

1. Overview

The dataset is intended for evaluation of methods for activity recognition and human pose estimation that use inertial sensor data as an input. It was recorded with a set of 6 inertial orientation sensors that were synchronized to an optical, marker-based motion capture system. Two of the sensors were attached to each of the arms of the subjects and one sensor was attached to each leg. In total, 9 subjects were recorded on a set of 11 activities, where each activity was repeated five times by each subject. The activities considered in this dataset (along with their short names) are shown in the following table.

Activity	Name	Description
1. Clapping hands	clap	Clapping hands in front of the body.
2. Golf swing	golf	A golf swing with an imaginary golf club.
3. Raising arms	hurrah	Raising arms as in the case of happy excitement.
4. Jumping jack	jack	Jumping jacks, moving arms and legs.
5. Jumping on one leg	jump	Jumping on one leg, keeping the arms together.
6. Knee bends	knee	Knee bends with arms stretched out forward.
7. Binding shoe laces	laces	Kneeing down, reaching to one foot, standing up.
8. Picking up an object	pickup	Reaching to the ground with right hand.
9. Scratching head	scratch	Scratching the had with the right hand.
10. Walking	walk	Walking in a relaxed style in circles.
11. Waving	wave	Waving with the right hand above the head.

The files provided with this dataset contain multiple streams of data extracted from the inertial sensors and the optical motion capture system. For every captured frame, the following information is available:

Data	Count	dof	Description
1. Inertial Acceleration	6	3	Acceleration vector with 3 spatial components.
2. Inertial Gyroscope	6	3	Gyroscopic rate with 3 spatial components.
3. Inertial Orientation	6	3	Orientation in yaw, pitch and roll.
4. Inertial Angular Velocity	6	3	Angular velocity in with 3 spatial components.
5. Marker Position	14	3	Position of motion capture markers in space.
6. Marker Orientation	14	3	Orientation of motion capture markers in space.
7. Joint Position	13	3	Position of skeleton joints in space.
8. Joint Angles	13	1-3	Joint angles for each skeleton joint.

2. Directory Structure

After extraction of the compressed file archive, a hierarchical directory system is revealed. At the first level, there is one directory for every subject, labeled by imaginary person names. Each person's directory contains 6 sub-directories named "calib" and "seq1" through "seq5". The "calib" directory contains body parameters for each subject that allow calibrating the skeleton model. The directories "seq1" through "seq5" contain the data files for each of the five repetitions per subject. The contents of these directories are listed in the following table, with reference to the data types described in the previous table. The structure of each file type is presented in the following sections.

File Name Pattern	Type	Description	Provided Data
art_{activity}.drf	ASCII	Tracking system files	5, 6
is{1-6}_{activity}.txt	ASCII	Inertial sensor files	1, 2, 3, 4
angles_{activity}.txt	ASCII	Joint angle files	8
joints_{activity}.txt	ASCII	Joint position files	7

3. Tracking System Files

The files “art_{activity}.drf”, where “{activity}” is replaced with the names given in the first table, are generated by the ART Dtrack optical marker-based tracking system. A reference manual is provided by the manufacturer and can be downloaded from <http://ar-tracking.de>. A short outline is presented here. The files are plain ASCII text files comprised of the following line triplet for each frame:

```
fr t
ts -1.0
6d n [k 1.0] [p_x p_y p_z 0 0 0] [r_11 r_12 r_13 r_21 r_22 r_23 r_31 r_32 r_33] [...]
```

Here, t is a frame number that is also used in all other files for synchronization. n gives the number of markers present in a frame (typically 14). The following block is repeated for every marker, where k is replaced with the marker number (from 0 through 13). The marker position is given by p_x , p_y and p_z , the nine elements of the rotation matrix specifying the marker's orientation are given by the values r_{ij} .

4. Inertial Sensor Files

The actual inertial sensor data is stored in files named “is{1-6}_{activity}.txt”, where “{activity}” is replaced with the names from the first table and “{1-6}” identifies each of the six sensors. Each line in these ASCII files contains the inertial data for one sensor and one frame:

```
t o_x o_y o_z a_x a_y a_z n_x n_y n_z g_x g_y g_z
```

Here, t is the frame number determined by the tracking system. o_x , o_y and o_z is the orientation of the sensor in degrees (yaw, pitch and roll), a_x , a_y and a_z is the acceleration in the three spatial directions, n_x , n_y and n_z is the angular velocity and g_x , g_y and g_z is the gyroscopic rate. Before every movement begins, the sensors were reset to a reference boresight direction.

5. Joint Angle Files

The joint angle files, named “angles_{activity}.txt”, contain motion-capture-processed data, i.e. the tracking system data was used to fit a skeleton body model by means of an inverse kinematics method. The skeleton model (described below) has a total of 39 degrees of freedom, corresponding to 13 joints with 1 or 3 degrees of freedom, each. Joints with 1 degree of freedom are hinge joints (e.g. elbow, knee), joints with 3 degrees of freedom are ball joints (e.g. shoulder, hip). These 3 degrees of freedom are represented by 3 subsequent rotations around 3 axes. Each line of the joint angle files is constructed as follows:

```
t {7 x LA} {7 x RA} {7 x LL} {7 x RL} {12 x TO}
```

The frame number t is followed by five blocks of numbers representing joint angles (in radians) for the left arm (LA), right arm (RA), left leg (LL), right leg (RL) and torso (TO). For the arms, the 7 values are nk , sh_x , sh_y , sh_z , el , wr , and hd for the neck, shoulder, elbow, wrist and hand. The hand value is present for technical reasons and can be ignored. The 7 values for the legs are constructed accordingly. The 12 values for the torso represent angles of a simple spine model capable of frontal and lateral bending.

6. Joint Position Files

While the tracking system files give the positions of the optical markers placed on the subjects' body, the joint position files are motion-capture-processed. The joint positions are thus the result of fitting the skeleton body model described below to the marker positions (see Figure below). The joint angles mentioned in the previous section typically suffice for representing a human pose – the joint positions are provided for completeness. Analogous to the joint angle files, each line in the joint position files is structured as follows:

t {21 x LA} 0 {21 x RA} 0 {21 x LL} 0 {21 x RL} 0 {36 x TO}

After the frame number t , there are five blocks of numbers, separated by zeros. Each block corresponds to one of the blocks of the joint angle files. This time, instead of single joint angles, there are three values for each joint characterizing its spatial location. For instance, the 21 values in the left arm (LA) block are the 3D locations for the 7 joints of the left arm.

7. Body Calibration Files

To be added soon.

8. Skeleton Model

To be added soon.

