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# Automated Remote Pulse Oximetry System (ARPOS) Methodology and Protocol

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1 Works for me

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## ABSTRACT

Participants took part in the Automated Remote Pulse Oximetry System (ARPOS) study where their vitals including heart rate and blood oxygenation level were measured using a camera-based system. Participants were asked to stand or sit in front of a Kinect V2 camera in resting state and later also retake vitals after doing some light exercise. The study took approximately 35 to 45 minutes per participant. In order to take part in the research study, participants were required to have an XBOX One or a Windows OS computer.

The anonymized data including the regions of interest extracted from the face (forehead, cheeks and lips) collected from the study are available from DOI:

<https://doi.org/10.5281/zenodo.6522389> (Pireh Pirzada, Automated Remote Pulse Oximetry System (ARPOS), May 2022).

## DOI

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#### KEYWORDS

rPPG, health monitoring, remote participation, real life scenario data, data acquisition

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#### GUIDELINES

After using the equipment, please follow the steps below:

1. Wash your hands before cleaning and packing the equipment.
2. Use alcohol wipes to clean the equipment properly.
3. Place the equipment inside its package.

#### MATERIALS TEXT

Windows OS PC or XBOX One

Kinect V2

Kinect V2 Adapter

Wellue Pulse Oximeter device

All the participants were required to have access to at least Windows OS PC or XBOX One to sign up for the study.

Participants within the UK, who did not have access to the required equipment were sent the material via courier. In cases where international participants did not have the commercial pulse oximeter, they were provided the option to use any device that could record vital data or to use the manual method of placing fingers on their pulse to measure heart rate.

#### SAFETY WARNINGS

Unplug all external power sources and cables before wiping the equipment with provided alcohol wipes.

#### BEFORE STARTING

COVID guideline: Please wash your hands before using the equipment.

## Study Information and Sign Up

- 1 Participants were asked to sign up for the research study using the Qualtrics consent form. All participants were required to have access to at least a Windows OS PC or an XBOX One to sign up for the study. Participants within the UK provided information regarding the equipment they had access to and details necessary to post equipment and a gift voucher to thank them for their participation. Participants outside the UK (worldwide) were selected on the basis that they had access to the required equipment. In cases where international participants did not have the same commercial pulse oximeter, they were provided the option to use any device that could record vital data or to use the manual method of placing fingers on their pulse to measure heart rate.



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St Andrews

### Automated Remote Pulse Oximeter System (ARPOS)

#### Your Participant Id is : PIS-8879

Please note down your Participant Id. This will be needed when you are logging into the ARPOS research study application. This Participant Id will only be active, once you have completed the consent form.

#### Participant Information Sheet (code : PIS\_07082020\_1\_ARPOS):

##### What is the study about?

We invite you to participate in a research project in which we will measure your vital signs such as heart rate and oxygenation levels using camera-based (Kinect) technology (Automated Remote Pulse Oximeter system – ARPOS). You may be asked to stand and sit in front of the Kinect camera and later also retake vitals after doing some light exercise. A pulse oximeter clip or a smartwatch may be used to also attain your vitals along with the ARPOS system.

**NOTE:** You must have access to an XBOX ONE or a WINDOWS COMPUTER to participate in the study. You will be able to download ARPOS application from Microsoft Store for free to your XBOX ONE or windows computer. You will receive instructions from the researcher to guide you.

##### Why have I been invited to take part?

You have been invited to take part in this study so we can test the hypothesis that the remotely measured values are comparable to the standard pulse oximeter values i.e. test the accuracy of the ARPOS system.

##### Do I have to take part?

This information sheet has been written to help you decide if you would like to take part. It is up to you and you alone whether you wish to take part. If you do decide to take part you will be free to withdraw at any time without providing a reason, and with no negative consequences.

##### What would I be required to do?

You will have a pulse oximeter clipped to your finger or a smartwatch on your wrist to measure your heart rate and blood oxygenation level as shown in the image below:



ARPOS Consent Form using Qualtrics.

