Predicting Carpal Bone Kinematics using an Expanded Digital Database of Wrist Bone Anatomy and Carpal Kinematics

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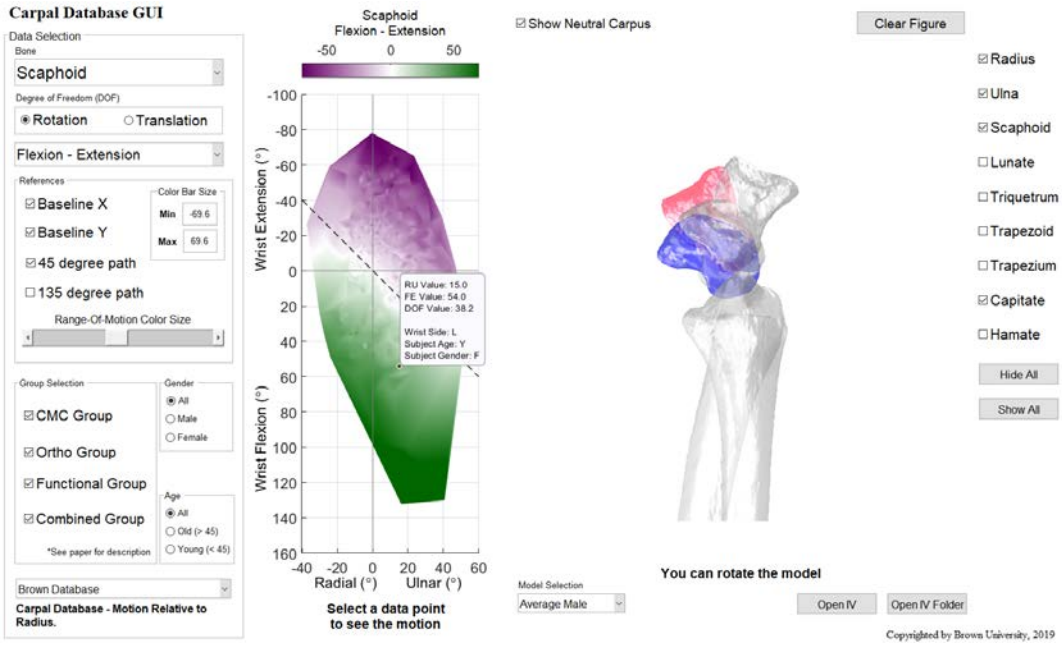
Brown Wrist Graphic User Interface (GUI)



Overview

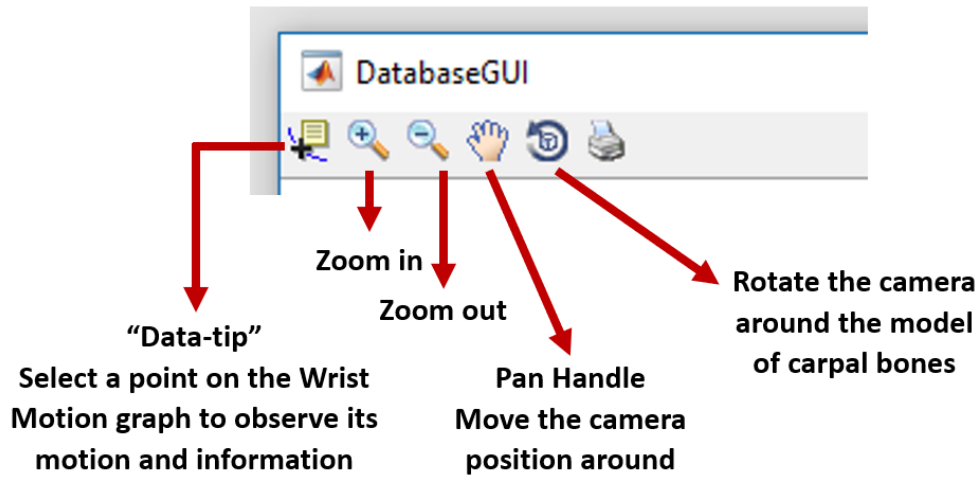
The interface lets users select a wrist motion to observe its carpal bones orientation and translation both quantitively and visually. Users can select a data point from the wrist graph (middle pane) and look at the motion of the carpal bones on an average carpal bones' model (right pane). When you select a point, you can see information such as the wrist's radial-ulnar deviation (RU), wrist's flexion-extension (FE), the selected-DOF value (e.g., scaphoid flexion-extension), age, wrist's side, and gender of the subject that the information is coming from.

