

**The author(s) shown below used Federal funds provided by the U.S. Department of Justice and prepared the following final report:**

**Document Title: Long-Range 3D Face Collection – Phase II, Final Report**

**Author(s): Bojan Cukic, Ph.D., Jeremy M. Dawson, Ph.D.**

**Document No.: 249539**

**Date Received: December 2015**

**Award Number: 2010-IJ-CX-K024**

**This report has not been published by the U.S. Department of Justice. To provide better customer service, NCJRS has made this federally funded grant report available electronically.**

<p><b>Opinions or points of view expressed are those of the author(s) and do not necessarily reflect the official position or policies of the U.S. Department of Justice.</b></p>
---

**Long-Range 3D Face Collection – Phase II**  
**8/2018 - 12/2013**

**FINAL REPORT**

**For:**  
**ManTech International Corp.**

**Dr. Bojan Cukic, PRINCIPLE INVESTIGATOR**  
**Dr. Jeremy M. Dawson, Co-PI**

# Contents

1. Project Overview .....	3
2. Data Collection .....	3
2.1 <i>Imaging Devices</i> .....	3
2.2. <i>Collection Site</i> .....	4
2.2.1 Indoor Ground Truth Photo Capture .....	4
2.2.2 Outdoor Image Capture.....	5
2.3 Data Types & Organization .....	5
2.4 <i>Collection Procedure</i> .....	8
2.4.1 Consent .....	8
2.4.2 Enrollment.....	8
2.4.3 Indoor Photos .....	9
2.4.4 Outdoor Image Capture.....	10
2.4.5 Post-Processing .....	14
3. Collection Demographics.....	14
4. Damage Information .....	20
5. Operator Feedback .....	20
Operator 1 .....	20
Operator 2 .....	21
Operator 3 .....	21
Operator 4 .....	22

## 1. Project Overview

The purpose of this data collection was to obtain data to enable the evaluation of a prototype binocular-based stereoscopic facial image acquisition system developed by StereoVision Imaging, Inc. (SVI), by comparing to data captured using similar COTS facial imaging hardware. In addition, human factors information was collected from operators performing the data collection to assess the operability of the prototype device. The original target number of participants for this collection was 100 based on initial evaluation of SVI image quality and hardware performance. Data collection took place between 8/19 and 11/25/2013 with 100 participants providing data.

The following is a description of the data collection effort, a summary of data collected and participant demographics, and operator feedback from seven WVU staff members.

## 2. Data Collection

Data collection was performed on the WVU Evansdale Campus. The collection utilized existing equipment from FBI biometric collection projects as well as equipment provided by ManTech. The location for the collection was outside of the Engineering Sciences Building atrium and the Engineering Research Building. This provided unobstructed views from 35 meters to 125 meters for participant data collection. Data was collected from each device and assembled in a common data repository on a regular basis.

### 2.1 Imaging Devices

Data collection was performed using three different facial imaging devices.

1. SVI binoculars prototype
2. Digital SLR camera
  - a. Outdoor: Canon 6D digital SLR camera with a Sigma Zoom Super Telephoto 300-800mm f/5.6 EX DG APO IF HSM Autofocus Lens
  - b. Indoors: Canon 5D Mk II digital SLR camera with a Canon EF 70-200mm (f/2.8L, image stabilized) lens

Images of these devices are shown in Fig. 1.



**Figure 1:** Imaging Devices: prototype SVI stereoscopic binoculars (left), Canon 5D MkII with 800mm super-telephoto lens (right).

## 2.2. Collection Site

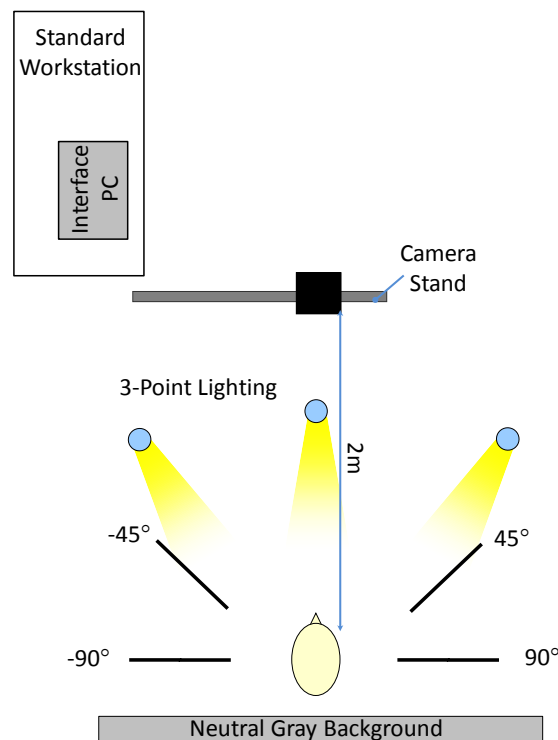
The following section describes the arrangement of the equipment used for the data collection.

### 2.2.1 Indoor Ground Truth Photo Capture

A Canon 5D Mark II DSLR camera and a Sigma EF 70-200mm f/2.8L IS II USM telephoto zoom lens were used for high-resolution ground truth image capture. Camera settings were as follows:

- White Balance: Tungsten
- ISO: 1000
- F/#: 1/10
- Exposure: 1/60 sec.
- Resolution: 5616x3744
- Horizontal/Vertical ppi: 72/72
- Bit Depth: 24

This camera was used to capture 5 different poses: -90 deg, -45 deg, 0 deg, 45 deg, 90 deg. A schematic view of the indoor photo collection is shown in Fig. 2.



