

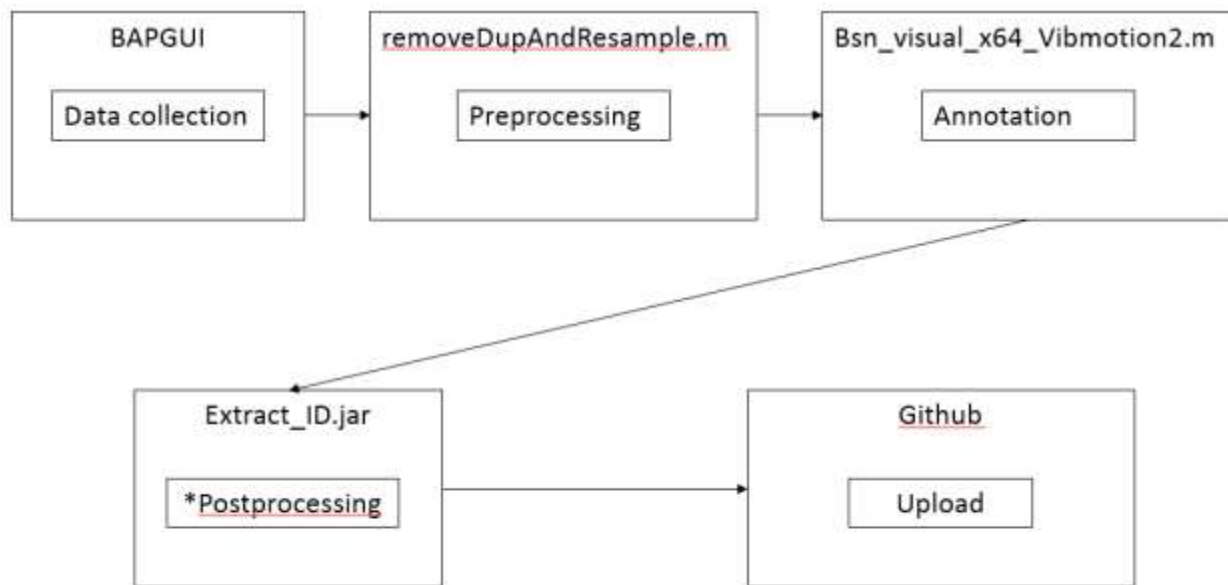
MoST
Guide to Developing
And
Collecting Data

An Introduction

It's probably best to understand the thinking behind the MotionSynthesis Toolset (MoST) project before diving too far in. You can also read the published work to understand this [[MotionSynthesis toolset \(MoST\): a toolset for human motion data synthesis and validation](#)], but a short overview is provided here. For most research endeavors, one of the most time consuming and labor intensive portions of a project is the collection of data. Many groups attempt to alleviate this by providing pre-collected datasets for specific fields. MoST can fit into this category, with a small twist. The data provided is human activity data meant for activity recognition and related research areas. We provide this data by collecting it from human subjects.

Each collection from a subject consists of several movements performed repetitively while wearing six inertial sensors in predetermined locations. The idea is that the movements performed are “low level” activities. The novelty in this tool is that these movements can be strung together to form higher level activities for algorithm validation. An example of this might be taking a subject’s “lying down”, “lie to sit”, “sit to stand”, “walking” data and forming a wake-up routine. This is the main motivation behind this toolset.

In this guide we will walk through the steps taken when collecting data from a subject, and how we process the data. The order in which things occur can be seen in the following diagram:



*: This step is no longer necessary/performed

First we do our data collection from the subject using the BapGUI software. After this step, we preprocess the data for use with the annotation tool named bsn_visual. The idea behind annotation is to segment the data to get the portions where the subject performed the specified activity, differentiating them from the data not containing any activity of interest. After annotation, we used to do a step in which we separated that data from the non-activity data, but after some feedback we stopped. The process will still be outlined in this document. Finally, the data is uploaded to GitHub.