The database is coming from four different studies with different age and gender categories and all these parameters can be toggled on or off inside the GUI. The bone models can be selected or browsed by the user. As a default, an average (based on bone volumes in the database) male model from the database is selected. Users can also upload subject-specific bone models (note: they must be acquired in the neutral pose described in the manuscript) to evaluate the database motions on the specific model. Please look at the "ReadMe_File Structure" document for more information on the mathematics and behind the seen calculations.

GUI Descriptions

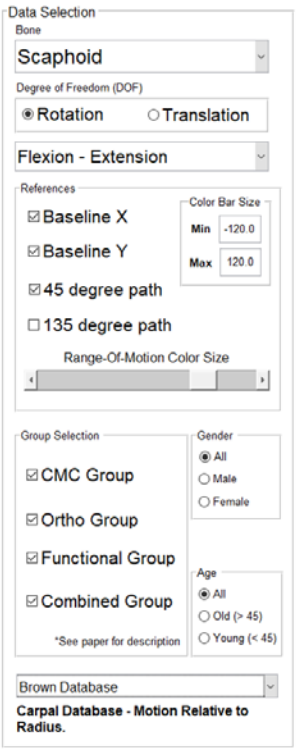
- **Rotation and Data Selection Handles**

On the top-left of the window, you can see this toolbar:



Data-tip is the most important tool for selecting a data point on the wrist graph (middle pane). This will help you to change the viewpoints, so you can look at the models the way you like to or find an optimal orientation.

- **Data Selection Panel**



Select the bone *(Default: Scaphoid)*
Scaphoid—Lunate —Trapezoid—Trapezium—Hamate—Capitate—Triquetrum

Select the degree-of-freedom of the bones *(Default: Flexion-Extension)*

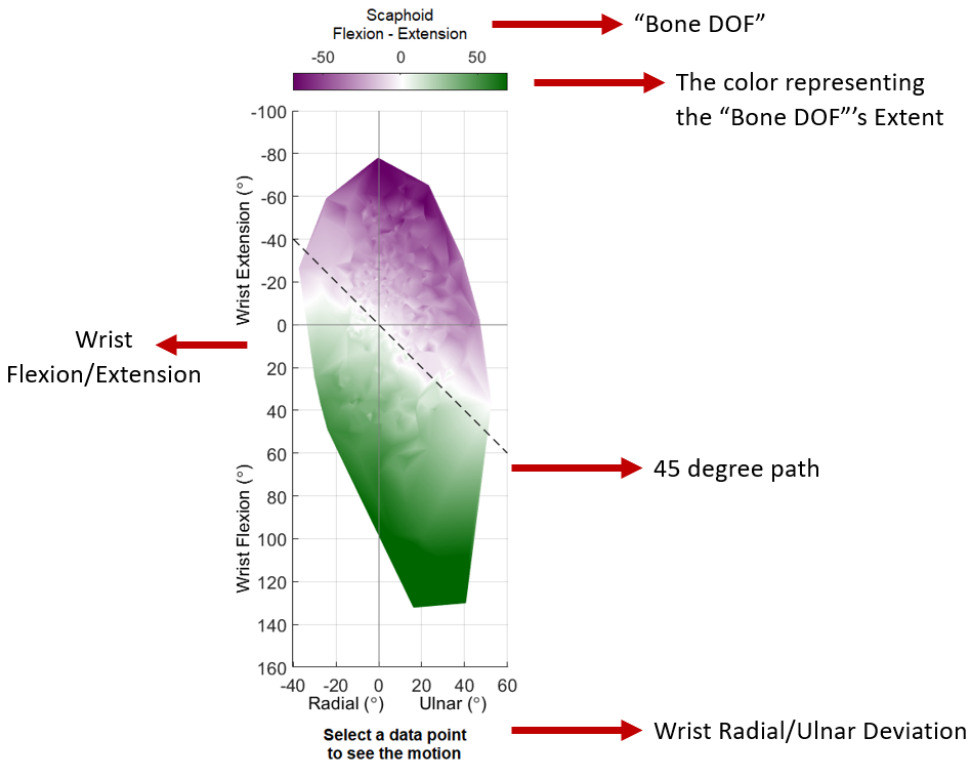
Rotation:	Supination-Pronation	Flexion-Extension	Radial-Ulnar Deviation
Translation:	Proximal-Distal	Radial-Ulnar	Volar-Dorsal

