Chapter 2 STATEMENT OF THE PROBLEM

Skeletons from motion capture can be produced by two broad categories: predictive and direct. Predictive methods start with an existing pose and, through constraints or rules, projects forward to find the next pose or fills in between data. These methods are good for filling in missing data or solving for new poses for a skeleton where no data existed before. Examples of predictive methods are inverse kinematics and kinetics. These methods are basically simulations of what the skeleton should look like based on some rules. Direct methods, on the other hand, are raw calculations that produce a skeleton from existing motion data. Examples of direct methods are sphere-fit joints and best-fit whole skeleton squishing. The problem addressed in this thesis lies in direct skeleton formation from motion capture data. The solutions presented do not in any way predict where a skeleton should be but instead calculates directly from raw motion data where the skeleton is currently. The motion capture systems in use today produce real-time data, but producing a skeleton usually involves many off-line processes. Iterative procedures, both linear and non-linear, are currently used to produce a skeleton that fits the data. Although some of these are considered fast with today's computers, they still take much computer labor. The goal of this thesis is to produce a faster direct measurement of a skeleton that produces a solid basis for further uses.

2.1 Why are skeleton calculations required?

Joint locations are one of the key steps in producing animation from motion capture data. Just like the human skeleton, a skeleton from motion capture data is a solid framework on which shapes can be attached. The movie industry has been using motion capture for the purposes of animating a figure (e.g. Gollum of "The Lord Of The Rings") for many years. The status quo for this science seems to satisfy many industries. The research presented here will show that producing a skeleton can be improved ten-fold in speed.

2.2 Problems encountered

Many animation systems require painstaking detail to determine point of rotation. A-priori knowledge of the skeleton is a major obstacle in finding joint locations. The human body does not come in standard sizes and the point of rotation is below the skin making measurements difficult. The a-priori measurements taken are usually segment lengths and marker positions on the body. Unfortunately, most readily available motion capture data do not come with this detail. There are ways around the measurements of the actor. They usually involve a non-linear iteration of squishing a skeleton until it fits the motion capture data as in Kirk:2005 [60].

2.2.1 Inaccuracies

The inaccuracies in determining joint location can be divided into two types - positional and systematic inaccuracies. Positional errors are those that simply explain the error ellipsoid around the position coordinates. These are usually referred to as measurement error and are symbolized as σ for the standard deviation and Σ for the full variance-covariance matrix in this paper. Systematic errors involve gradual drifts, hysteresis, or other kinds of "slippages". One simple example on a marker system is when a marker is placed on loose clothing so that the marker position does not represent a stationary position on the segment. Even if the marker is glued flush with the skin, the fact muscles flex and contract will introduce systematic errors. It would be better if the markers were drilled under the skin and attached to the bone, but volunteers are hard to find.

2.2.2 Non-standard Files

Another issue that comes with motion capture data is that files incompletely follow a standard format. This may result in integers being stored in signed instead of unsigned format or vice versa. This produces messed up data that may or may not be visible after the file is read. Some of the fields in files may be filled incorrectly. This would lead to unknown behavior or worse.

2.2.3 Missing Data

There are many situations that occur during a motion capture session when data becomes unavailable to grab. Markers can be occluded during even normal motion depending on angles and positions of cameras. This shows up in the data file as various frames of data with missing pieces. The reader of the file must carefully consider what to do when data is missing. Frame-based storage of the data has inherent holes whereas linked data can skip over these holes as long as the non-linear time increments are considered.