- 2 Once the consent form was completed, an autogenerated unique participant-id (for example, PI-001) was shown to the participants. An autogenerated email configured using Qualtrics was also sent to the participants with the consent and participation information summary. The email also included their unique participant id number and a link to the study website to guide them further.

## ARPOS study Consent Form

Thank you for participating in ARPOS research study.  
This email contains your response summary and Participant number.

Please follow the steps on:  
<https://pp62.host.cs.st-andrews.ac.uk/web/>

If you have any questions, please contact on the details in signature.

Kind Regards,

Pireh Pirzada  
Researcher (PhD)  
School Of Computer Science  
North Haugh  
The University of St Andrews  
Fife, KY16 9SX, Scotland

Email: [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk)

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### Recipient Data:

Time Finished: [REDACTED]

ResponseID: [REDACTED]

Link to View Results: [Click Here](#)

URL to View Results: [REDACTED]

---

### Response Summary:

I understand the contents of the previous page (Participant Information Sheet 'PIS\_07082020\_1\_A.R...  
Yes

Autogenerated email containing consent, participation information and participant id required for the research study.

- 3 The ARPOS study website provided the study description, the application's latest version published on Microsoft Store, requirements for taking part in the research study, step guide for the research study (for Windows and XBOX One users), QR code and links to the content form and contact information of the researcher.

# ARPOS - AUTOMATED REMOTE PULSE OXIMETRY SYSTEM

RESEARCHER : PIREH PIRZADA, UNIVERSITY OF ST ANDREWS [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk)

Current Version of App is Version 1.3

This study is being conducted as part of Pireh Pirzada's PhD Thesis in the School of Computer Science at the University of St Andrews. We invite you to participate in a research project where we will measure your vitals such as heart rate and blood oxygenation level using camera-based technology (Automated Remote Pulse Oximeter system – ARPOS). You may be asked to stand and sit in front of the Kinect camera and later also retake vitals after doing some light exercise. You will receive instructions from the researcher to guide you. The study will take less than 45 minutes per participant. You will be given **10 GBP book voucher** as compensation for your time (for UK participants only). You must have an XBOX one or a windows computer to participate in the study.

**Note: The data collected from the study will be available for researchers to analyse for indefinite period. This data will include images of your face collected from the study but is not linked to your name and will be anonymised during publication. The analysed data will be published in a research journal/conference. The current study will test the hypothesis that the remotely measured values are comparable to the pulse oximeter values.**

If you are interested, please get in contact using the details below. You will then be given a Participant Information Sheet that further details our research and have the opportunity to ask questions, before being asked whether you consent to participate.

Contact Details: [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk)

ARPOS study website main page showing current version of the applications, description and contact details.

## PARTICIPATION GUIDE

Current Version of App is Version 1.3

Following are the steps to participate in the research study. Please click on each step to see details.

### STEPS FOR XBOX ONE:

- ➔ 1. Read Information about the research study
- ➔ 2. Consent to Research Study to participate
- ➔ 3. **(ONLY FOR UK PARTICIPANTS)** Wait for the Equipment (Kinect and pulseoximeter) to be sent to you (Researcher will contact you regarding more details). Please note you will not be able to proceed with the research study until you receive the equipment.
- ➔ 4. Setup Kinect with XBOX One (Video 1)
- ➔ 5. Setup Kinect with XBOX One (Video 2)
- ➔ 6. Download ARPOS Game Application and Setup the Equipment
- ➔ 7. Executing the Study
- ➔ 8. Please email your pulse oximeter data (in form of recorded video or text) to [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk). This is to submit pulse oximeter data or manually measured heart rate using fingers on pulse.

### STEPS FOR WINDOWS PC:

- ➔ 1. Read Information about the research study
- ➔ 2. Consent to Research Study to participate
- ➔ 3. **(ONLY FOR UK PARTICIPANTS)** Wait for the Equipment (Kinect and pulseoximeter) to be sent to you (Researcher will contact you regarding more details). Please note you will not be able to proceed with the research study until you receive the equipment.
- ➔ 4. Check Kinect Requirements (Please check the Requirements section of this website as well)
- ➔ 5. Setup Kinect with Windows PC
- ➔ 6. Download ARPOS Game Application and Setup the Equipment
- ➔ 7. Executing the Study
- ➔ 8. Please email your pulse oximeter data (in form of recorded video or text) to [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk). This is to submit pulse oximeter data or manually measured heart rate using fingers on pulse.