Guides for the motion graph:
Baseline X: Shows the absolute wrist Radial-Ulnar deviation path
Baseline Y: Shows the absolute wrist Flexion-Extension path
45/135 degree path: Path oblique to X and Y baselines
Color Bar Size: The magnitude of maximum angle/distance wrist motion
Range-Of-Motion Color Size: An easier method to change the maximum values

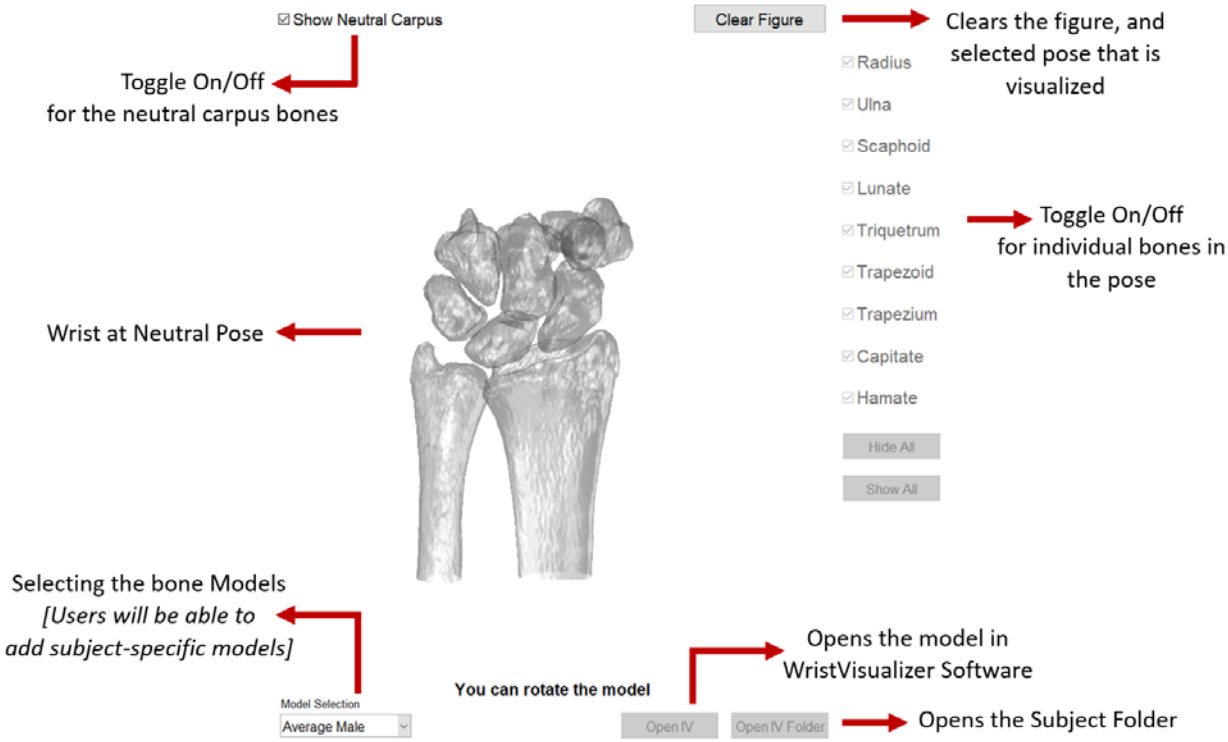
Change these parameters if you want to select a subset of the database

