# MITes Data Collection and Annotation Instructions

For questions, contact Stephen (617-232-5755, intille@mit.edu).

## Software Installation

If you have any previous MITes software installed on the computer, backup all acquired data if you have not done so already. Next, delete the relevant directories (e.g. C:/MITes).

Installing the MITes software requires running one setup program.

Run the provided MITes installation MITesSetup.msi file and install the software on your PC. Once the installation is completed, you will find on your Start menu an 'MIT' entry. To run the software choose MIT> MITesDataCollection Software.

One icon will be placed on your desktop. You can also reach it under Start Menu (under Programs - > MIT).

If MIT updates the software, you will be sent a zip of the new installer program and you simply have to reinstall (which will write over the older version).

## Hardware Installation

In order for the MITes to work, one or two receivers must be properly connected to the computer. For flexibility, use a laptop with a standard USB port.

The image below shows the MITes receiver. Be careful with this device. It is fragile and can be sensitive to static electricity. If you are in an environment where you are feeling static shocks, be sure to ground yourself by touching a large metal object before touching the MITes receiver. This is especially true if you are working on carpet and it is particularly dry.


Ensure that no devices are using the COM1 port, such as a serial port mouse or a PDA docking station cable. Unplugging those devices and rebooting the computer will probably free COM1.

Plug the receiver into the USB port. If the electronics should slip out of the plastic case, try not to touch the components and gently slide them back into the case.

If you have never used the receiver on this computer before, Windows will detect a new USB device. You need to install a "serial to USB" driver. This allows the USB receiver to work. This only needs to be done once on each computer the first time the receiver is plugged in. At that time, direct the windows driver installer program to use an existing driver in the MITesSetup/FT232BM/winXP directory.

The receiver should now be ready to go.

**Running the MITes Data software**

If the program does not run (you will get an error message about debugging), it is probably because you don't have the .NET Framework Version 1.1 installed on the computer. The .NET Framework can be installed (on XP, anyway), by running Internet Explorer and running WindowsUpdate from the Tools menu. It seems to be installed automatically if you install the XP service pack 2 update. Alternatively, you might need to look under optional installation packages for the .NET Framework. Once this is installed, MITesDataCollection should work. If it does not or you get an error, contact Stephen – something is missing from your computer (but missing from these instructions).

The software will take you through a number of steps to configure a data collection session. Initially, you will see the form shown in Figure 1. The form is resized to your screen size. This is to allow the software to run on devices with small screen sizes.

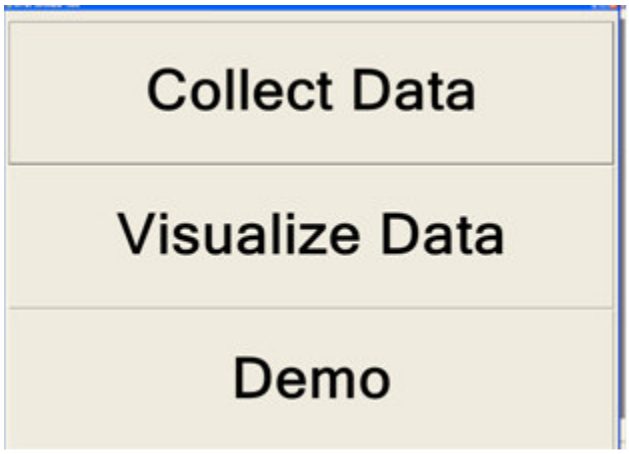



**Figure 1, MITes Software Tools**

At the moment, you can only use the Collect Data option. Once you click the collect data option, you will see the MITes Data Collection Setup form, shown in Figure 2.