Steps for Windows OS PC and XBOX One users for taking part in the study.

### Equipment Postage within the UK

- 4 The researcher contacted and confirmed postal information from participants within the UK who required equipment to take part in the research study. International participants were also contacted if they had any questions regarding the study. The researcher activated international participants' unique Id once they confirmed they had access to all the required equipment. The equipment package to UK participants included Kinect V2, Kinect V2 adapter to USB, and Wellue commercial pulse oximeter device. A 10 GBP book voucher to thank them for their participation was also included in this package.

Wellue Bluetooth Finger Pulse Oximeter  
Pulse Oximeter

Wellue FS20F [↗](#)



Kinect Adapter for Windows PC and XBOX  
One  
Adapter

Microsoft B07HT4224B [↗](#)



Kinect V2  
Colour, IR and Depth Camera

Microsoft KinectV2 [↗](#)



- 4.1 The researcher packed all the required equipment in the package box, covered it using the black postage bag provided by the University, and labeled it to the participant's address. The researcher also activated participants' unique Id in the database on the server side.
- 4.2 Once the researcher was ready, they informed the University admin team to collect the equipment, which was then arranged via the University post.
- 4.3 The courier collected the package from the researcher and posted it to the participant's address. This would usually take two to three (🕒 72:00:00 )

3d



working days from the time of collection.

- 4.4 The participant then informed the researcher via email that the equipment had been received.

#### Conducting the research study

- 5 Participants were asked to set up the applications and equipment before starting the research study. They were also informed that the study was designed to take approximately <sup>45m</sup> 00:45:00 minutes.

- 5.1 Download the ARPOS application from Microsoft Store and connect Kinect V2 to a Windows PC or Xbox One.