Change the data (*Default: Brown Database*)
Brown Database — Quadratic Surface Model

- **DOF Visualization Panel**

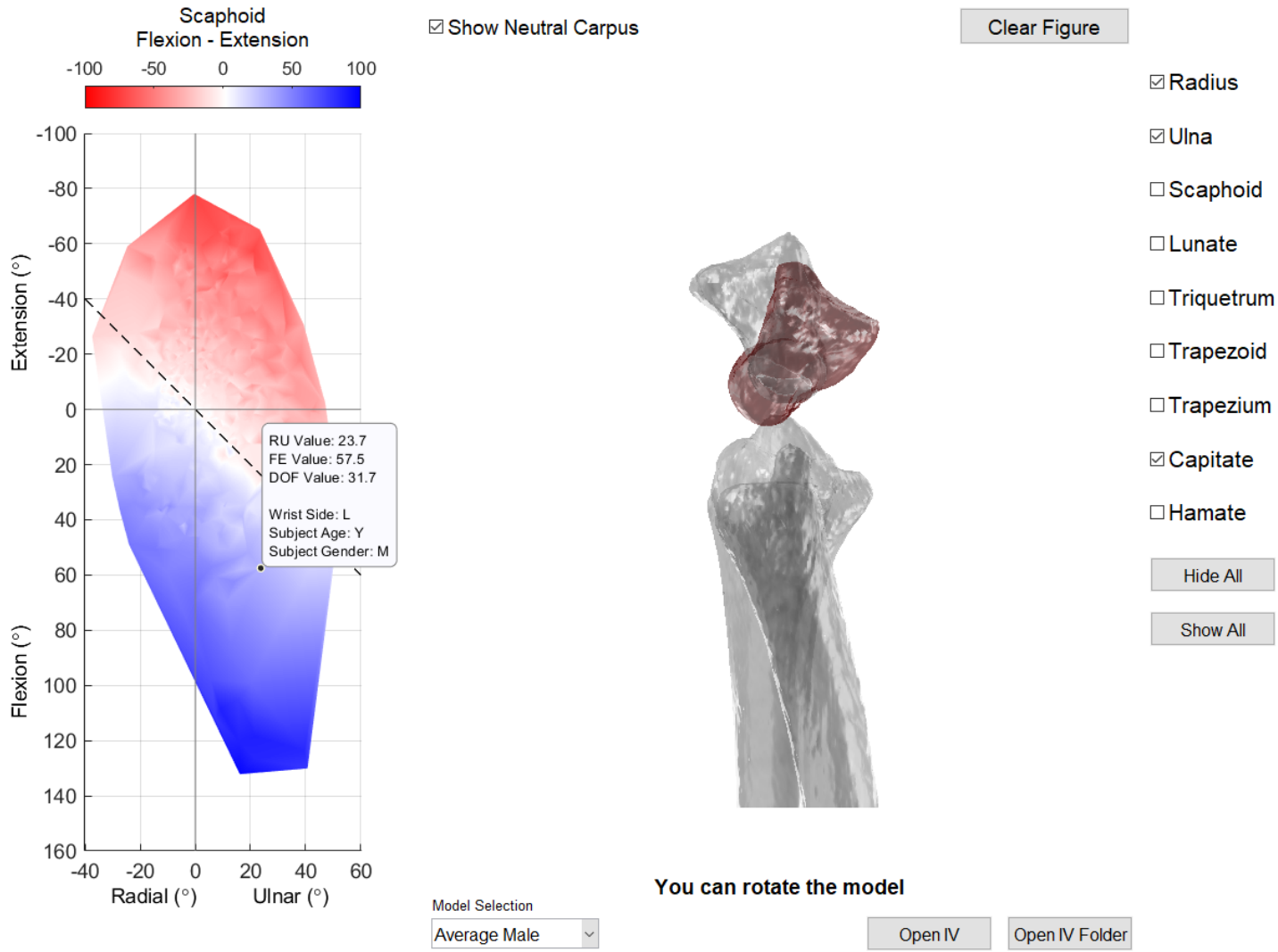