MoST Data Collection Steps

NOTES:

Data can should be collected using the BapGUI software on a PC running Windows 7. Windows 8 has the following known issues when using the BapGUI software: It is possible in some Windows 8 installations that BapGUI will either fail to initialize, or that the video will be created with a frame rate that differs from the expected frame rate of 15 frames per second (fps). This second potential issue is particularly troubling as the video is still saved as though it were a 15 fps video so it plays at half speed if the video is captured at 30 fps.

It is also of note that many of the steps listed below refer to tripod positions and individual sensors. The tripod positions refer to individual camera placements that allowed for the most efficient data collection with a subject – grouping together movements that could be done using the same props and camera angle. If any further collection is done, new sensors will be used so the table in the following section will be useless (sensor #s and COM port #s will be different).

Collection Steps

1. Ensure subjects have all charged sensors on his or her body with the USB port/micro-SD card slot facing up (□) when in the neutral standing posture.
2. Connect the external webcam to the PC via USB. Make sure that the webcam is the main camera device on the PC (Control Panel > Device Manager > Imaging Devices > Disable any webcam that will not be used).
3. Start the BapGUI application: wait for both the application and video stream to open.
4. Select subject number, select movement number, and position camera according to the chart below. Leave the "Experiment" number at 1. The second chart directs where to place the legs of the tripod and where to face the camera.

Position	Camera Location	Tripod Placement
1	Looking at open area where a chair may be placed.	T_1
2	Looking at shelf at angle where dominant arm is clearly visible	T_2
3	Looking at table with subject's arms visible	T_3
4	Looking at a bed so subject's full body visible	T_4

5. Make sure all of the boxes next to each sensor is checked in BapGUI. Make sure the port numbers are correct (referenced in the chart below)
6. Click "Initialize" in BapGUI. Check to make sure no connections failed to connect. If it failed to connect, click "End Collection" and try again.
7. Wait 15 seconds after all sensors have a lit blue LED.

8. When you are ready to collect the data, click "Collect Data." All movements are repeated for 15 repetitions unless otherwise stated below.
 - a. #14: Basic Standing - 35 seconds
 - b. #15: Basic Sitting - 35 seconds
 - c. #16 Basic Lying - 35 seconds
 - d. #17: Walking – 4 steps
9. Click "End Collection" when you are finished with each movement.
10. Ensure that a video has been created for the movie in the "video" folder.
11. Update Experiment and Movement numbers
12. Click "Initialize" and prepare for the next movement.
13. Repeat steps 6-12 until all movements have been collected.
14. Preprocess data.

Sensor #	Corresponding body position
1	Right Ankle
2	Waist
3	Right Arm
4	Right Wrist
5	Left Thigh
6	Right Thigh

Tripod Position 1 (Movement 1, 2, 5 - 8, 10-11, 14-15, 17-23)

1. Sit to stand

Prop Location: Place chair so that it faces camera and subject's full body is visible when seated or standing.

Repetitions required: 15

Description: Have subject start by sitting down on the chair. Start the collection then ask the subject to slowly stand up and sit back down; this is counted as one repetition.

2. Stand to sit

Prop Location: Place chair facing camera as in Sit to stand.

Repetitions required: 15

Description: Have subject start by standing up in front of the chair. Start the collection then ask the subject to slowly sit down and stand back up; this is counted as one repetition.

5. Step Forward & Backward

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Start the collection then ask the subject to step forward with his/her right foot first. Full body should be visible after the subject steps forward. Then wait 2-3 seconds then step back, right foot first; this is counted as one repetition.

6. Looking back Right

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Start the collection then ask the subject to turn his/her torso and look behind him/her. And then wait 2-3 seconds then step turn to the starting position; this is counted as one repetition.

7. Grasp from floor

Prop Location: Place an object that can easily be grabbed in one hand in front of subject. Should be fully visible by camera.

Repetitions required: 15

Description: Have subject start out by standing with the object in front of them, so that they face the camera and their full body is visible. Start the collection then ask the subject to bend over and pick up the object and return to the default position. Then wait 2-3 second and return the object to its starting position; this is counted as one repetition.