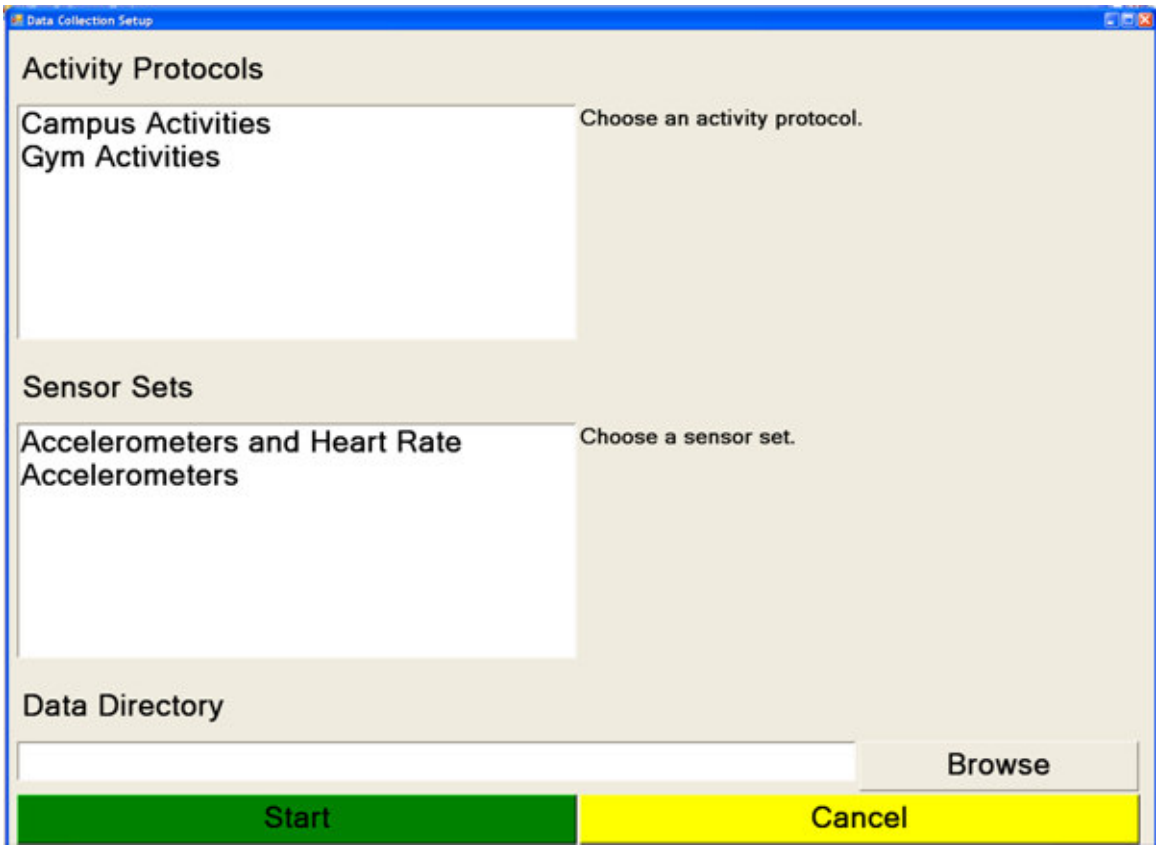



**Figure 2, MITes Data Collection Setup Form**

To start collecting data, you will need to choose an activity protocol, a sensor set and a data directory. An activity protocol is stored in an XML file that includes different sets of activities and labels. All activity protocols are stored in your installation directory under NeededFiles\ActivityProtocols. For a discussion of the format of an activity protocol file, please see Appendix A.

A sensor set is described in an XML file that includes the different sets of sensors that you will be using in the data collection process. All sensor set files are stored in your installation directory under NeededFiles\SensorConfigurations. For a discussion of the format of a sensor set file, please see Appendix B.

Once you have selected the activity protocol and the sensor set, choose a data directory then click start. **If you choose to store files in a directory that you have used earlier and contains ActivityLabelsRealtime.xml, SensorData.xml and SubjecData.xml. You will need to delete these files manually before re-using the directory.**

A progress bar will show as the software detects connected MITes receivers. It is important to emphasize that the number of MITes receivers has to coincide with the selected Sensor Set. For example, if the set requires 1 receiver then 1 and only 1 receiver has to be connected. If 2 receivers are listed in the sensor set then 2 receivers have to be connected.

Once the receivers are detected, a subject data form will pop up, shown in Figure 3. You may click cancel and an empty subject xml file will be created in your data directory for later editing.

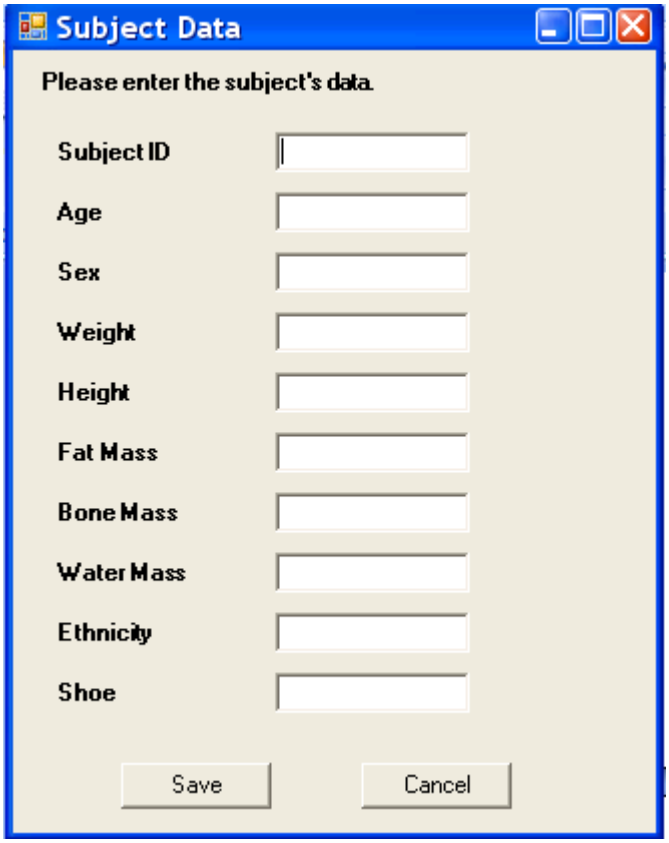



**Figure 3, Subject Data Form**

Once the subject data is entered and saved, the annotation window and a MIT Environmental Sensors Window will popup as shown in Figure 4 and 5, respectively. By clicking on the different categories, you will be able to scan through the different labels that you have within each category. Once you make your choices, click start to record an entry. Click stop to save the entry in the output annotation file in your data directory. You will find 2 versions of the annotation file an XML version and CSV version.