- **Bone Visalization Panel**



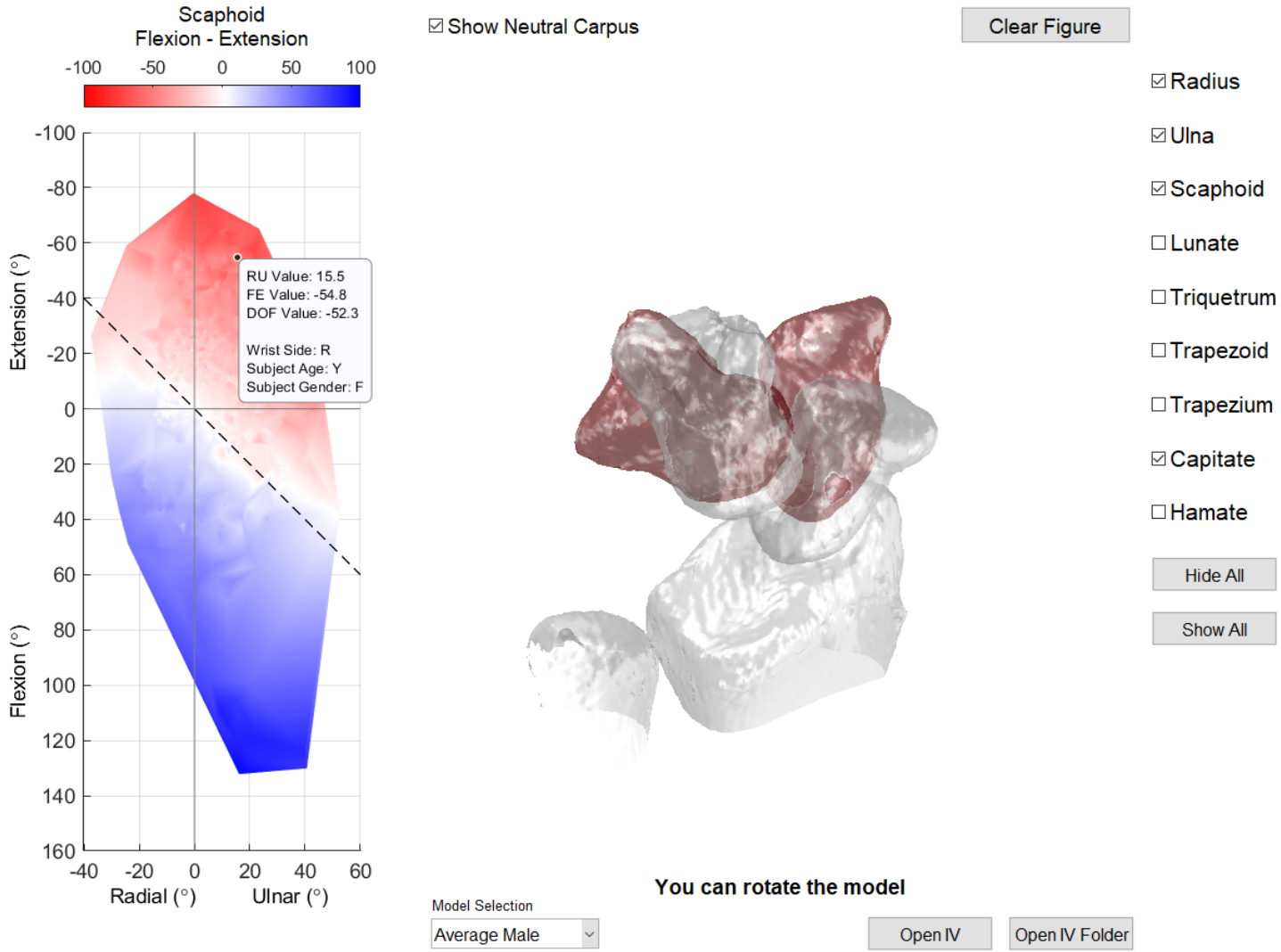
Example (1) – Capitate Visualization

The wrist is 23.7° ulnarly deviated and 57.5° flexed. The