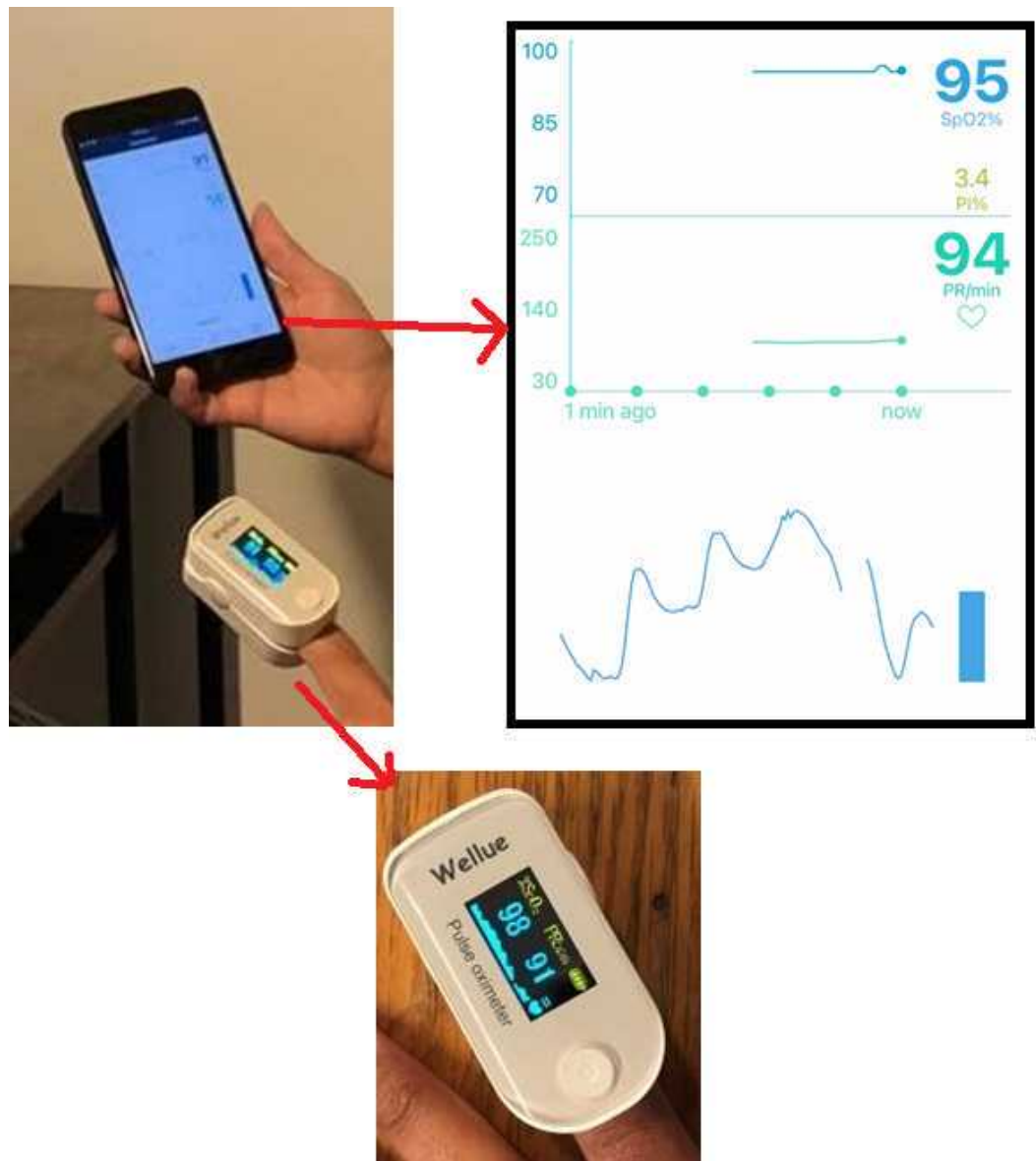


Downloading and initiating ARPOS application from Microsoft Store setup.

- 5.2 Download the Wellue application from the smartphone store (Android or Iphone) and connect it to the pulse oximeter device.

Link to Android Application: [https://play.google.com/store/apps/details?id=com.viatom.vihealth&hl=en\\_GB&gl=US](https://play.google.com/store/apps/details?id=com.viatom.vihealth&hl=en_GB&gl=US)

Link to Wellue Application: <https://apps.apple.com/us/app/vihealth/id1413644737>



Ground Truth pairing to smart phone and screen recording commercial pulse oximeter application user interface.

- 5.3 Once the setup mentioned above is complete, the participants can start the screen recording on their smart phone to record vital data from the pulse oximeter device. They can also start the acquisition from the ARPOS system simultaneously while facing the camera. The setup will look like the image presented below:






Final setup of the research study where pulse oximeter and ARPOS system acquire data simultaneously.

Executing and navigating ARPOS application 45m

- 6 Participants were required to login to the application using their unique PI number provided on the consent form and email.

#### 6.1 Login to the application using PI number example PI-0000

002 000



ARPOS

Name:

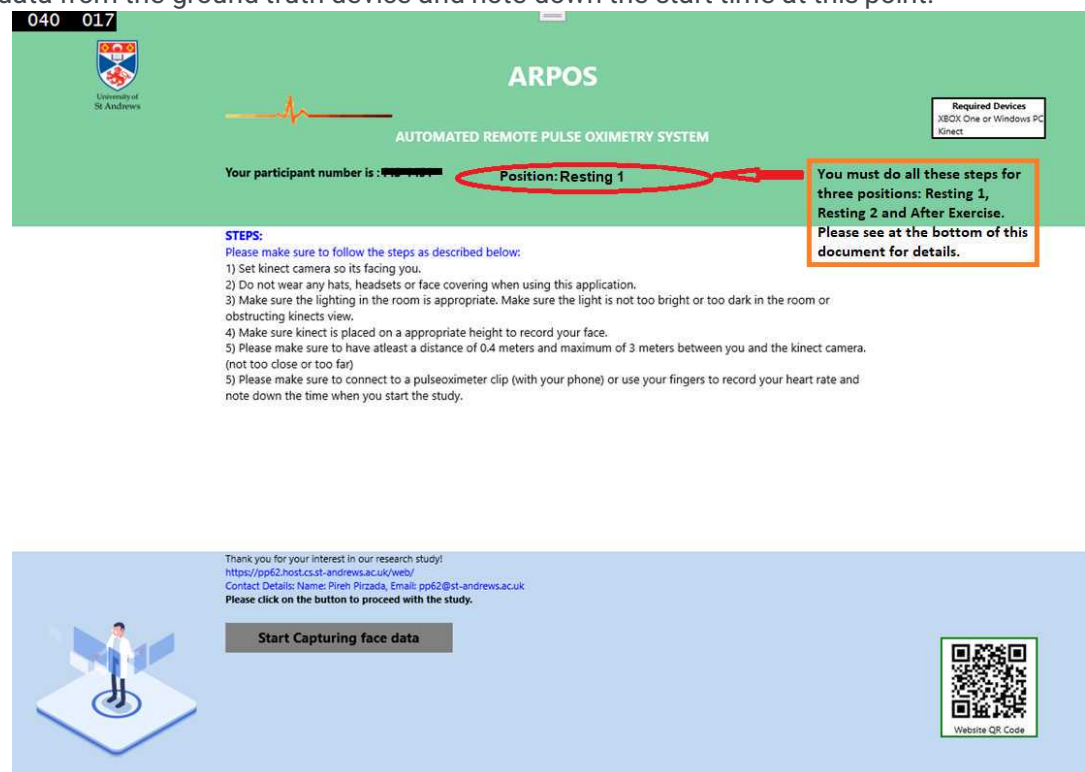
PIS-0000

Start

Login page of the application.

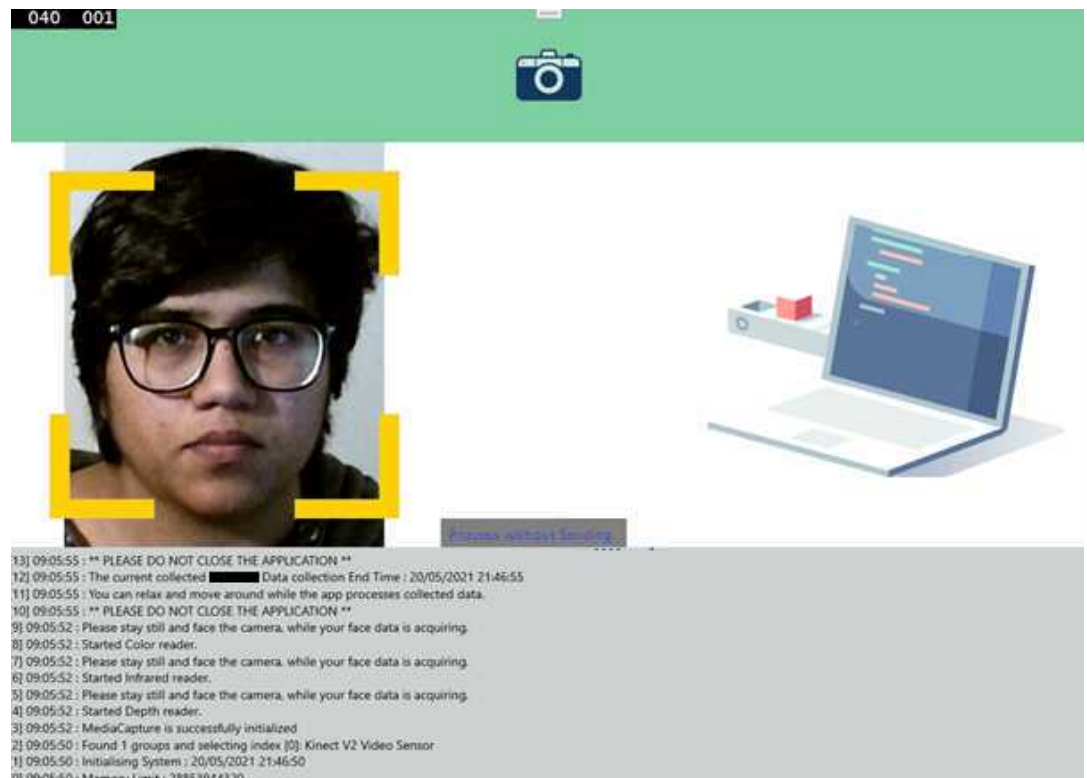
## 6.2 The application shows data acquisition state which updates automatically after completion of each round.

