

The following features and modified framework for web enabled Virtual Musculoskeletal Cadavers will be implemented in future:

- Deployment of a **computational musculoskeletal analysis tool** called “AnyBody” on high end server.
- Development of high fidelity musculoskeletal analysis models of various parts of the human anatomy and incorporating parametric interaction capability with those models
- Providing access to this parametric interaction capability to users via web server.