**Figure 2:** Photo station layout.

3-point lighting is used to meet standards outlined in ANSI/NIST–ITL 1-2007 Best Practice Recommendation for the Capture of Mugshots [1]. The lighting is comprised of one 250-watt

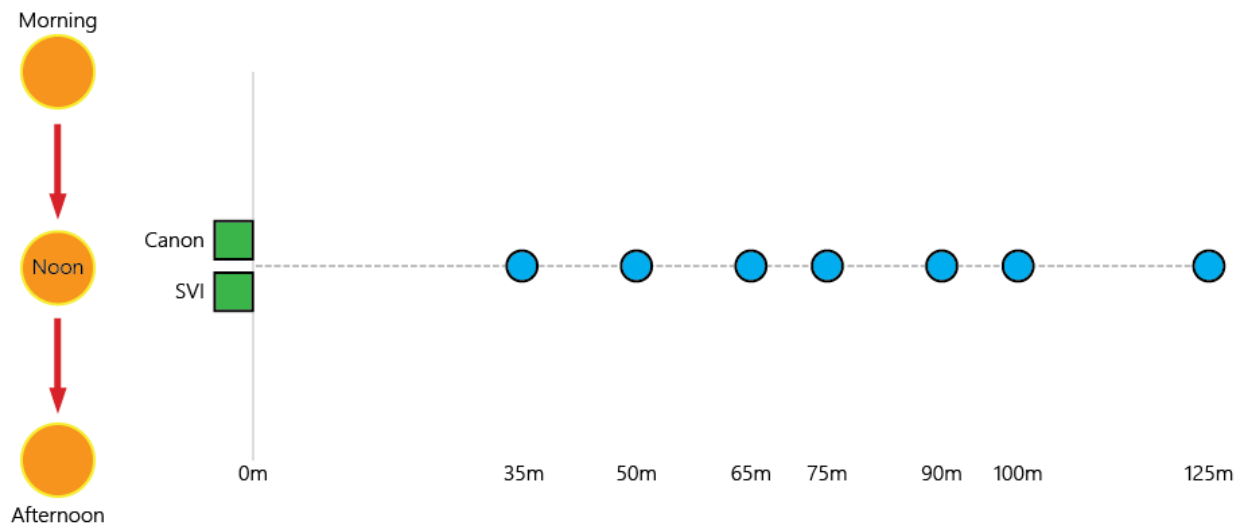
---

1. <http://www.nist.gov/itl/ansi/upload/Approved-Std-20070427-2.pdf>

fixture and dual 500-watt fixtures. The positioning of these sources with respect to the participant is slightly asymmetric and there is sufficient distance between the backdrop (neutral gray) and the participant to avoid shadows on the background. In addition, plastic diffusers in front of the reflector-mounted light bulbs are utilized to avoid “hot spots” on the face.

### 2.2.2 Outdoor Image Capture

This iteration of the SVI binoculars has auto-focusing and auto-exposure capabilities. Images were captured at distances of 35, 50, 65, 75, 90, 100 and 125 meters to survey the quality of images at varying distances from the SVI camera system. To accommodate these large distances, data collection was performed outdoors on the WVU Evansdale engineering campus. A schematic view of the collection setup is shown in Fig. 3.



**Figure 3:** Outdoor collection setup.

The imaging devices were co-located to make imaging distances as equivalent as possible. Camera alignment was chosen to provide varied natural illumination on the faces throughout the day. By situating the cameras and image capture direction so that the sun was behind the collection hardware, facial illumination was most uniform during midday, with strong left or right illumination in the morning and afternoon. This was mainly the case for sunny days, with cloudy or overcast days resulting in uniform facial illumination. Since the Engineering Research Building blocked the light from the left side of the face, most strong illumination appears on the right side of the face in sunny conditions.

The SVI camera included a pre-set exposure setting called, ‘Tripod Mode.’ In this mode, the binoculars auto-corrected for exposure differently than when turned off. This led to challenges acquiring images in low-light conditions (dusk, cloudy, overcast, etc) with tripod mode set to “off.” Due to time limitations and with the consent from ManTech Inc. images which normally would be collected with Tripod Mode *off*, could be collected with the mode *on* when necessary. This was to allow for a higher exposure during lower light conditions.

### 2.3 Data Types & Organization

The following data was collected from each participant:

- Indoor photos (image distance = 2m), low-compression JPEG format and camera raw (.cr2):
  - ground truth image of participant holding random ID number
  - ground truth image of participant holding white balance color card
  - one image of frontal (0 deg) pose\*
  - one image 90 deg\*
  - one image -90 deg\*
  - one image 45 deg\*
  - one image -45 deg\*
  - \* some participants had two sets of these photos taken
- Outdoor photos/video
  - SVI binoculars
    - images captured at 35, 50, 65, 75, 90, 100, and 125 meters with ‘Tripod Mode’ *on*
    - images captured at 50, 75, and 100 meters with ‘Tripod Mode’ *off*
    - A left and right JPEG image at each distance
    - all images also in SVI proprietary VUR format
  - Canon Camera with 800mm lens
    - One image at each distance captured in camera raw CR2 and low-compression JPEG

The file structure for the dataset is as follows:

- Canon Indoor
  - RID
    - Original (Raw data: includes RID and Color Card photos)
    - SAP\_50 (Cropped to SAP 50 Standard 3300 X 4400: RID and color card not included)
    - SAP\_51 (Cropped to SAP 51 Standard 2400 X 3200: RID and color Card not included.)
- Canon Outdoor (First 59 participants)
  - RID
    - Cropped (1024 X 1365)
      - 35
      - 50
      - 65
      - 75
      - 90
      - 100
      - 125
    - Moved (Contains whitespace at top so the AutoCropper could be used)
      - 35
      - 50
      - 65
      - 75
      - 90

- 100
  - 125
- Original (Raw Data)
  - 35
  - 50
  - 65
  - 75
  - 90
  - 100
  - 125
- SAP\_50 (3300 X 4400)
  - 35
  - 50
  - 65
  - 75
  - 90
  - 100
  - 125
- SAP\_51 (2400 X 3200)
  - 35
  - 50
  - 65
  - 75
  - 90
  - 100
  - 125
- Canon Outdoor ( Last 41 Participants)
  - RID
    - Cropped (1024 X 1365)
      - 35
      - 50
      - 65
      - 75
      - 90
      - 100
      - 125
    - Original (Raw Data)
      - 35
      - 50
      - 65
      - 75
      - 90
      - 100
      - 125



- SVI
  - RID
    - 35
    - 50
    - 65
    - 75
    - 90
    - 100
    - 125

The reason for the change in structure approximately half way through the collection was due to changing the crop dimensions of the outdoor images as permitted by ManTech Inc.