Scaphoid is flexed 31.7°. Data comes from a left wrist of a young male.



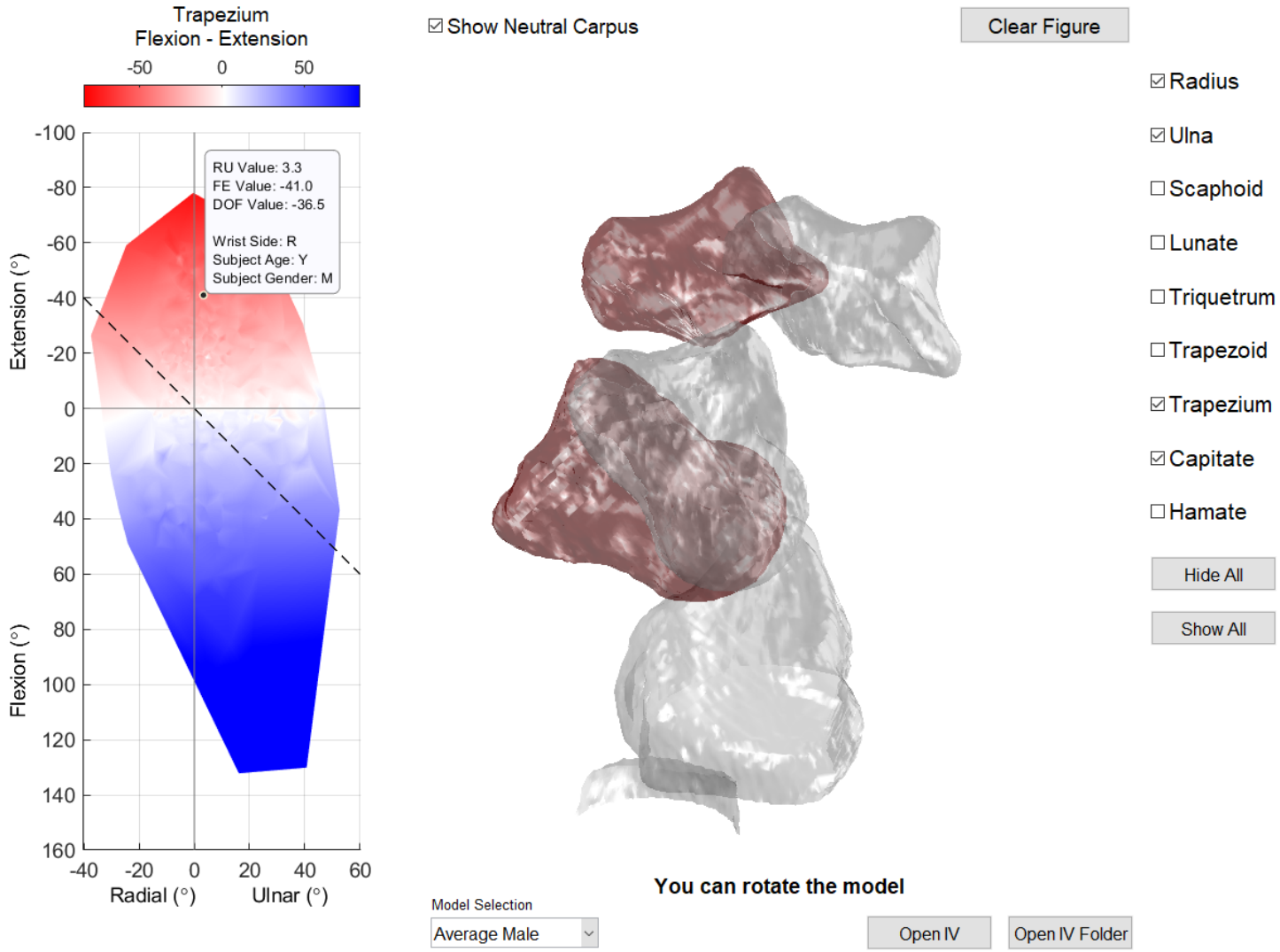
Example (2) – ScaphoidCapitate Visualization