When ready, click on the 'start acquisition' button to start the data acquisition process from the ARPOS system. Make sure to start screen recording of vital data from the ground truth device and note down the start time at this point.



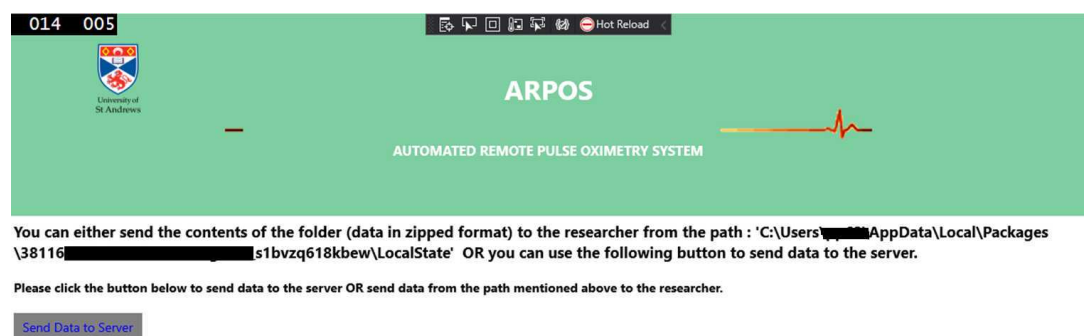
Data Acquisition Application showing study details with a button to start data acquisition process.

## 6.3 The log is displayed on the user interface of the application. This will alert when the data acquisition process has completed. A button named 'Process without sending data to server' will appear, click on this button to locally process colour, infrared and depth data.



Data Acquisition Application showing participant that their face has been detected and provides detailed log.

- 6.4 The application will give the option to send data to the server directly. In case the internet connectivity is not stable, the participant can copy the data from the path shown on the user interface and share that with the researcher.