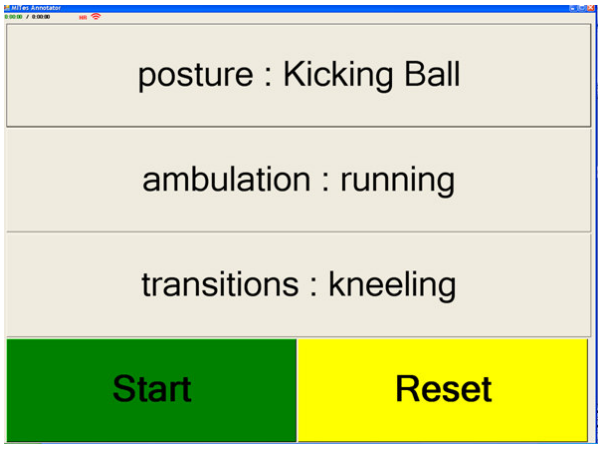



**Figure 4, Annotation Window**

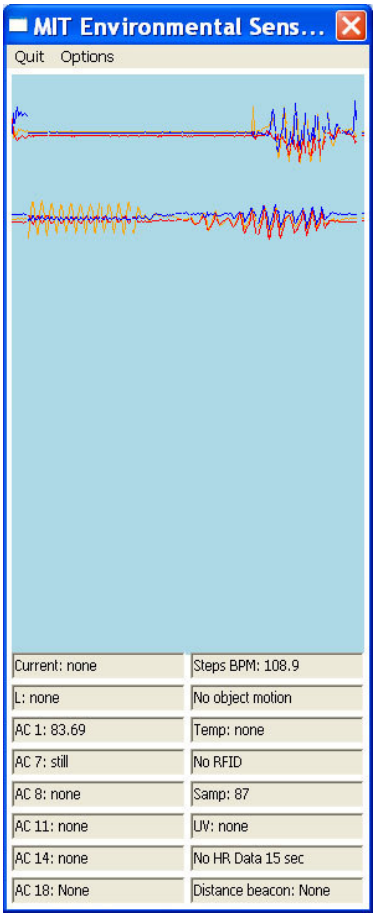



**Figure 5, MIT Environmental Sensor Window**

Figure 6 shows the annotator toolbar. On the left of the toolbar, there are 2 timers that are used to track the progress of an activity annotation. The second timer (in black) specifies the time duration that passed since the 'start' button has been clicked. The first timer (in green) specifies the time duration that passed with good quality data. In a perfect

situation, the black and green timers will move together indicating that all captured data is of good quality.


**Figure 6, Annotation Toolbar**

Two visual indicators are at the top right of the toolbar to indicate the quality of the wireless signal between the HR transmitter, accelerometers and the receivers. Both the HR and the Signal indicator  turn red when the quality drops. Good quality data will result in green indicators. For more detailed statistics on the performance of each sensor, click on the signal indicator  . This will pop up a sampling rates window (shown in Figure 7) that will show the sensor ID along with the % of expected samples that are received by that particular sensor. The percentages will update in real-time and can be useful in debugging or optimizing the placement of sensors on the body.

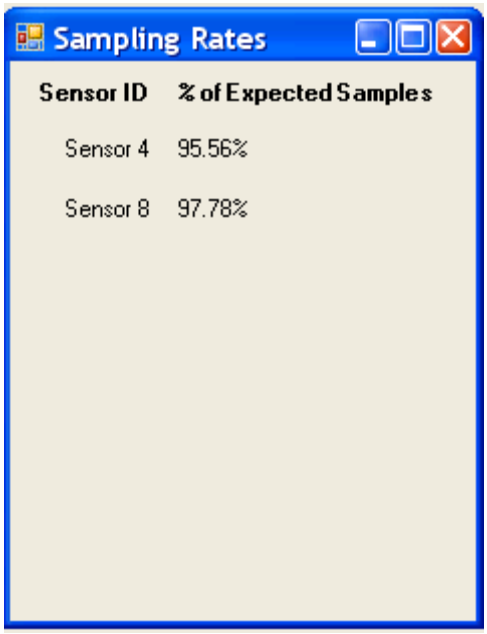



**Figure 7, Sampling Rates Window**

So far, the program is getting no data because only the receiver is powered up, not the transmitters, which contain the accelerometers. To start, you need to insert batteries in the MITes transmitters.