The wrist is 15.5° ulnarly deviated, it is at 54.8° extension. The Scaphoid is extended 52.3°. Data comes from the right wrist of a young female.)



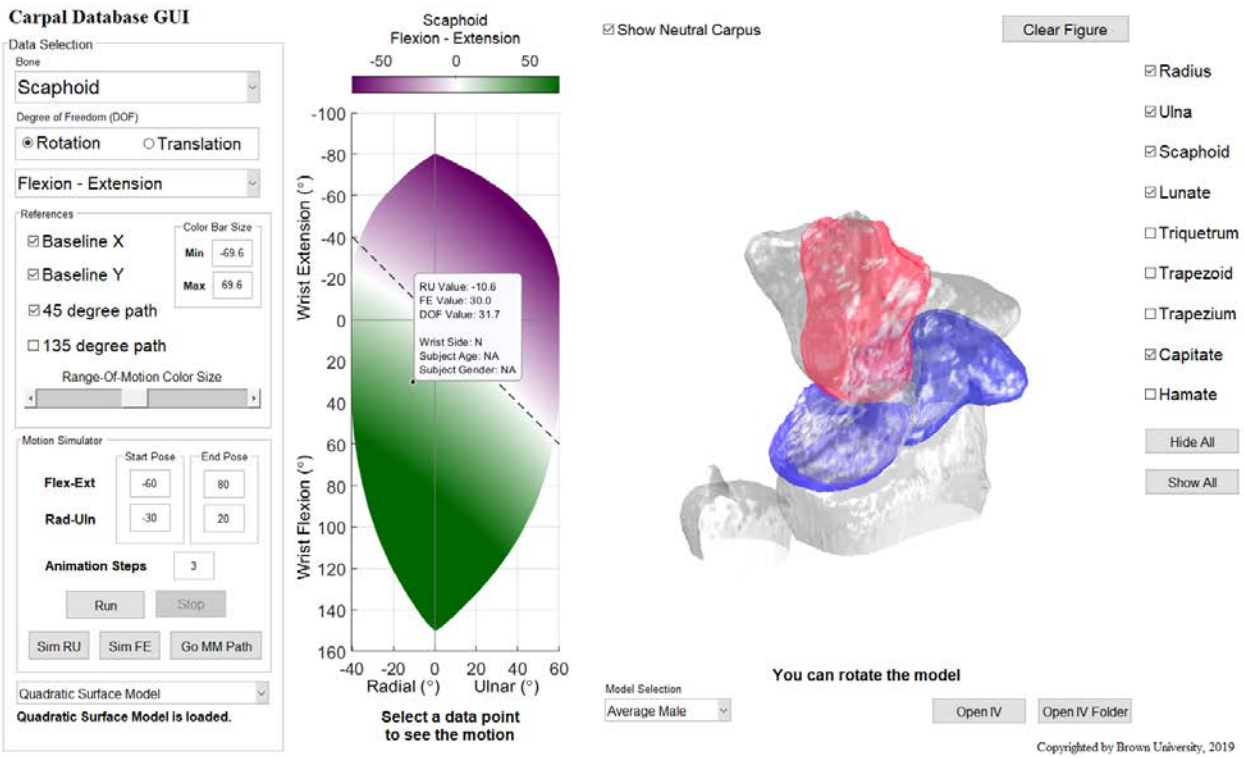
Example (3) – TrapeziumCapitate Visualization