8. Turn Right 90 degrees

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Ask subject to turn to his/her right then pause for 2-3 seconds and return to his/her default position; this is counted as one repetition.

10. Jumping

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Ask the subject to jump every 3-4 seconds; this is counted as one repetition.

11. Step Left then Right

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Have subject step left, wait 2-3 seconds then return to his/her default position; this is counted as one repetition.

14. Stand in neutral posture

No props required for this movement.

Description: Have subject start out by standing facing camera with full body visible. Have subject stand still and collect 35 seconds worth of data.

15. Sit with feet on floor

Prop Location: Place a chair facing camera, so that the subject's full body is visible when the subject is seated.

Description: Have subject start out by sitting still in the chair. Collect 35 seconds worth of data.

17. Walking

No props required for this movement.

Description: Have the subject take 4 small steps towards the camera.

18. Sitting with leg crossed

Prop Location: Place a chair facing camera so that subject's full body is visible while seated.

Repetitions required: 15

Description: Have subject start out by sitting in the chair. Start the collection and ask the subject to place his/her right ankle on his/her left knee. Wait 2-3 seconds and return to default position. This is one repetition.

19. Sitting with crossed ankles

Prop Location: Place a chair facing camera so that subject's full body is visible while seated.

Repetitions required: 15

Description: Have subject start out by sitting in the chair. Start the collection and ask the subject to place his/her right ankle on his/her left ankle in front of the chair. Wait 2-3 seconds and return to default position. This is one repetition.

20. Standing with legs crossed

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Start the collection and ask the subject to cross his/her right leg over left leg. Wait 2-3 seconds then return to default position. This is one repetition.

21. Standing with one leg forward

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Start the collection and ask the subject to step only his/her right leg forward and shift his/her weight onto the right leg. Wait 2-3 seconds then return to default position. This is one repetition.

22. Kneeling

No props required for this movement.

Repetitions required: 15

Description: Have subject start out by standing facing camera with full body visible. Start the collection and ask the subject to step only his/her right leg forward and kneel then return to his/her default position. This is one repetition.

23. Using a phone

Prop Location: Have subject hold a cell phone in his/her hand.

Repetitions required: 15

Description: Have subject start out by standing still facing the camera with their full body visible with his/her hand down. Start the collection and ask the subject to raise his/her phone onto his/her ear. Wait 2-3 seconds then return to default position. This is one repetition.

Tripod Position 2 (Movement 9)

9. Grasp from Shelf

Prop Location: Place an object on whichever shelf position is most comfortable for the subject.

Repetitions required: 15

Description: Have subject start by standing directly in front and facing the shelf. Their full body and the object on the shelf should be clearly visible at all times. Start the collection then ask the subject to grab the object and return to his/her resting position. Wait 2-3 seconds then return the object to its location on the shelf and put arm down to his/her side; this is counted as one repetition.

Tripod Position 3 (Movement 12-13)

12. Eating

Prop Location: Place a plate and a fork/spoon on the table directly in front of the camera.

Repetitions required: 15

Description: Have the subject raise spoon/fork close to his/her mouth and put it back down. This is counted as one repetition.

12. Drinking

Prop Location: Place a cup on the table directly in front of the camera.

Repetitions required: 15

Description: Have the subject raise cup close to his/her mouth in a drinking motion and put it back down. This is counted as one repetition.

Tripod Position 4 (Movement 3-4, 16)

3. Sit to lie

No props required for this movement.

Repetitions required: 15

Description: Have the subject start by placing his/her feet firmly on the ground while sitting on top of the bed. Start the collection and have him/her lie down, wait 2-3 seconds and sit back up and place feet on ground. This is one repetition.

4. Lie to sit

No props required for this movement.

Repetitions required: 15

Description: Have the subject start by lying in bed. Start the collection and ask him/her to sit up and place feet on the ground, wait 2-3 seconds and lie back down. This is one repetition.