The next image shows some MITes. You can use up to 5 MITes simultaneously, plus the heart rate monitor with the current software. The sampling rate drops as more MITes are added.


To start the MITes transmitters, you simply insert a fresh coin cell battery. Be sure the positive (+) side of the battery faces the "+" mark on the MITes battery holder. Slide the battery all the way in. Once you do this for the MITes you want to use, the display should start graphing acceleration data, as shown in the screenshot. If you shake each of the MITes transmitters you should see the corresponding signal in real-time, without any noticeable lag. If there is lag, it may mean the computer you are using is significantly slower than those this software was tested on … contact Stephen.

Each MITes has an ID number. This can be found on the small label on the chip inside the casing. It looks like "7 D 10G 442". You can ignore everything here except the first number, which is the channel, and the third number/letter, which stands for 10G. You can only run 1 MITes with the same ID at a time, so you should select MITes with IDs 1, 7, 8, 11, and 14. You have at least one 2G MITes (probably ID 1). **You cannot run the 10G MITes with ID 1 and the 2G MITes with ID 1 at the same time**.

It is possible that the receiver is not set to listen to the right channels of the MITes you are using. To check this, go to Options -> Set Channels1 (for receiver 1) or Options-> Set Channels2 (for receiver 2). If you don't see "0 1 7 8 11 14" under current then click on Change -> Add -> and add the channels you want to use. You must then hit Change -> Set to actually set the receiver. If you are using the HR monitor, you should always have channel 0 set. "Channels 0,1,7,8" sets the receiver to listen to channel 0 (HR) and accelerometer's 1,7, and 8. You want to set the receiver to be equal to the channel numbers of MITes you are using. If you use three MITes, use only 0,1,7,8. If you use one MITes, use only 0,1. If you are using all 5 MITes, you should use 0,1,7,8,11,14. (The non-consecutive numbers have to do with wireless channel frequencies and minimizing interference). You do not need to do this every time if you are using the same MITes every time. The receiver remembers the last state even when unplugged.

Shake each device in the three directions and you should see the three signals. After a few seconds, you will see the activity counts being display in the text boxes (AC1 = activity count for the first MITes (ID1). AC7 is the activity count for the second MITes (ID7)). By default the epoch length is set to 1 second (for a longer epoch length the data can be manipulated in Excel). When the sensors are sitting perfectly still you should not see values changing … it should say still. If you see noise, contact Stephen. If the program has not heard at all from the accelerometer, it will say "none". Note that right now the accelerometers do not plot in ID order (i.e., the first line is not necessarily from accelerometer with ID1).

If you look closely, you will see that the software is plotting all three axes on each device.

Now you can plug in the HR monitor. You should have someone wearing the band. Assuming everything is working properly, you should start to see HR data indicated in the text box. When using the HR monitor, unplug it by pulling out the black plug from the plastic casing carefully. Don't unplug the battery each time, because the 9V battery connectors tend to break after a while.

If you have the audio turned up on the computer and all sensors are plugged in and working, you should not hear any more sounds except an "ok" ping once every 30 seconds.

To quit the program, use the "Quit" button. You may not see any data in the saved files until you quit, and you should not load the data file into another program while the MITes AC program is accessing it.

**Data**

The data collection and annotation programs will continuously save data to the C:\MITesData\data\ directory. This directory is created if it does not exist.

That directory has the following subdirectories: activity, log, raw, ims, labels. The main activity count data (and HR data) is saved in the activity subdirectory by the MITesDataRecorder program.

The datafiles are named with the date at the time of creation. For example, the file:

MITesActivityData.2005-5-16-10-44-46-950.csv

Is a comma-delimited file of activity counts saved on May 16, 2005 at 10:44 AM, 46.950 seconds. The .csv file contains all the activity count data in a format easy to load into Excel.

Other types of data (e.g. raw accelerometer signals, special log information) are saved in other directories. Some applications save images in the ims subdirectories, although not for the CS-EMA study.

The MITesDataRecorder program will continuously save the activity counts in the specified MITesActivityData.*.csv data file. The first line in the data file is the key, indicating what data is in each column.

Col D indicates the type of data in the row. Some data are log COMMENTs. The second line is the KEY. You can filter this out easily in excel if processing the DATA lines.

```
Each DATA line has
```

- A computer-specific system time (in milliseconds)
- The date and time the data value was saved
- Milliseconds
- A code indicating what type of information is to come (typically DATA)

This information is followed by data for specific sensors that may or may not be attached. Columns for sensors not used can be deleted. See the KEY line.

Data includes:

- The activity count value for x axis for each MITes
- The activity count value for y axis for each MITes
- The activity count value for z axis for each MITes
- The 3 axis activity count value for each MITes
- HR value (or "NO_HR")
- HR average value over last 30 seconds (or "NO_HR_AVE")

There are other types of data used in other studies. These columns can be ignored.

The csv file can be loaded into Excel to combine values to create longer epochs or to look at values from specific axes. If you would like us to change the format of this file we can easily do that.