#### *2.4 Collection Procedure*

The following is a description of the collection procedure the participant experiences from consent to remuneration. It is written as an instructional document describing to staff members the standard operating procedure of each data collection station.

##### 2.4.1 Consent

Greet the participant and provide the consent form. Explain each section of the consent form to include all locations on the form that need to be initialed, dated, or signed. Ensure that your explanation includes the following:

- The purpose of the study is to collect data for biometrics research funded by ManTech International and the National Institute of Justice.
- Data collection consists of photographs taken by different types of cameras, including a prototype system
- Participation is strictly voluntary; they may opt out of the process at any time.
- Inform the participant that they will be receiving a gift card upon completion of data collection and that if they choose to not complete the study they will not receive the gift card.

Once the participant has read and completed the consent form, ask if they have any further questions and direct them to the Enrollment workstation.

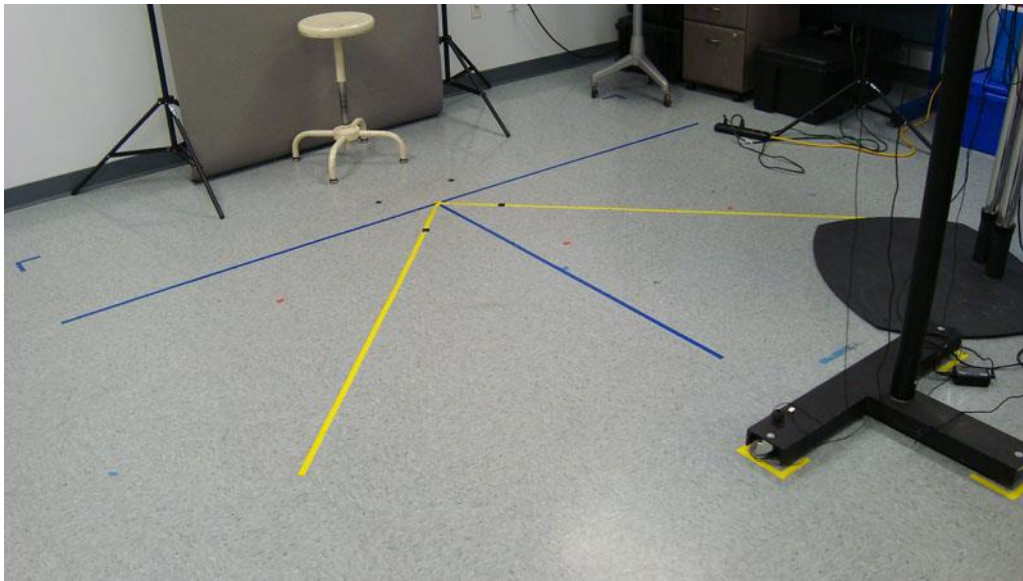
##### 2.4.2 Enrollment

Once the participant has arrived at the Enrollment Workstation, ask them for a photo ID to verify their identity. Participants may already be in the Enrollment database from another study, so ask if they have participated before. If they have participated before they will already have an RID number, if not they will need a new RID generated in the system. Using the Enrollment interface, search the database to see if the basic information (name, date of birth, etc.) exists in the database. Searching the database can be completed by using the participant's first or last name, date of birth, or all three. Typically, it is most efficient to search by last name and identify the correct person based on the date of birth that appears after searching. If the participant already has an RID in the system, make a note of the RID for use while completing the enrollment process. If the participant is not in the system proceed to enter new data for the participant. Once you have completed the

enrollment form, print the barcode and save the information. Instruct the participant to proceed to the indoor photo station

#### 2.4.3 Indoor Photos

- 1) Have the participant stand at the intersection of the lines on the ground in front of the camera, facing the camera. An overview of the area in which the participant will be standing is shown in Fig. 4.



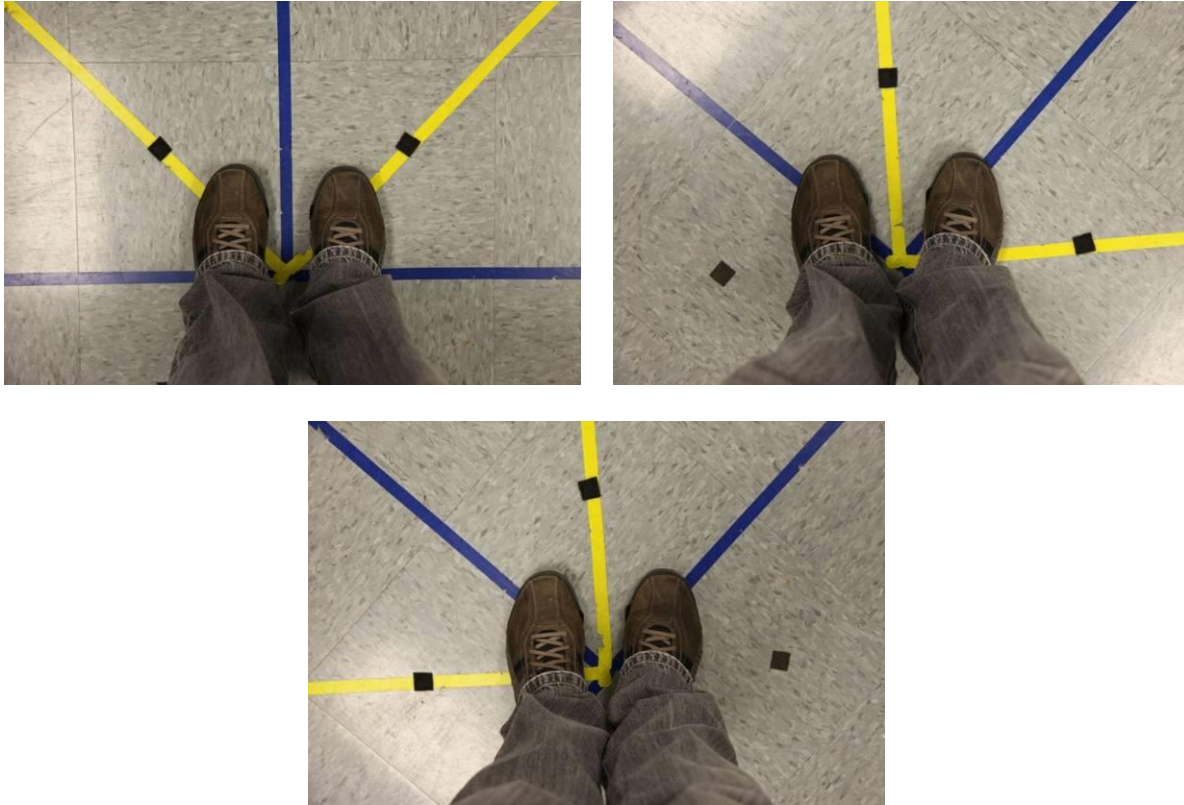
**Figure 4:** Pose angle indicator lines.