The wrist is 3.3° ulnarly deviated, it is at 41.0° extension. The Trapezium is extended 36.6°. Data comes from the right wrist of a young male.)

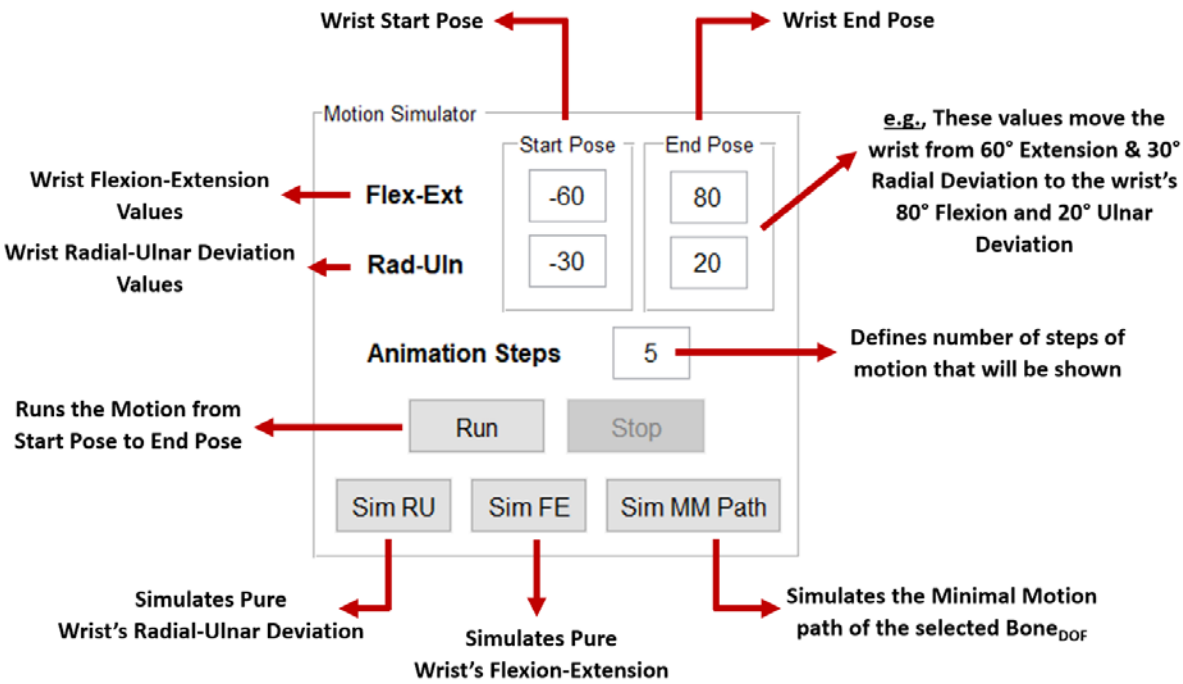


Mathematical Model of Wrist Motion

Our Quadratic Surface Model is preloaded in the GUI, and it can be selected from the data panel:



- **Motion Simulator**



Example (4) – Carpal Bones Visualization

The wrist is 13.8° radially deviated, it is at 74.0° flexion. The scaphoid is flexed at 70.9°.