Any entries with negative values or extremely large values are bad data and should be deleted.

The file also contains some lines marked as COMMENT instead of DATA. These can be deleted when plotting/manipulating raw data. Do not delete them permanently, however.

When doing annotation using the PDA, it is necessary to synchronize the PC and the PDA. This is done by hitting a sync button on both the PC and the PDA. This adds timestamps to a .log file. Sync marks are added by clicking on Options -> Sync -> Misc

This will put a line in the log file (saved in the log directory with a name of the format MITesLogFileBytes.*.log) such as

```
9064914 5/16/2005 11:41:16 AM: timeSync 304
```

This can be used later to find specific points in time in the data files very precisely. It is only needed when annotation is done using the PDA.

The MITesDataRecorder program also saves raw data to be used for signal processing algorithm development. This is saved in the raw directory with a format of MITesAccelBytes.*.b.

The MITesDataMerger program (described below) helps to organize all these files, in addition to merging the annotation and activity counts files.

**Set-up for data collection session**

Here is the procedure to follow when collecting data from the lab (using the PC annotation software).

1. Check that the computer clock has the right time and date. If not, correct this before beginning.
2. Plug the USB MITes receiver into the laptop.
3. Run MITesDataCollection.bat program.
4. Run MITEsActivityAnnotator. The 1st category should be left on "Setup" until annotation begins.
5. Make sure the laptop is not muted. You should hear funny sounds.
6. Put coin cell batteries in the mobile MITes.
7. Attach the 9V battery to the HR MITe sensor.
8. After a few seconds, you should see signals plotting for each MITe. Make sure that MITes are working properly by shaking each MITe in several directions and noting whether counts increase. No HR count will be detected yet.
9. If you are not receiving acceleration signals, double check that the receiver is set to all the right channels (options-> set channels).
10. Double check that you have 10G or 2G MITes as appropriate, depending upon what is currently being used for data collection.
11. Moisten HR strap and instruct subject on proper way to wear it.
    a. The HR strap should be as tight as comfortably tolerable, against the skin with the hard sensor centered on the chest.
    b. The HR MITe should be placed in a fanny pack worn around the waist of the subject, attached to belt, or in a shirt pocket. The HR MITe must be close in proximity to the HR strap in order for HR signals to be transmitted from the strap to the HR MITe.
12. Instruct the subject on how to wear the MITe sensors. The most common configuration for the MITes is to wear them on the ankle(s), wrist(s), and hip, depending upon how many MITes will be used. It should also be determined which MITe will be worn in each location, and whether 2G or 10G MITes will be used. The orientation of the MITes should be as follows:
    a. Top of dominant wrist with battery away from skin and pointed side of case toward the hand, as shown in the image.

b. Just above dominant ankle, on the outside of the leg, with battery away from skin and the pointed side of the case towards the foot, as shown in the image.

c. The hip sensor should be placed in the small black purse, with battery away from the skin, pointing towards the participants back, as shown below. This sensor may also be worn clipped to a belt.

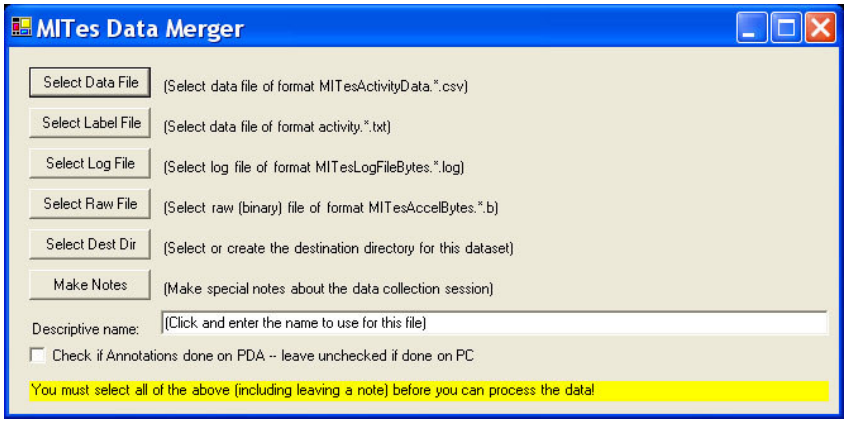
13. When the subject is standing near the MITes receiver, you should not hear any tones except for a beep every 30 seconds to indicate that the software is running. Counts should be recording for all MITes and for HR. If something breaks, a battery goes dead, or the receiver is too far from the sensors, you will hear tones.

**Annotation**

1. On Activity Annotator screen on laptop, click on each category to indicate what the subject is doing. Click in quick succession to choose appropriate action; by clicking quickly through the options until the desired option is chosen, the intermediate options that were passed over will not be recorded as data.
2. Use the "U" button to return to Unknown (or, in 1st category, to return to Setup, then click once to get to Unknown). Use the "B" button to go backwards to previous option.
3. When the MITesActivityAnnotator program is running, data will automatically be saved in the directory MITesData/data/labels.
4. When annotating session is complete, return all the categories to Unknown (except the first category, which should be returned to Setup) and close the MITesActivityAnnotator program on the computer by click on the tiny little square in the bottom left corner.
5. Close the MITesDataCollection.bat program.