- 2) Turn on the Canon EOS 5D Mark II and adjust the camera height and angle such that the participant is framed in the picture as shown in Fig. 5. Have them hold the barcode up as shown; they are permitted to wear their glasses for this photograph and the white balance color card only. All further photos must be taken without glasses and, if applicable, hair kept behind the ears



**Figure 5:** Ground truth photograph.

- 3) Begin the photo capture by taking a ground truth photo. After capturing the Ground Truth photo and white balance color card photo, the participant will turn and face -90 deg towards the camera. They will then turn to align with -45 deg and so on, until they are facing 90 deg for the final photo. Foot placements for some of these shots are shown in Fig. 6.



**Figure 6:** Proper foot placement for all pose angles.

#### 2.4.4 Outdoor Image Capture

After completing the indoor photo session, the participant will proceed outdoors for the remainder of the collection. The outdoor equipment should be set up prior to the day's collection activity. It takes 10-15 mins to set up the equipment and take test shots to ensure proper sensor operation under the current outdoor conditions. The following equipment is used in the camera setup:

- StereoVision Imaging (SVI) camera with battery power supply and wireless dongle for communicating with the laptop computer
- Canon Mark II camera with 800mm lens
- 2 tripods
- Laptop computer for data transfer
- Location markers for each location (tape was used and applied one time at the beginning of the collection)

The collection hardware should be configured as follows:

1. Place the cameras on their respective tripods and ensure level with bubble indicators. The SVI camera should be on the right and the Canon camera on the left of the equipment setup, . The battery power supply should be sufficiently charged and plugged into the SVI camera.
2. Check that the Canon is set to automatic focus, full-auto operation (green square on selector knob).
3. The SVI collection software should be started and made sure to be connected to the camera. This is done by completing step 1 above, assuring that the Tripod Mode checkbox is checked and that the checkboxes for saving images as both '.jpg' and '.vur' are checked.
4. A test image should be captured with the SVI (with both the 'Tripod Mode' *on* and *off*) and Canon cameras to assure that images are able to be captured and that the images are clear and useful. *Note: taking photos with both Tripod Modes requires a restart of the application.*

After setup is complete, the collection procedure for each participant is as follows:

**At Distance = 35 m**

1. Collection guide walks with participant to 35 meter marking tape and instructs participant stand in position then records the lux value (light reflecting from the face of the participant).
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 50 m**

1. After completing the 35 meter location, the collection guide escorts the participant to 50 meters and repeats the 35 meter procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 65 m**

1. After completing the 50 meter location, the collection guide escorts the participant to 65 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule

- b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 75 m**

1. After completing the 65 meter location, the collection guide escorts the participant to 75 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 90 m**

1. After completing the 75 meter location, the collection guide escorts the participant to 90 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 100 m**

1. After completing the 90 meter location, the collection guide escorts the participant to 100 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**At Distance = 125 m**

1. After completing the 100 meter location, the collection guide escorts the participant to 125 meters and repeats the procedure.

2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *on* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.
3. Take the Canon Image
  - a. Align the participant's face in the center of the viewfinder and press the capture button

**Traveling back to camera station:**

**At Distance = 100 m**

1. Computer operator restarts the SVI application
  - a. Operator does **not** check the 'Tripod Mode' check box, but still checks the save file type checkboxes of '.jpg' and '.vur'. The operator then connects the SVI camera via the connect button in the GUI.
2. The collection guide escorts the participant back to the 100 meter mark.
3. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *off* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.

**At Distance = 75 m**

1. After completing the 100 meter location, the collection guide escorts the participant to 75 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *off* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.

**At Distance = 50 m**

1. After completing the 75 meter location, the collection guide escorts the participant to 50 meters and repeats the procedure.
2. Take the SVI Images
  - a. Center the participant's face inside the reticule
  - b. On the laptop computer, with 'Tripod Mode' *off* click the Capture Image button within the GUI. The images are finished being captured when the camera beeps once.

Consent forms are checked again at this point assuring all items are properly noted and correctly filled. The participant is then instructed to affirm they have received a gift card and the gift card is given to the participant.



#### 2.4.5 Post-Processing

After completing the participant collection. Computer operator assures that all lux values are recorded in the lux table. Operator also assures that each participant has 40 image files from the SVI camera in total (which includes both JPEG and '.vur' files) and moves files into a folder designated for each participant. After all participants are complete for a given day, the Canon images were then added to the appropriate participant folders.

