Sleep Monitoring Component

The sleep monitoring component consists of four pieces of hardware, shown individually in Fig 1 (a-d). The Microsoft Kinect sensor (a) is a commercial device originally designed as a video game input controller. It is equipped with visible light colour, infra-red and depth cameras and a microphone array. Similar devices are available from other manufacturers. A tripod (b) is used to position the Kinect sensor with a good view of the bed (c) whilst the laptop (d) runs the monitoring software which logs data during a night of sleep. Though it's possible to use a standalone PC, a laptop is more convenient for deploying to a subject's home as the screen, keyboard and mouse are integrated into one portable device.

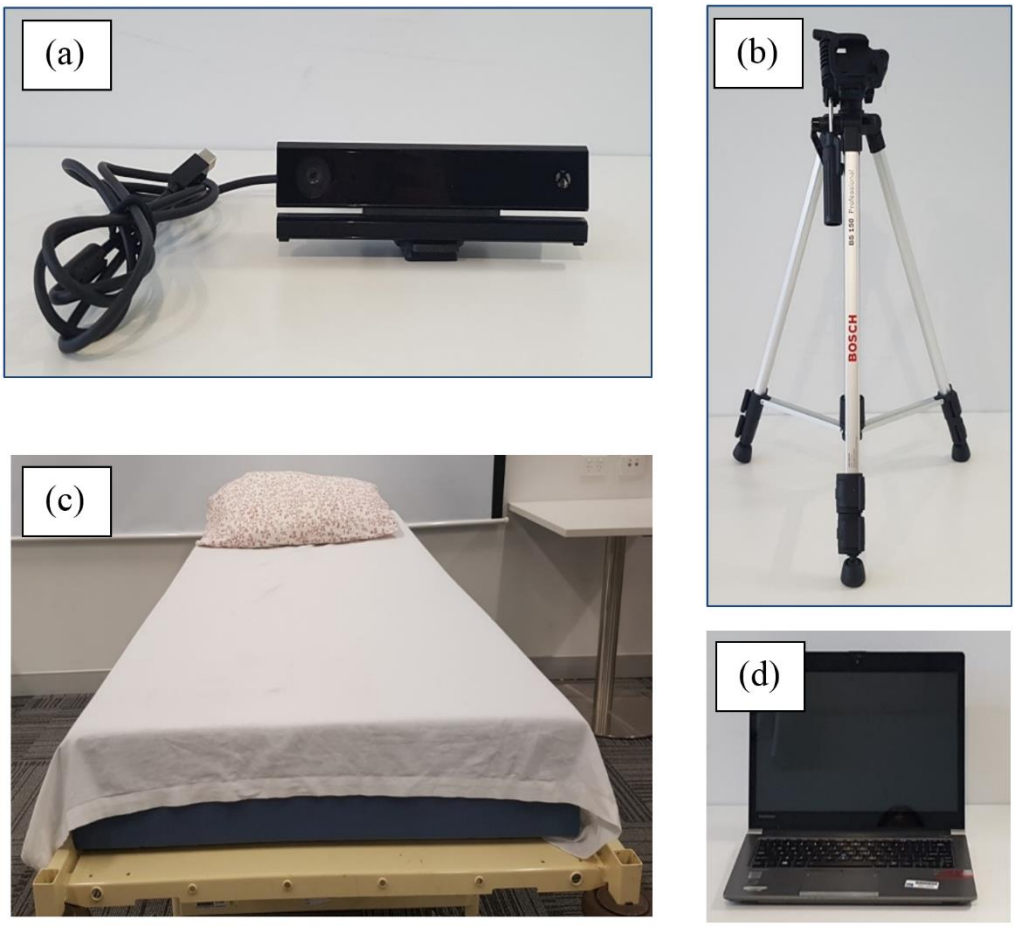

Fig 1. The four physical component of the monitoring system, (a) a Microsoft Kinect 2 sensor, (b) tripod to help position the camera, (c) the bed which is to be monitored, and (d) a laptop computer which can run the data logging software.

The system is shown set up in

Fig 2. The setup procedure consists of the following steps:

(1) Mount the Microsoft Kinect Sensor on the tripod.

(2) Position the Kinect Sensor and tripod at the foot end of the bed.

(3) Connect Kinect Sensor USB cord to the laptop.

(4) Have the client lie on the bed with toes at the end of the bed where the tripod is.

(5) Open the logging application on the laptop and adjust the tripod so that the Kinect sensor has a good view of the bed.

(6) Start recording. Lights, including the laptop display may be turned off.

(7) Finish recording once the desired data have been gathered.

Fig 2. Demonstration of the monitoring system set up and ready for monitoring.

The monitoring software saves still images from the colour, infrared and depth cameras at pre-defined intervals (default 7 seconds). For convenience, the software creates a new folder each time a new recording is done and includes date and time information.