16. Basic lying

No props required for this movement.

Description: Have subject lie still in bed. Collect 35 seconds worth of data.

Preprocessing

BapGUI produces files related to the sensor data and related to the video data for each run. For preprocessing, we perform some small operations on the sensor data which is placed in the 'Split' folder by BapGUI. All that this step entails is placing a MATLAB script named `removeDupAndResample.m` in the same folder as the Split files and running it. This will produce a new folder which contains the preprocessed data files. These files, along with the Video files, are the files used by the annotation tool used in the next step.

The preprocessing step does basically three things. The first row in a data file contains column labels that interfere with MATLAB opening the file in the annotation step. Removing this row is the first thing it does. The second thing it does is remove duplicate or incomplete packets that may have arrived over the Bluetooth connection. The last thing it does is remove incomplete lines at the end of a data file in the event that the last packet was incomplete (a rare problem that pops up now and then).

Data Annotation Instructions

Annotation is the step where we go through and segment the data to contain only the movements of interest. This involves running the `bsn_visual_x64_vibmotion2.m` MATLAB script in the same folder as your 'Split' and 'Video' folders – as the script looks for those two folders in its working directory and then runs using the files contained within them.

The goal is to go by hand and match both the data and video to find start and end points of movements performed by the subject. You will mark the start and end points of a movement with an annotation point, created by either right clicking or hitting the space bar. This part of the process is the most labor intensive and time consuming due to the large amount of manual labor involved in the visual inspection and annotation of the data.

Instructions on annotating each individual movement:

Movement 1 – Sit to stand:

Start: When the person begins to stand up

End: When they have finished standing up (when no significant movement is occurring)

Movement 2 – Stand to sit:

Start: When the person begins to sit down

End: When they have finished sitting down (when no significant movement is occurring)

Movement 3 – Sit to lie:

Start: When the person begins to lie down

End: When they have finished lying down (when no significant movement is occurring)

Movement 4 – Lie to sit:

Start: When the person begins to sit up

End: When they have finished sitting up (when no significant movement is occurring)

Movement 5 – Step forward & backward:

Start: When the person begins to step forward

End: When the person is again back at their original position.

Movement 6 – Looking back right:

Start: When person begins to look back to the right

End: When the person is again looking straight forward

Movement 7 – Grasping from floor:

Start: When the person begins to reach down

End: When the person has stood back up. Note: *Do not* annotate the times when the person is putting the object back on the ground. It may be very similar in type of movement, but for the sake of consistency we will not annotate these.

Movement 8 – Turning 90 degrees to the right:

Start: When the person begins to turn to face right

End: When the person has finished turning right. Note: Unlike the movement Looking Back to the Right, we do not want to annotate when the person is facing forward again.

Movement 9 – Grasping from shelf:

Start: When the person begins to grab the object from the shelf

End: When the person has the object and is close to their original position. Note: *Do not* annotate the times when the person is putting the object back on the shelf, same as Grasping from Floor.

Movement 10 – Jumping

Start: When the person begins to jump

End: When they have landed, and the data from the sensors has subsided a little.

Movement 11 – Step left and right:

Start: When the person begins to step to the left

End: When the person is back in their original position

Movement 12 – Eating:

Start: When the person begins to lift the utensil up towards their face

End: When the person has moved the utensil back towards its original position.

Movement 13 – Drinking:

Start: When the person begins to lift the cup up towards their face

End: When the person has moved the cup back towards its original position.

Movement 14 – 16, Basic ____:

These movements are a little special. We want these in ~200 sample segments. The reasoning behind this is that the data was collected at 200 Hz, meaning each 200 samples is 1 second. The first start should be around 10 to 50 samples in, or whenever there is not much activity in the data. *We want to avoid sections where the subject is moving around.* Just chop these into 200 sample segments as best you can avoiding movement.

Movement 17 – Walking:

Start: When the person begins to put their first foot forward

End: Every subsequent time the person begins to put this first foot forward.