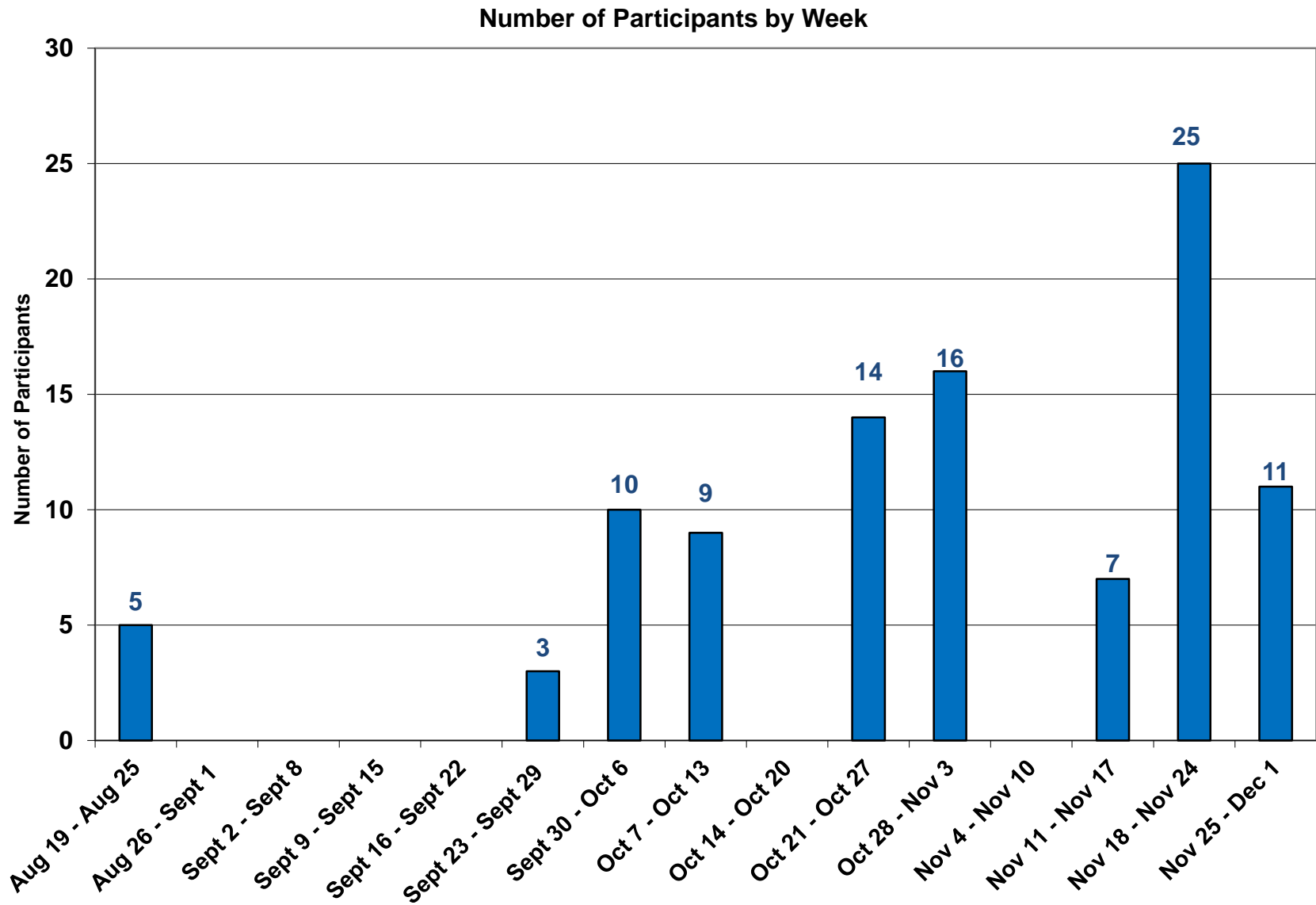
An automatic cropping tool was provided by Azimuth, Inc, Autocropper, to crop the images taken by the Canon camera to a uniform size and resolution. This was performed for both the indoor and outdoor photos. Cropping was performed on the outdoor photos to reduce their size to make them compatible with automated matching software. The procedure for cropping the images is as follows:

1. Open Autocropper and select 'open images.'
2. From here select the 'Canon' folder for the participant and select the first photo. The image will open in Autocropper and a red 'T' will appear on the screen.
3. Place this red 'T' so the crossbar is across the subject's eyes and the vertical bar is down the center of the nose.
4. Double click, and the image will automatically crop, save, and close.
5. Do this for all Canon images in the participant's directory.

The indoor ground truth photos were cropped to SAP 50 and 51 pixel sizes: 3300x4400 and 2400x3200 respectively. For the outdoor Canon photos, the participant may have been positioned in the image frame such that these images could not be cropped to SAP 50 size without first shifting the image position in Photoshop due to the position of the horizontal eye-marker line in the Autocropper tool. This shift often caused significant white space above the participant's head, which could lead to non-ideal behavior when the images were fed into automated matching software. To address this issue, outdoor Canon photos were cropped to a smaller size of 1024x1365 pixels (*NOTE: This is the cropping dimension used for the outdoor Canon photos on the Phase I collection as well, and was performed using the Autocropper tool*).

### **3. Collection Demographics**

The charts on pages 16-20 provide information on cumulative participation in the data collection and a breakdown of ethnicity, age and gender. Figs. 7 and 8 provide weekly and cumulative participation respectively. Fig. 9 indicates that Caucasians make up 79% of the participants, followed by Asian Indians (6%) and Asians, African Americans and Hispanics (all at 4%), and Africans (3%). This ethnicity distribution is consistent with the WVU student population. Fig. 10 indicates that the majority of participants were in the 20-29 age range, making up 85% of the total. Fig. 11 shows that male participation was greater than female for all ethnicities.



