# A First Approach to Generate Hybrid Animations for Maintenance Tasks in IPS²

**Ulrike Schmuntzsch, Ulaş Yılmaz, Ralf Reichmuth & Matthias Rötting**
**{usc, uyi, rre, mro}@mms.tu-berlin.de**
Department of Psychology and Ergonomics, Chair of Human-Machine Systems
Franklinstr. 28/29, 10587 Berlin

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## Motivation and Project Objectives

Due to reduced prices and system complexity, Motion Capture (MOCAP) technologies, which traditionally are applied in ergonomics research and film/game industry, nowadays find more and more use in other areas (Bergler 2007, Brodie et al., 2008, XSens 2012). Another new technology, which finds application in an extended set of areas,like online markets or computer games, is the provision of instructions by animated virtual characters in order to successfully support a multitude of different users. Yet, when considering maintenance tasks, there are only few examples (Ziegeler & Zühlke, 2005). A well-known one is the animated pedagogical agent "Steve", who teaches users how to use or overhaul complex machines (Rickel & Johnson, 1999). According to Rickel (2001) many advantages are united in animated pedagogical agents such as attention guidance with gaze and gestures. The major benefit is a deeper and faster learning process especially of procedural knowledge. This results from synchronizing oral explanation with visualized action sequences and with that a much more facilitated transfer of practical knowledge (Mischas & Berry, 2000).

Regarding the context of *Industrial Product-Service Systems* (IPS²), which are characterized by a variety of different users, contexts of usage and highly specialized products and services an urgent need of descriptive and comprehensible user support is clearly noticeable (Uhlmann et al., 2008, Schmuntzsch & Rötting, 2011). Thus, our IPS²-related project (SFB/ TR29 B4) focuses, inter alia, on the combination of MOCAP technology with the modeling of an animated pedagogical agent, who demonstrates how to perform a maintenance task in an instruction video. In this article we will give a brief overview of the design process and address the advantages and challenges which came up.

## Design Process

The overall design process of hybrid animation consists of three consecutive steps explained in the following sections.

### Capturing Hand Movements with MOCAP

The first step is to use a data glove to capture hand movements of a human operator replacing a spindle on a micro milling machine as shown in Figure 1.

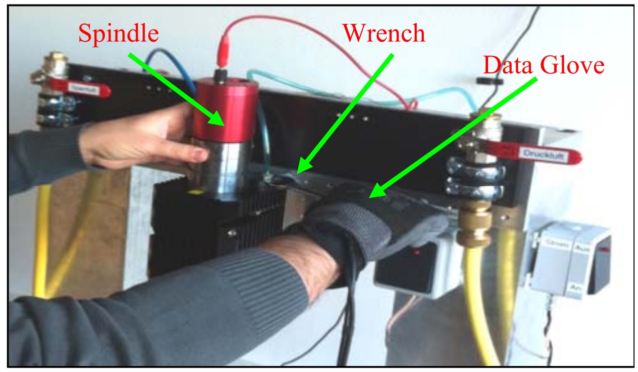


Figure 1: Replacing the spindle of a micro milling machine using the data glove.

There are four typical data glove systems on the market: optical, mechanical, inertial and bend. We chose a system that uses bend sensors so that we could safely acquire the hand movements without the effects of occlusion and the magnetic interference of the metallic parts. We use an *X-IST Wireless DataGlove* that has bend sensors on fingers (X-IST 2009): The sensors are located on each finger, 2 being on the thumb and 3 on each of the rest. Each sensor delivers a raw value in range [0, 1024] that corresponds to the relative bend of the finger bone at that instance. Since these bend values vary depending on the anatomy of the operator's hand, finding a general mapping of them on to a virtual hand model is a challenging task. Thus, we have implemented an interactive interface through which the operator calibrates the data glove, in order to get a personalized bend value to virtual hand mapping schema. Note that, with X-*IST DataGlove* hand rotation is poorly captured through inertial sensors and finger spread is not to be acquired at all.

### Creating the Human Model

The second step of the design process is to build a human model of the animated pedagogical agent by using the software tool *MakeHuman 1.0 alpha6.0*, which is followed by the export of the human model as "Blender Exchange" in *mhx* file format. Besides the human model, the micro milling machine with its spindle and different tools, such as a torque handle, allen key and jaw spanner, were created with the program *Autodesk Inventor 2012* and also exported to a *Blender* suitable Format. Hereafter, all exported models were modified through several small adaptations in order to create a natural and familiar impression on the user (See Figure 2).

Figure 2: Human model as virtual character in *Blender*.

After animating the visual sequences of events of the maintenance task, -in this case the spindle change-, the associated and already recorded oral explanations are integrated in the instruction video (Schmuntzsch, Reichmuth, Sturm & Rötting, to appear).

### Creating the Hybrid Animation of MOCAP and the Human Model as Instruction Video

In a third step, the combination process is carried out. i.e. the captured hand movements are mapped to the human model in *Blender*. The hybrid animation obtained through this process combines the easy-to-model and relatively coarse body movements with through data glove acquired and fine hand movements, which brings a considerable amount of realism to the created instruction video. There are two possible ways to merge the hand modeled animation and the animation acquired using the data glove. In the first approach, typical gestures of the hand are acquired and they are inserted as keyframes in the hand modeled animation. This approach is quite appropriate when the hand movements have repeating gesture patterns which do not vary much over time. In the second approach, dynamic action sequences are acquired and mapped on the overall animation by scaling over time. This approach enables modeling complex hand movements; however, it increases the number of introduced keyframes. In our study we use both approaches depending on the action under consideration: Grasping a tool is acquired as an action sequence whereas the hand state before and after the grasp action is acquired as a static hand gesture.

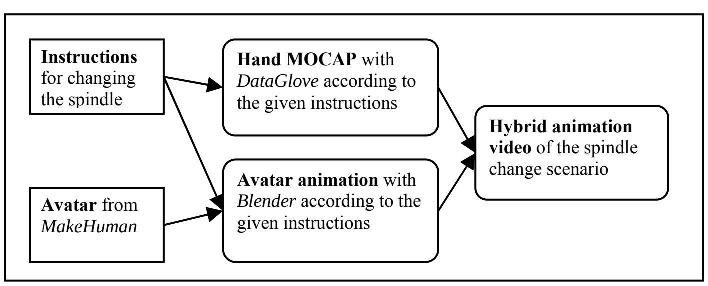


Figure 3: Overall system architecture.

## Conclusions and Future Work

This article describes the first steps in generating a hybrid animation for maintenance tasks in IPS². Starting off by capturing hand movements with a data glove, creating a human model followed. Then, we create a hybrid animation as an instruction video by combining the MOCAP and the human model. Overall system flow is illustrated in Figure 3. Even though these technologies are used in the film industry for quite a long time, IPS² is a rather new field of application. Growing product complexity and increasing heterogeneity of users and contexts highlight the importance of understandable and illustrative user support such as video instructions. Since maintenance tasks in IPS² require a great amount of dexterity, MOCAP systems allow exact visualization of single finger movements. Currently, the captured hand movements are combined with a full-body animated human model. However, we are striving for an integration of a data glove and a full-body motion suit to create instruction videos for maintenance tasks.

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