Example: Person puts their right foot forward first. We want an annotation here. They have taken a step with their left foot and the right foot is beginning to move forward again. We want another annotation here, and another directly after it (this is the start of the next annotation – remember annotations are in pairs of two), and then again when they are about to put the right foot forward again, etc.

Transitional Movements:

The following movements are special, in that they are what we refer to as 'transitional'. What this means is that each movement has a transition into a neutral state, followed by a neutral state (that could potentially be held for a long period of time), and then followed again by a transition back into the original state. For each time that one of these movements is performed, there should be 4 annotations – one at the start of the transition in, one when they are in the 'neutral state', one when they begin to transition back to their original state, and finally one where they are at the original state.

Movement 18 – Sitting (1) (legs crossed over knee)

Movement 19 – Sitting (2) (legs crossed at ankles)

Movement 20 – Standing (1) (legs crossed over one another while standing)

Movement 21 – Standing (2) (shifted weight onto right foot)

Movement 22 – Kneeling

Movement 23 – Using Phone

Hotkeys for the data annotation tool

←, → **on arrow keys:** move cursor left or right 1 frame.

Up on arrow keys: play video, moving cursor along with it at 1x speed.

Down on arrow keys: play video, moving cursor along with it at 1/3x speed. This can be slow on less powerful computers.

Delete an annotation: Hit 'd', then hold down right click and slide over to define the area in which annotations are to be deleted

Zoom in: Hold down 'shift' and left click, sliding to the right over area to zoom in on

Zoom out: Hold down 'shift' and left click, sliding to the left over any amount of the graph to show the full graph.

Place annotation: Hit 'space' or right click

Postprocessing

In this step of the process we will take the original files and annotation points to chop up the data into individual repetitions of the collected movement. There is one program used for this step: it is called ExtractID.jar. With this program, there are three options. The first option, fix up a file, can be ignored (it is a relic from when preprocessing was done by this program instead of the MATLAB script). The other two options are the ones used in postprocessing: Extract index and extract data. For each movement, you must go through each step (a little tedious, yes – but rewriting it is a difficult task because video extraction is done by a MATLAB script after Java).

First, select Extract Index from file: this will open a file selection menu. Navigate to and choose an index file generated by the annotation tool (usually under annotations/default) and open it. After this is completed, select the Extract data option and you will get another file selection menu. Navigate to and choose the 'split' files associated with the movement you just extracted index from. After this completes, it will call test2.bat which will call Untitled2.m to do the video splitting.

Finally, the last step to perform (though this step is not entirely necessary) is to run the RightNumeration.m script. This will open a file selection menu. Choose the split files generated by the ExtractID.jar step and hit open. What this does is change the sensor timestamps in the file to start from 0, so that it appears as though it is its own individual collection.

Adding to GitHub

It is a good idea for this step to familiarize yourself with Git version control. There are plenty of resources online regarding this, even directly from GitHub. You can also simply use the GitHub GUI interface instead of the shell interface, though at the time of this writing the GUI interface is unreliable compared to the shell interface.

There is a certain file structure format to storing the data that can be seen by simply observing the file structure of the subjects on GitHub. The movements are separated by individual movement. The 'raw' data refers to data that has not been post-processed, and annotations are the indices that index the actual movements inside the file.

Working on the Java code

There are a couple things you need to have to work on the Java code. The latest (not necessarily, but this is always a good thing to have) version of the JDK, and eclipse. On the GitHub is actually an eclipse workspace, so all you have to do is download the GitHub files and point the eclipse workspace at the GitHub workspace and you should be set to work on the code files.

Additionally, as of this writing there are two workspaces, a workspace and workspace_new. In workspace_new, you will find an unfinished attempt to develop an updated version of the Diary Generation tool. The goal of this tool was to stop using the graph panel (as it provides no useful information) and to update the tool so that it could select subjects based on age range and gender, as well as the features that were already there such as selecting certain nodes and certain modalities. It is actually somewhat far along in development, but time constraints and other projects have made it uncertain as to whether this will be finished.