**Figure 7:** Number of participants by week.



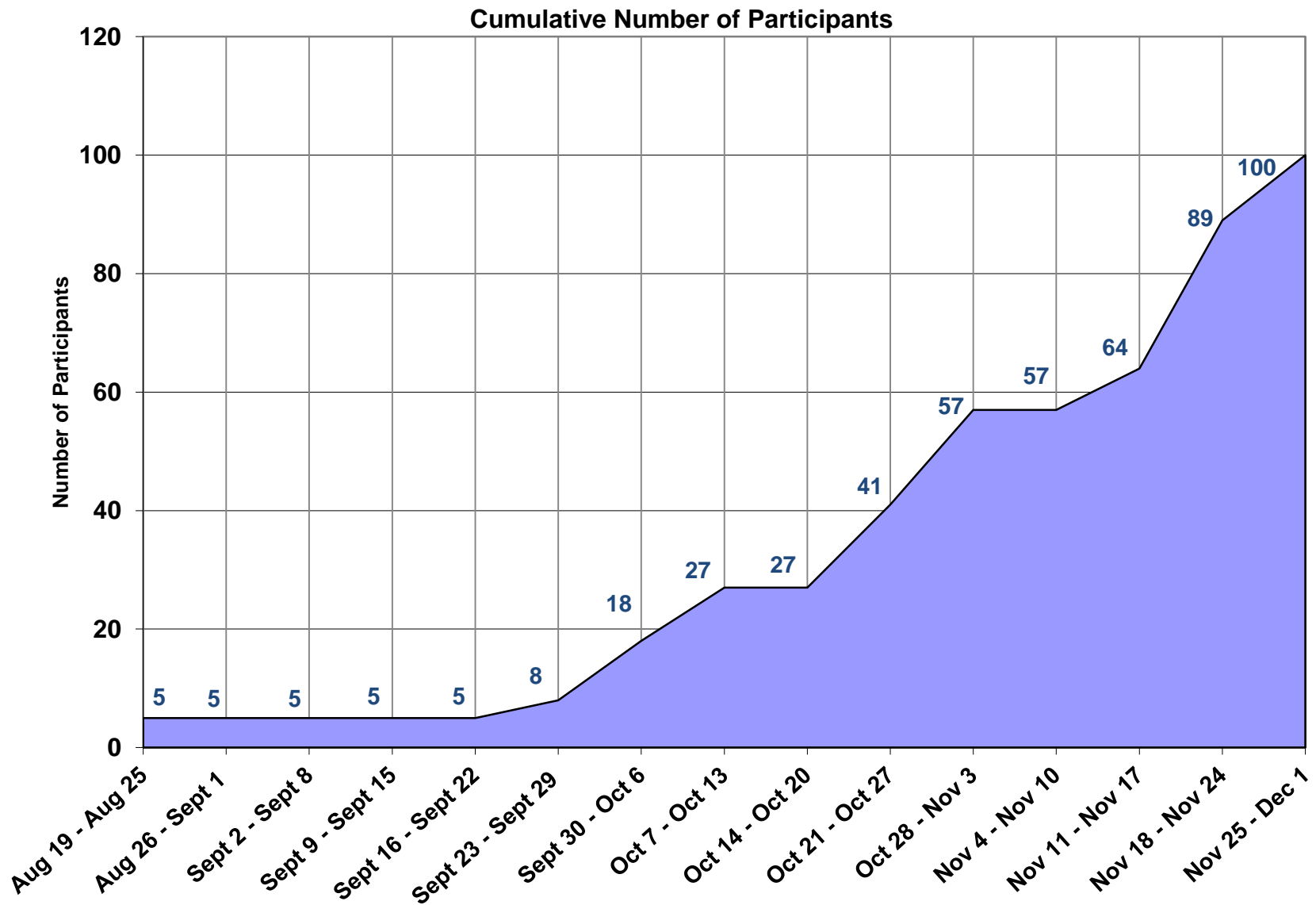
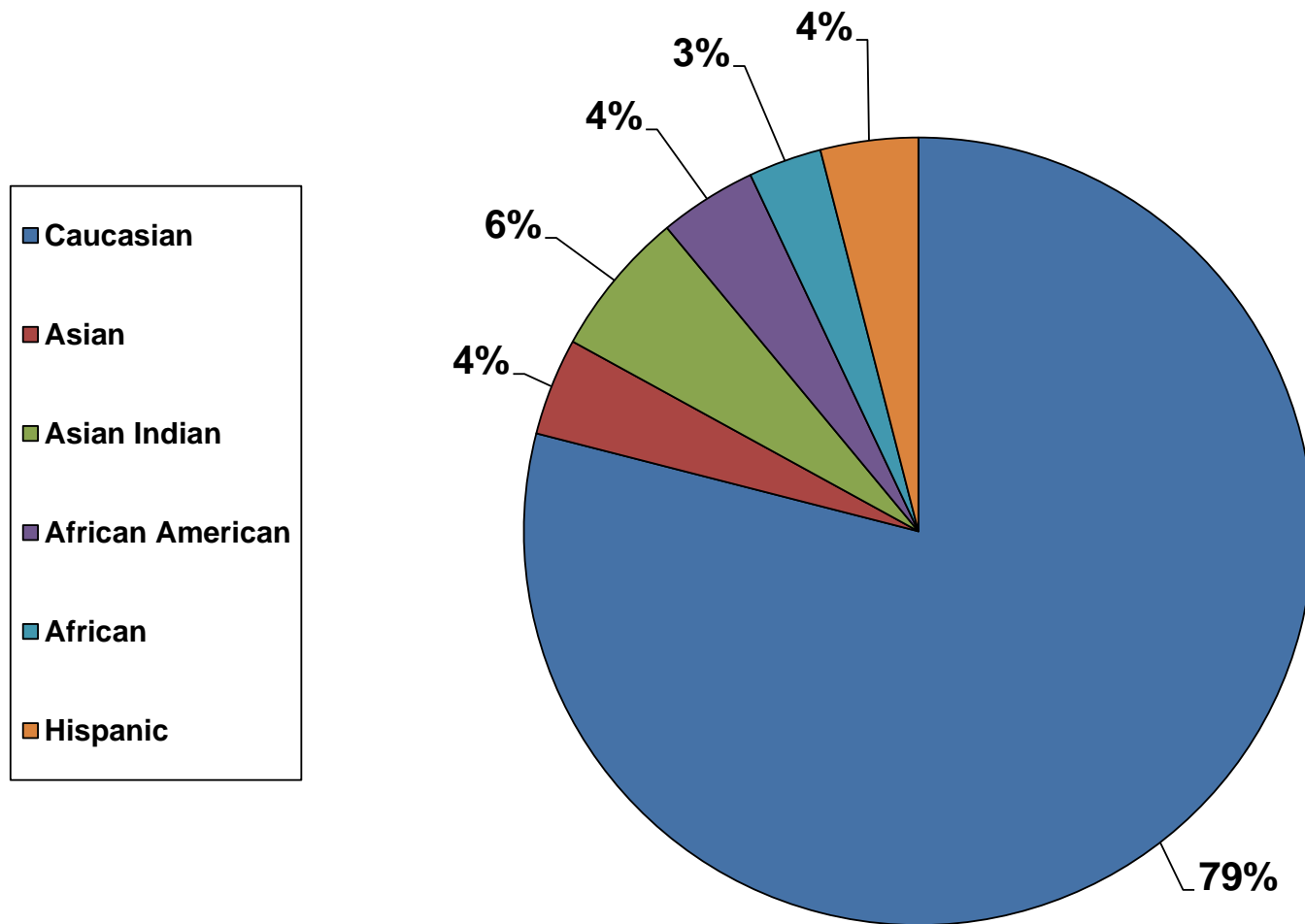


