SKAML

An XML Markup Language for Abstract Skeleton Definitions in the Context of Human Posture Assessments

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Abstract. An XML-dialect for the description and configuration of abstract human skeletons for ergonomics assessments with motion capture (MoCap) systems - the Skeletal Assessment Markup Language (SKAML) - is presented. A SKAML document is the semantic description of the MoCap system and assessment method conjunction. It describes the skeletal system of a human body as a system of rigid bones and joints from a MoCap observer perspective and allows straightforward combinations of MoCap data and digitized methods for ergonomics assessments. We anticipate our work as help for researchers and developers that implement new assessment methods or MoCap systems.

Keywords. Skeleton Markup, Motion Capture, Ergonomics Assessment, Musculoskeletal Disorders

1. Introduction

Motion Capture (MoCap) systems are increasingly used for ergonomics assessments, i.e., the determination of risk factors for occupational diseases, e.g., work-related musculoskeletal disorders (WMSD). When implementing a method for ergonomics assessment in software (to use it in conjunction with MoCap systems), one must define a skeleton model as well as the rules of the assessment method in code, which is costly and error-prone. A computerized assessment method must be specially adapted to this pre-defined skeleton to work correctly. Here the description of an abstract skeleton structure that can be annotated to support multiple MoCap systems, as well as multiple assessment methods, is needed. For example, an optical MoCap system (e.g., Kinect) provides a predefined abstract Skeleton structure and updates the spatial joint coordinates accordingly whereas an inertial measuring suit provides relative orientation rather than joint positions. An annotated skeleton structure could support both systems.

2. Skeletal Assessment Markup Language

The Skeletal Assessment Markup Language proposed here fits into the gap of XML-based description languages between descriptions of human motion on an abstract level and descriptions of the human biomechanics. SKAML describes the skeletal system of a human body from a full-body motion capture observer perspective. It is not possible nor intended to describe details of the human biomechanics with SKAML. Developers may refer to the XSD-specification[2] for further details.

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2 See http://www.skaml.org/SKAML.xsd for the specification.

On the technical side, SKAML allows the definition of simplified skeleton structures mainly consisting of joint and bone definitions. Root of an SKAML-document is the `<body>` tag, which has the direct child `<skeleton>`. A skeleton consists of a set of joints and bones. The `<joints>` tag contains one or more `<joint>` tags. Each joint may have one or more children so that the topology of joints can be described, e.g., a joint *hip* has two child joints *back_mid* and *femur_left* each having children as well. Bones of the skeleton can be defined using the bones tag followed by one or more bone tags. A bone is defined as a rigid connection between two joints:

```
<bone id="arm_right"
   from="ellbow_right" to="hand_right" length="0.279">
```

It is also possible to attach a `sensor`-tag to a joint, which is useful if the motion capture system provides joint coordinates. This is the case for most optical MC-systems, e.g., Kinect. The sensor type is not enforced by SKAML but application-specific.

SKAML allows for the definition of various skeleton structures. Screening methods for posture or motion assessments consider only specific joint or bone combinations, in most cases different to the structure defined in SKAML. To address this, an assessment tag was introduced. The tag can be placed as a child to a joint or bone.

```
<joint id="ellbow_left">
    <sensor type="Kinect" id="ELLBOW_LEFT" />
    <assessment type="OWAS" joint="ELLBOW_RIGHT"/>
    <assessment type="EAWS" joint="EllR"/>
</joint>
```

The attributes type and joint of the assessment tag refer to user-defined strings, i.e., identifying strings specific to the used assessment method and software. With the assessment tags, the model skeleton and the assessment method are loosely coupled.

3. Conclusion

An XML description language was introduced that allows the definition of abstract body skeletons that can be annotated for various MoCap systems and different ergonomic assessment methods.

We have shown that the description language can be easily integrated into software applications. SKAML makes it possible to increase the maintainability, reusability, and adaptability of the software, which reduces the development effort for new technologies and methods.

Also, the formalization of the description avoids errors and enables automatic consistency checks using the XSD grammar. Additionally, SKAML may be used in conjunction with formally defined digitized assessment methods, e.g., formulated using Arden Syntax. In subsequent additions, we plan to expand SKAML by modeling motion constraints, and we will provide an Open Source library (libskaml) as a convenience for developers and researchers.