**Supplementary File 3**

**Marker set**

****

**Figure 1** – Modified in-shoe marker set and model

**Definition of Anatomical frames**

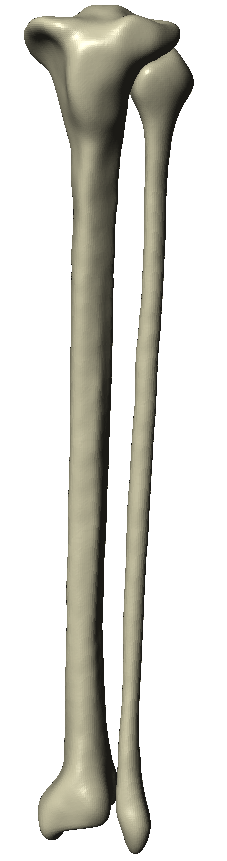
Lower leg

MFE

LFE







LM

MM





**Figure 2** – The lower leg segment

*Definition Markers*

|  |  |  |
| --- | --- | --- |
|  | Medial | Lateral |
| Proximal | Medial femoral epicondyle (MFE) | Lateral femoral epicondyle (LFE) |
| Distal | Medial malleolus (MM) | Lateral Malleolus (LM) |

*Anatomical Reference Frames*

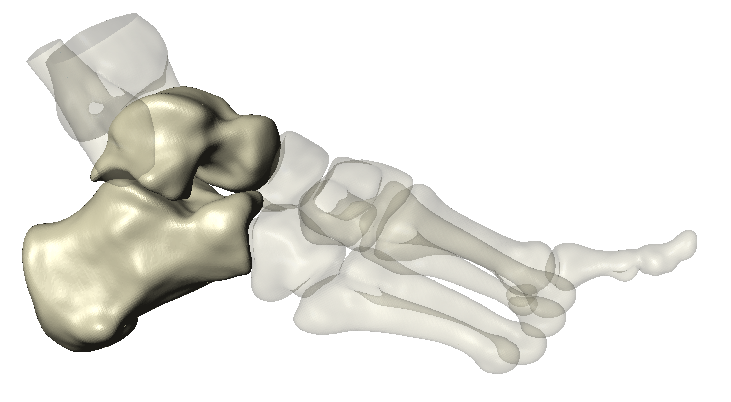
*O*shank  The midpoint between the MFE and LFE

*x*shankThe x-axis joints the origin and the LFE marker

*y*shank The y-axis is orthogonal to the x-axis and lies in the coronal plane.

*z*shank  The z-axis is orthogonal to the *xy* plane.

Hindfoot

****

LM

SP

MM

NT

**Figure 3** – The hindfoot segment

*Definition Markers*

|  |  |  |
| --- | --- | --- |
|  | Medial | Lateral |
| Proximal | Medial malleolus (MM) | Lateral malleolus (LM) |
| Distal | Navicular tuberosity (NT) | Styloid process (SP) |

*Anatomical Reference Frames*

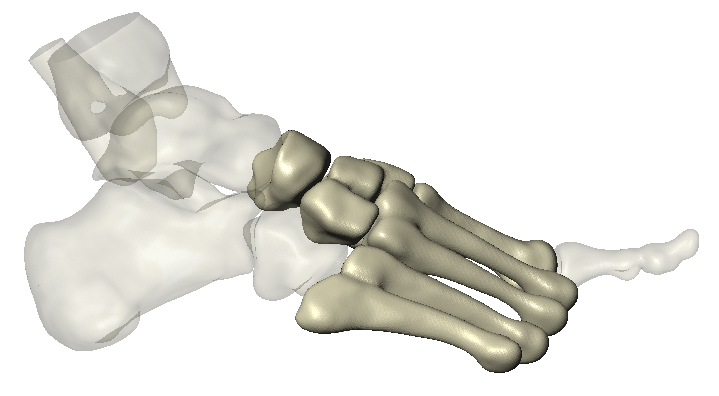
*Ohindfoot segment* The midpoint between the MM and LM

*x hindfoot segment*The x-axis joins the origin and LM marker

*z hindfoot segment* The z-axis is orthogonal to the x-axis and lies in the transverse plane

*y hindfoot segment*The y-axis is orthogonal to the *xz* plane.