Figure 8: Cumulative participation.

## Participants by Ethnicity Group (%)



**Figure 9:** Participant ethnicity.

## Participants by Age Group (%)

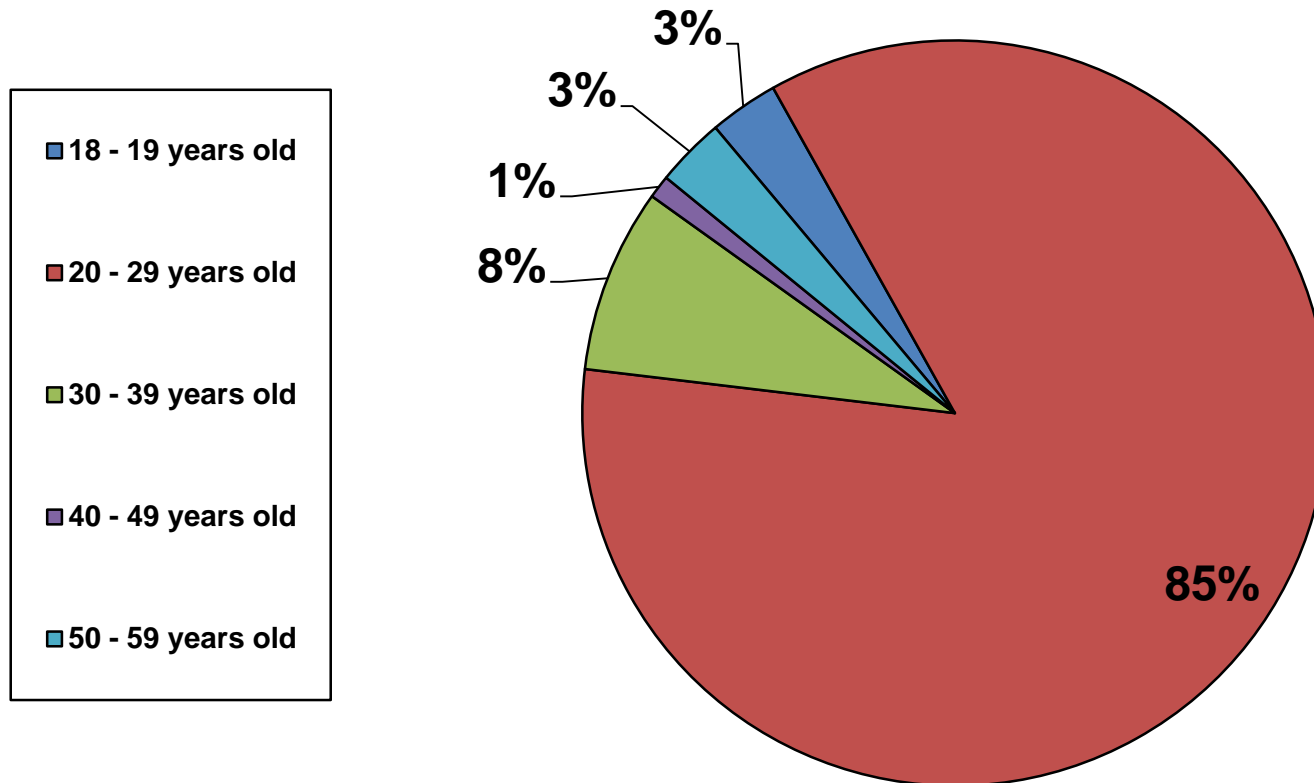
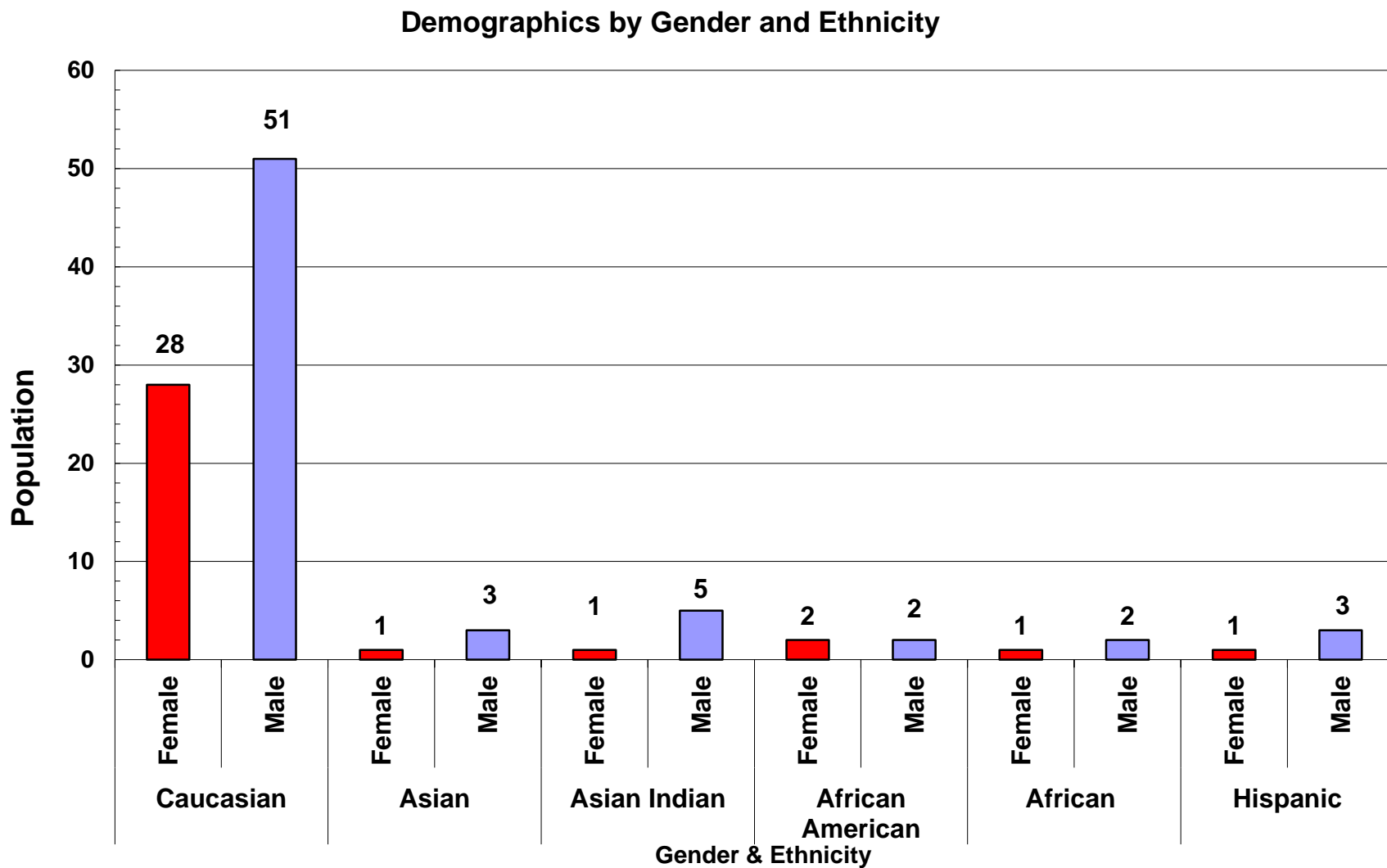