**Cleaning and merging data**

1. After each annotation session, data should be cleaned and merged using the MITes Data Merge and Clean program.
2. Open this program. You will see a screen like the one shown here.
3. Select the data file that was just collected



by clicking on Select Data File. There should only be one file in the activity folder that you are directed to, if merge and clean is performed after each annotation session. If there is more than one file, choose the file with the date and time that indicates when the annotation session began.

4. Select the annotation file that was just collected by clicking on Select Label File. There should only be one file in the activity folder that you are directed to, if merge and clean is performed after each annotation session. If there is more than one file, choose the file with the date and time that indicates when the annotation session began.
5. Select the log file that was just collected by clicking on Select Log File. There should only be one file in the activity folder that you are directed to, if merge and clean is performed after each annotation session. If there is more than one file, choose the file with the date and time that indicates when the annotation session began.
6. Select the raw file that was just collected by clicking on Select Raw File. There should only be one file in the activity folder that you are directed to, if merge and clean is performed after each annotation session. If there are more than one file, choose the file with the date and time that indicates when the annotation session began.
7. Click on Select Dest Dir to select a destination directory for the file. By clicking this button, you will automatically be directed to: MITesData/cleaned. Click OK to select this location.
8. Click Make Notes to make any notes about this annotation session, such as anything that went wrong during the session, etc.
9. Enter a descriptive name for the file in the space provided. For consistency, name files with the activity(s) done and the date. If more than one session was done on the same date, indicate the particular sessions by consecutive letters. For example, if two annotation sessions were performed on January 4, 2006, measuring a subject's activity using the treadmill, the files could be named: S1-Treadmill-01-04-06-a and S1-Treadmill-01-04-06-b.
10. For now, annotation will be performed on the laptop, so the check box for using a PDA may be ignored.
11. Click on the Merge button and then quit.

This program will merge the annotation file and the activity counts data file to create a new master file with both sensor data and annotations with the format: [nameYouCreated].labels.csv. This will be saved in C:\MITesData\cleaned\[nameYouCreated]\

Also in that directory will be the notes file for that data collection session: [nameYouCreated].notes.txt.

Also in that directory will be all the original files moved to one convenient location: C:\MITesData\cleaned\[nameYouCreated]\origFiles\

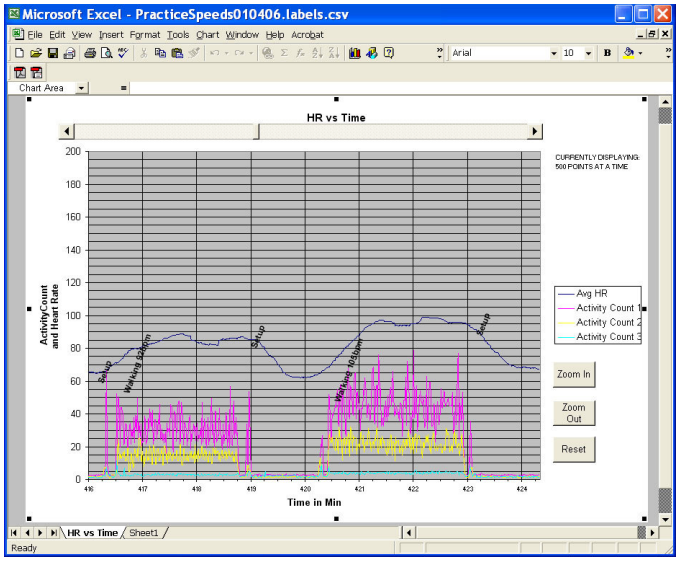
**Final manual cleaning of data**

At this point you should immediately look at the C:\MITesData\cleaned\[nameYouCreated\ [nameYouCreated].labels.csv file in excel and manually clean it up further.

First, look at the cleaned, merged file. Locate any data that is irrelevant, such as MITe data and HR data recorded during setup. This data may either be deleted or labeled to indicate that it should not be used. Deleting bad data may be best, but if the data will be labeled rather than deleted, an identifier may be added to the Comments column (e.g., you could change "DATA" to "JUNK_DATA"). Only delete rows, not columns, otherwise the graphing program may not work.

Now you should graph the MITes and label data, to make sure it looks reasonable and there are no unexpected missing chunks. You can do this by loading the C:\MITesData\cleaned\[nameYouCreated\ [nameYouCreated].labels.csv file in excel. Then load the GraphCSEMA.xls macro. You can find this on the desktop or under the Start menu (Programs->MIT->GraphCSEMA.xls). When you load it, Excel may ask if you want to enable macros. Click "Yes" or "Enable Macros". Switch to the [nameYouCreated].labels.csv excel page. Scroll to the right side of the data. Control-click to highlight each of the label columns that you want to graph (cols BA-BH). For example, if you only want to graph one type of label, only select that column. You select an entire column in Excel by clicking on the column label at the type of the column. To graph the data, press Alt-F8 and then select MyMacros.xls!ChartMacro.