Midfoot-Forefoot Complex Segment

****

SP

5MTP

1MTP

NT

**Figure 4** –The midfoot-forefoot complex segment

*Definition Markers*

|  |  |  |
| --- | --- | --- |
|  | Medial | Lateral |
| Proximal | Navicular tuberosity (NT) | Styloid process (SP) |
| Distal | 1st metatarsal head (1MTP) | 5th metatarsal head (5MTP) |

*Anatomical Reference Frames*

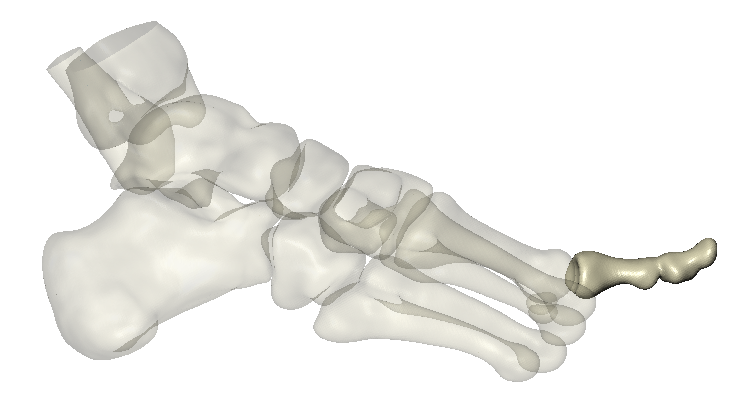
*O*midfoot/forefoot segment  The midpoint between the NT and SP

*x* midfoot/forefoot segmentThe x-axis joins the origin and SP marker

*z* midfoot/forefoot segment The z-axis is orthogonal to the x-axis and lies in the transverse plane

*y* midfoot/forefoot segment The y-axis is orthogonal to the *xz* plane.

Hallux

****

1MTP

A1

2MTP

**Figure 5** –The hallux segment

*Definition Markers*

|  |  |  |
| --- | --- | --- |
|  | Medial | Lateral |
| Proximal | 1st metatarsal head (1MTP) | 2nd metatarsal head (2MTP) |
| Distal | Joint: Apex hallux (A1) | |

*Anatomical Reference Frames*

*O*Hallux The midpoint between the 1MTH and 2MTH

*x* HalluxThe x-axis joins the origin and the 2MTH marker

*z* Hallux The z-axis is orthogonal to the x-axis and lies in the transverse plane

*y* Hallux The y-axis is orthogonal to the *xz* plane.

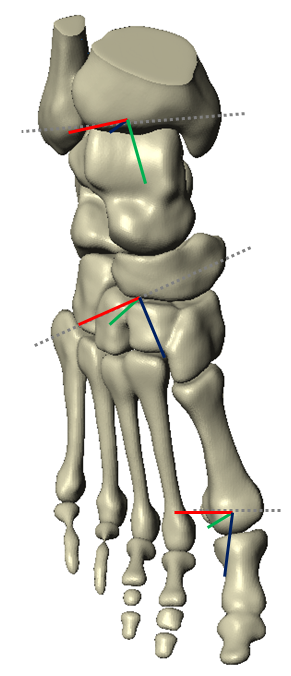
**Definition of Model Joints**

The articulation between each segment and the corresponding proximal segment defined a joint. The three joints established in the model accurately reflect the surrounding anatomical articulation and are defined as:

1. the tibiocalcaneal joint (defined as the articulation between the lower leg and hindfoot segment)

2. the tarsometatarsal joint (defined as the articulation between the hindfoot segment and the midfoot/forefoot complex)

3. the 1st metatarsophalangeal joint (defined as the articulation between the midfoot/forefoot complex and the hallux segment).



**Marker:** Lateral Malleolus

**Marker:** Navicular tuberosity

**Virtual Marker:** 5th Metatarsal base

**Marker:** Apex 1

**Virtual Marker:** 2nd Metatarsal head

**Virtual Marker:** 5th Metatarsal head

**Marker:** 1st Metatarsal head

**Marker:** Lateral Malleolus













**Figure 6** – The complete multi-segment foot-shoe complex model (Bishop et al. 2013)

**Joint parameters of the in-shoe foot kinematic model**

The joint rotations are expressed as a movement around the three orthogonal axes of the segment coordinate system (SCS). Each joint is modelled as three rotations and zero translations along each axis (except for the hallux which is a one DOF hinge). The methods proposed by Lu & O’Connor (1999) are used to optimise the joints.

**Table 1** – Parameters for modelling foot joints

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Joint** | **Order of Rotations** | **Degrees of freedom** | | | | | **Normalisation** |
|  |  | Rotations | | | Translations | |  |
| Tibiocalcaneal | X - Y - Z | *x* | Flex-extension | Nil | | Yes | | |
|  |  | *y* | Abd-Adduction | Nil | | No | | |
|  |  | *z* | Inv-Eversion | Nil | | No | | |
| Tarsometatarsal | X - Y - Z | *x* | Flex-extension | Nil | | No | | |
|  |  | *y* | Abd-Adduction | Nil | | No | | |
|  |  | *z* | Inv-Eversion | Nil | | No | | |
| Metatarsophalangeal | X - Y - Z | *x* | Flex-extension | Nil | | No | | |