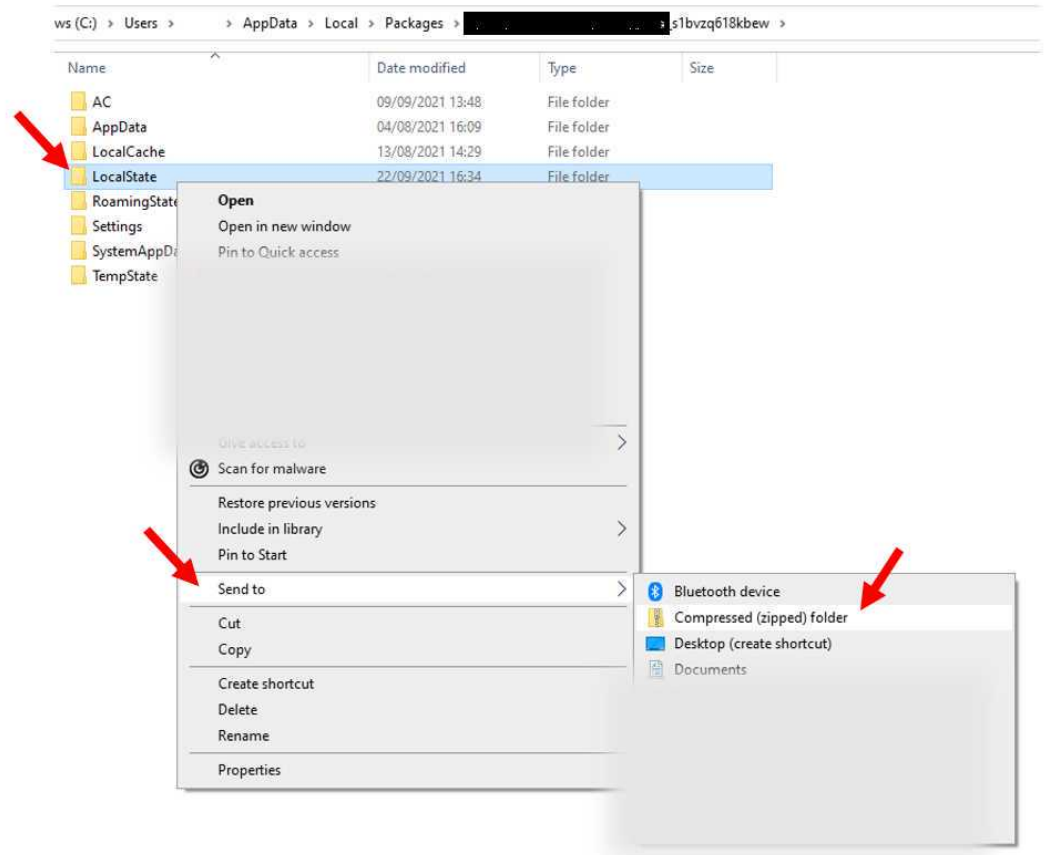


Application showing path that contain data acquired from the application.

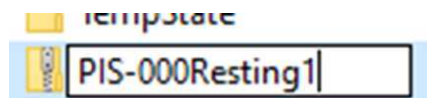
- 6.5 Compress the data to a folder and name it using the participant number id and vital status as shown in figure below and share it using one drive. Participants were also required to include ground truth screen recording of their smart phones

or text files if any other device, or manual method was used to obtain ground truth vital data.

Once the researcher confirms that the data has been received, the shared folder is deleted.



How to compress folder containing data acquired from the application.



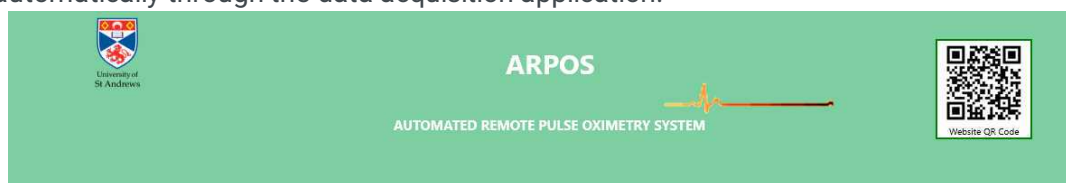
How to name compressed folder containing data acquired from the application.

- 6.6 Participants were required to conduct the study for two times at rest e.g. sitting<sup>1m</sup> on a chair. They were also required to re-conduct the study immediately after ⌚00:01:00 minute of exercise, this is so the system could be stress tested for active state vitals i.e. raised heart rate.

🔄 go to step #6.1 Repeat for Resting 2 and Active State

Thank you

- 7 Participants were thanked for their participation and their participation status was updated automatically through the data acquisition application.



**Thank you for taking part in my research project; your contribution is very valuable and appreciated.!**

This research project was conducted to measure the accuracy of an existing system where participants heart rate and blood oxygenation level was measured using camera-based (Kinect) technology (Automated Remote Pulse Oximeter System- ARPOS). The system recorded images of your face. The remotely measured values will be compared to validate the system. The data collected from the study is to analyse and report in the form of a paper publication in anonymous format.

**You have completed the study for : Resting1. Please restart the app to complete for the remaining phases.**

This research study has been approved by University of St Andrews Ethics. You can access details about the study using the QR Code provided or via <https://pp62.host.cs.st-andrews.ac.uk/web/>

If you have concerns or if you would like to view a summary of the results of my research, please email the researcher or the supervisor detailed below.  
Contact Details: Name: Pireh Pirzada, Email: [pp62@st-andrews.ac.uk](mailto:pp62@st-andrews.ac.uk)

Thank you Screen of the Application.

## Returning Equipment

- 8 Once the participant completed the study, they would repack the package according to the instructions provided ( [COVIDprotocol.pdf](#) ) and inform the researcher to arrange collection.

- 8.1 The researcher would then ask the University admin team to arrange collection and delivery of the package via courier from the participant to be delivered back to the researcher's address.