Out of the three types of images, only the infrared and depth images are usable in a typical night of sleep where lights are turned off. We still store the colour images for verification on how much light was actually in the room. The Kinect provides a source of infrared light, allowing the infrared images to be captured in a dark environment. The depth camera produces an image where the brightness of each pixel represents the distance of that object to the camera, objects closer to the camera appear brighter. To demonstrate the performance of each camera in both light and dark environments, images from each are shown in Fig 3.

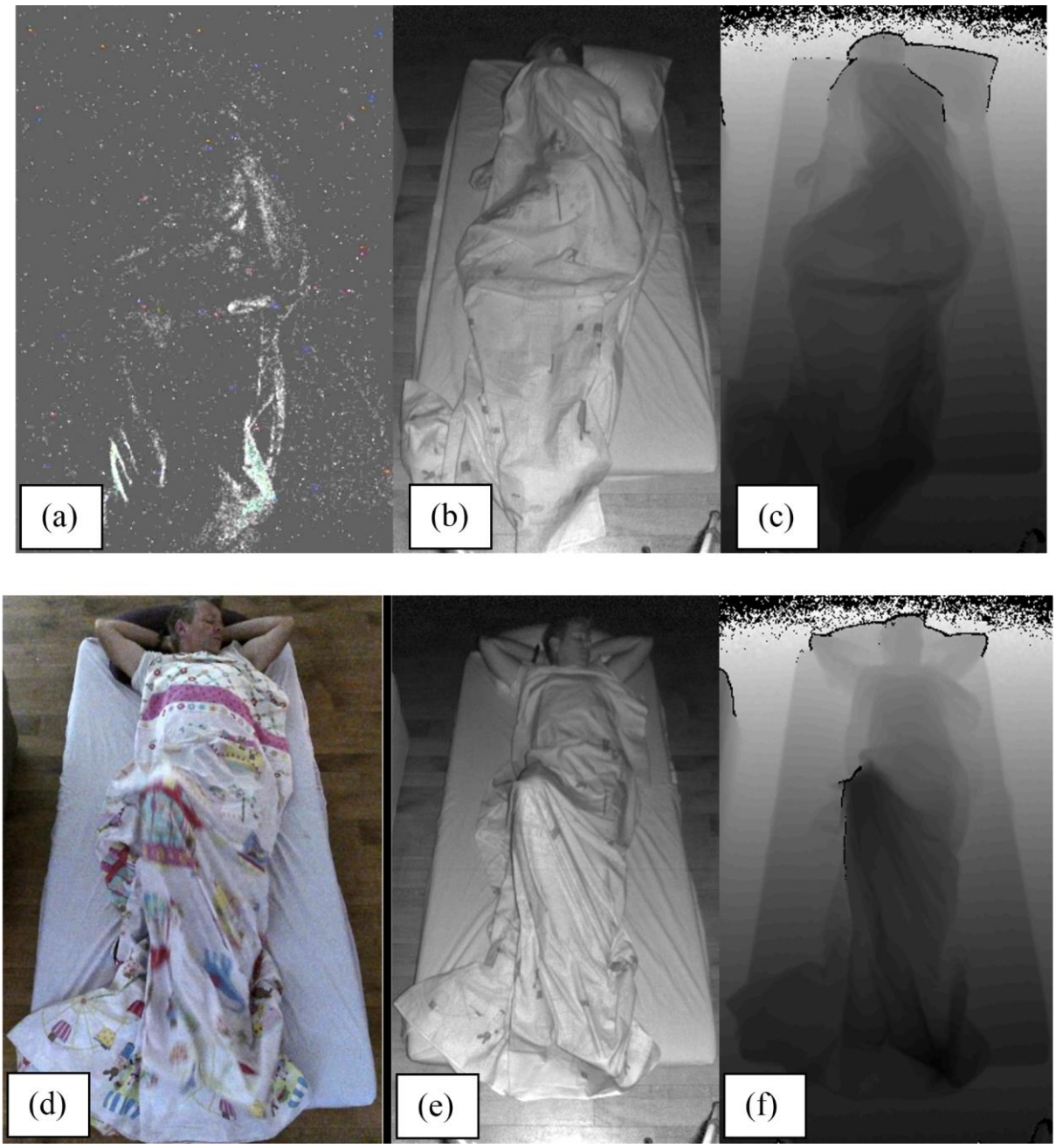

Fig 3. Example image from the colour (a), infrared (b) and depth (c) camera for a setting at night, and (d), (e) and (f) for morning with daylight illumination, demonstrating the independence of the infrared and depth images to room lighting conditions. The subject being monitored for this demonstration is one of the authors. Images have been cropped and contrast stretched to improve clarity.