If all goes well, you should see a plot of data from the accelerometers and the HR with the annotated labels overlaid as shown in the image. If there is no data, values plot as zeros. You can click on the scroll bar to move back and forth through the data. When you quit the graphing program, **do not save changes to the file!** The operation of graphing adds junk data to the original file that you don't want to save.




This graphing program still has some bugs, so it may crash, especially if you do a lot of zooming in and out. Here are known issues we hope to fix at some time:

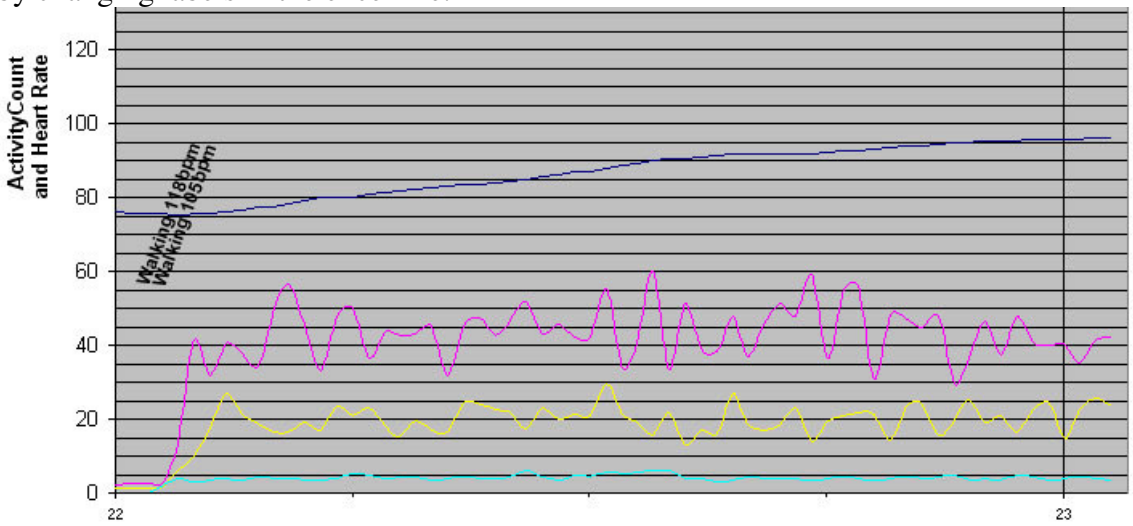
- If you have a very short data file, the program will crash.
- Sometimes zoom in/out can cause problems

- The labels always appear shifted slightly to the right (few seconds) on the plot of where they actually begin.
- Reset doesn't work well

If you try to plot a file and it doesn't work, email the file to Stephen immediately.

If any strange data is noticed by visual inspection of the plot, make additional notes in the [nameYouCreated].notes.txt notes file to explain this and propose any possible solutions.

You might notice that in some cases you have a double label as in the image below. This happens if the annotator did not switch to the new label quickly enough. If there is a pause of a second (e.g., below the annotator probably paused on Walking 118bpm when selecting walking 105bpm), then the program will not automatically clean the first label. We can increase the allowed pause time, but when people annotate fast activities on the PDA this time must be short. Annotators should try to get to the desired label with as little pausing as possible. These type of mislabeling situations could be manually cleaned by changing labels in the excel file.




When the data files are cleaned and merged through the MITes Data Merge and Clean program, the raw data files will automatically be moved from the data folders to a different location. However, if other files are still in the data folders (e.g. because you started and stopped the programs during setup), and these files are junk data files (i.e., files that contain no worthwhile data, were accidentally created, etc.), they should be deleted to avoid future confusion. If you do this step very time you collect data, you can simply delete the entire C:\MITesData\data directory. Don't do that if you think someone else may have left uncleaned good data files, though.

**Sending data files**

To send data files to others, zip the directory: C:\MITesData\cleaned\[nameYouCreated\ and then email the ip. This contains the cleaned and original files. For a long data collection session, it may be several megabytes. To make a smaller zip, remove the raw data file (.b file).

**Battery Life**

When not using the MITes, don't forget to unplug the receiver and remove the coin cell batteries.

The coin cell batteries will last about 30 hours each. The receiver 9V battery should last for at least several days of use. If any batteries fail, you will be able to tell because the data collection program will no longer display data. When in doubt, use a new battery because an old battery may work but transmission range may not be as good.

**Range**

You should try to maintain a distance of 10-15 feet between the receiver and the transmitters. You can test the range in your lab by watching the signal graphs and moving away until they stop or become sporadic. If you have the sound on, you will hear odd sounds when any of the sensors go out of range.
20-30 feet ranges indoors are typical. Outdoor range is better because there is less metal. A coin cell battery that is not fresh will first reduce transmission range before it stops working completely.

