**Protocol**

**Physical and daily activity recognition by using three tri-axial accelerometers placed on wrist, chest and ankle**

**Study Aim and Objectives**

The current study aims to determine to what extent the placement of the accelerometer and feature selection method has on the recognition of the various activities.

The aims of the experiment will be assessed through the following objectives:

* To assess usability and acceptability of wearable inertial sensors in the tested individuals.
* To assess the impact of the number of accelerometers and the placements of accelerometers on physical and daily activity recognition in tested individuals.
* To assess the performance of feature selection method on the activity recognition accuracy.

**Methodology**

**Accelerometer**

The SHIMMER platform developed by Intel Digital Health Advanced Technology Group will be used as the base board for the investigation. The SHIMMER is a compact, wearable sensing platform with an integrated three-axis accelerometer, which runs on the TinyOS operating system. Sensor data from the SHIMMER’s triaxial accelerometer is transmitted via Bluetooth to a PC.

SHIMMER is a research prototype experimental device and so has not been fully tested to commercial product nor medical class regulatory approved standards. Consequently, there are some risks associated with the design and manufacturing that may be assumed when using the device in close proximity of the body of a test subject. To counteract these risks the device will be electrically isolated from the subject’s body during the course of the study.

**Participants**

10 health adults with no known neuromuscular, musculoskeletal, or cardiovascular pathology which may affect their ambulatory capacity are to be recruited for the investigation. All subjects are to provide written informed consent.

To reassure the individual regarding confidentiality, it will be made explicitly clear in the participant information sheet and again when collecting consent from the participant that no identifiable information will be collected. Each participant will be assigned an ID number on entry to the trial in order to ensure confidentiality. Each participant will be given advice on how to continue with their activities on completion of the trial and will be given directions of how and where to access these activities.

The detailed experiment setup is showed in Table 1.

Table 1. Experiment setup

|  |  |
| --- | --- |
| Sensors | Three accelerometers in shimmers(take the calibration time into consideration) |
| Placement | Right wrist, chest and right ankle |
| Sampling rate | 102.4 Hz |
| Mode | In the controlled laboratory environment, the subjects perform the activities by following a verbal guided sequence |
| Data collection and analysis devices | Android phone and windows PC |
| Software | ShimmerCapture/Matlab/Consensys |
| Communication Protocol | Bluetooth |
| Test subjects | 10 people (5 male, 5 female) |

Each activity will be carried out in the predefined order above a rest period of one minute will be observed between each activity and each repeat. Participants will carry out each activity five times to ensure repeatability and reliability of measurement. For the retest all sensors will be removed and reattached to provide insight into normal placement error. The detailed target activities description is showed in Table 2. Investigators will be continuously monitoring the subject during the study and one investigator will stand at the rear of the treadmill in case of trips or falls.

Table 2. Target activities description

|  |  |  |
| --- | --- | --- |
| Static activities | Standing | Standing still for 5 mins, the participants could stand still or stand still and talk, it is better not to move the arms and legs too much. |
| Watching TV | Watching TV at smart home, with sitting on the sofa in whatever posture the participant feels comfortable for 5 mins, changing sitting posture is allowed. |
| sleeping | Lying on the sofa while doing nothing for 5 mins, small movements such as changing the lying posture are allowed. |
| Transitional activities | Stand-to-walk | In order to capture the whole transition, the participant is told to perform the “stand-to-walk-to-stand”, standing still for 15s then start to walk, keep walking for 15s, then standing still for 15s, repeat for 15 times. The first foot step movement and the last foot step movement would be labelled. This transition will be divided into “stand-to-walk” and “walk-to-stand” in the data analysis phase. |
| Walk-to-stand |
| Stand-to-sit | The participant is told to stand still for 15s and then sit on the chair. The start point is backward movement after standing, the end point is sitting on the sofa (record finish point), repeat for 15 times. |
| Sit-to-stand | The participant is told to sit on the chair for 10s and then stand up. The start point is forward movement after sitting, the end point is standing still (record finish point), repeat for 15 times. |
| Sit-to-lie | The participant is told to sit on the sofa for 15s and then lie down. The start point is backward movement after sitting, the end point is lying on the sofa (record finish point), repeat for 15 times. |
| Lie-to-sit | The participant is told to lie on the sofa for 15s and then sit on the sofa. The start point is forward movement after lying on the sofa, the end point is sitting on the sofa (record finish point), repeat for 15 times. |
| Dynamic activities | Walking | 5 mins walking on treadmill with the set speed. |
| Doing exercise | 5 mins running on the treadmill. |
| Sweeping | 5 mins sweeping with the vacuum cleaner in the home area. |

**Data Analysis and Storage**

All acceleration measurements collected from participants will be stored in the Ulster University server and will be anonymised.

**Risk Assessment**

This experiment has minimal risk to those involved, however, the requirement to complete the 12 physical and daily activities may put extra burden on the participants time. Whilst we do not envisage any further risks of increased agitation and confusion, therefore, the activities will be carried out for only 10 - 20 minute slots in order to reduce this risk. This experiment does require the storage or analysis of personal task information which will be securely stored with only responsible members of Smart Environment Research Group (SERG) staff in Ulster University having access to such information. The data will be kept confidential at all times.

**Voluntary Consent**

Written information consent will be obtained from each participant taking part. Participants will be provided with a written explanation of the research. Both the participant information sheet and the consent form will clearly state that participation is voluntary and that participants can with draw from the experiment at any stage should they wish. Clear information will be given regarding how any queries or concerns from participants will be addressed.