We have tested these devices in environments with WiFi (i.e. 802.11b) and other wireless devices and have not experienced significant drops in performance. However, it is still possible an environment with unusual amounts of RF or metal could reduce range or signal quality in a way we have not experienced at MIT. Microwave ovens and vaccums are known to seriously interfere with the signal.

**Attaching sensors**

We have custom made some Velcro carrying cases. However, we have found that tennis wristbands are the most comfortable for most people. We have also found that rectangular bandages are good ways to attach the sensors, particularly to a location above the knee. Once on, the sensors attached with bandages are easily forgotten. The downside is that the bandages hurt when pulled off and can cause irritation with several days of continuous use.

**Appendix A:ActivityLabelsRealtime.xml**

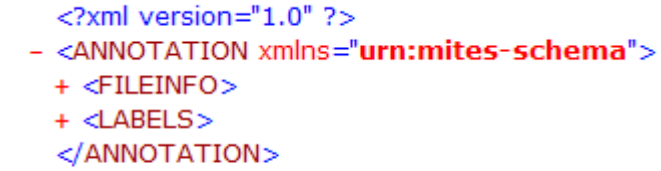



**Figure 8, Activities XML File**

The activities file specifies the different types of activities that are loaded by the annotation software and therefore can be used to change the activity labels that you want to use prior to a data collection session. As shown in Figure 8, the XML consists of a root ANNOTATION element that comprises two sub-elements: FILEINFO and LABELS. The FILEINFO element can be used to specify the subject's name, the location of the experiment, the name of the observer and any additional notes. Please note that all activities.xml files need the FILEINFO element, however, you may choose not to fill in the information in each field.

```
- <FILEINFO>
    <SUBJECT NAME="Fahd Albinali" />
    <LOCATION NAME="house_n Lab" />
    <OBSERVER NAME="Fahd Albinali" />
    <NOTES NAME="Observing physical activities of 2 users in the house_n lab
      with 2 mites attached on their ankle and wrist" />
  </FILEINFO>
```

**Figure 9, FILEINFO XML Element**

The second component of an annotation element (shown in Figure 8) is the LABELS element. This allows you to define an unlimited number of categories of mutually exclusive activities. Figure 10 shows a LABELS element with 4 different categories including social context, posture, ambulation and transitions. Within each category you can specify an unlimited number of labels that represent mutually exclusive activities.

```
- <LABELS>
  + <CATEGORY NAME="social context">
  - <CATEGORY NAME="posture">
      <LABEL NAME="bending over" />
      <LABEL NAME="sitting" />
      <LABEL NAME="squatting" />
      <LABEL NAME="standing still" />
      <LABEL NAME="sitting" />
      <LABEL NAME="lying still" />
    </CATEGORY>
  + <CATEGORY NAME="ambulation">
  + <CATEGORY NAME="transitions">
  </LABELS>
```

**Figure 10, LABELS XML Element**

## Appendix B : SensorData.xml

```
<?xml version="1.0" encoding="utf-8" ?>
- <SENSORDATA dataset="My Test">
  + <SENSOR class="MITES" type="ACCEL">
  + <SENSOR class="MITES" type="ACCEL">
  </SENSORDATA>
```

**Figure 11, Sensors XML File**

The sensor file specifies the different types of sensors that are being used in a set of experiments. As show in Figure 11, the XML consists of a SENSORDATA element that

includes sensor sub-elements. The dataset attribute is a description of the dataset and can be an empty string. Sensor elements belong to the MITES class and can be of 2 types ACCEL or HR indicating accelerometers or heart rate sensors respectively.

```
- <SENSOR class="MITES" type="ACCEL">
    <ID id="4" />
    <OBJECT text="" />
    <RECEIVER id="1" />
    <LOCATION text="Right hip" />
    <DESCRIPTION text="On-Body Channel 4 2G Flat surface to body and pointing
      down" />
  - <DISPLAY displaytype="DISPLAY_BOX" x="780" y="531">
      <COLOR on="orange" off="blue" />
    </DISPLAY>
    <CALIBRATION xmean="287.49" xstd="1.25" ymean="287.30" ystd="1.47"
      zmean="271.24" zstd="6.20" />
  </SENSOR>
```

**Figure 12, SENSOR Element**

A sensor element consists of 6 components:

- The ID element: This specifies the channel that the MITes sensor uses to transmit data. **The user has to specify the correct channel ID in the XML file for each sensor being used**. You can find the channel ID on the label shown on a MITes transmitter.
- The OBJECT element: Unused at the moment.
- The RECEIVER element: This element specified the ID of the receiver that is receiving data from the MITes sensor.
- The Description element: This is used to describe the particular sensor.
- The Display element: unused
- The CALIBRATION element: This element stores calibration data for accelerometers.

**Problems/Questions**

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