Figure 10: Participant age.



**Figure 11:** Breakdown of gender & ethnicity.

#### **4. Damage Information**

As previously mentioned the initial SVI prototype was damaged and replaced. The damaged occurred on October 9<sup>th</sup>, 2013 after the morning session of data collection during the clean-up procedure. This led to a two week delay in collection. Another delay also caused two days of down-time with the first prototype due to there being a problem with the wireless dongle connecting the SVI camera to the laptop. The SVI camera was replaced with another prototype and collection proceed.

#### **5. Operator Feedback**

The operators who performed the bulk of the data collection were asked to provide feedback on their experience using the SVI binoculars alongside other commercial image acquisition devices. They were to comment on the following aspects of their interaction with the various devices during the data collection process:

- What did you like about the SVI system?
- What were the biggest issues/challenges to operating the SVI system?
- What changes should be made to make the SVI system easier to use?

Anonymized, unedited responses from seven operators are provided below.

##### Operator 1

Understanding that this system was in fact a prototype, several observations were concluded throughout the duration of the collection. There were favorable features with this system which made the process easier from the collection stand point. There were however nuances which required explicit care during collection to avoid faulty data or missing information. Collectively, the best feature was the auto-focusing portion of the system. When the system was in full operation with no error, participants could be fully collected via the outdoor equipment in as little as ten to fifteen minutes. While not functioning at all distances – most notably at 35 meters – the system itself avoided a great deal of operator error by including this feature in the system. The challenges of the collection were numerous; however, this required that those collecting data were very knowledgeable about common and frequent errors of the system. Initially, in the first prototype, wireless connection issues were prohibitively common. These issues often required an entire system restart (of both the computer and the camera) and even then was no guarantee of a successful connection. Keeping the battery pack fully charged for a full day of collection became more of a challenge as the weather became colder. The battery life significantly suffered in cold temperatures often requiring the collection to be put on hold for around thirty minutes or more since passive charging was not an option. Again, knowing that this collection was done with prototyping equipment, these issues were expected. When the camera was powered off, images left in the buffer were sent to the computer and saved, this also occurred when the camera would fail to focus or an error dialog box would appear on screen during collection. The biggest problem encountered with the system was the amount of contrast required for the images to capture. On many collection days, by as soon as 3 p.m., the camera would fail to capture an image due to poor

lighting from the setting sun. This was most notably seen in the *Tripod Mode* 'on' setting where the exposure was decreased, thus depending on greater ambient lighting. Minor issues included the reticule not being centered on the captured image, requiring the participant to need intentional misalignment to fully capture the face.

### Operator 2

The main difference observed between the two versions of the system is the auto focus feature. In the old version, there was no auto focus. In order to capture the best data possible, the camera focus needed to be set to a designated distance. This required the subject to stand at 25, 50, 75 and 100m as well as 3m in front of and behind the designated distances. This increased the number of images to be captured and caused the duration of the collection to take up to 80 minutes per subject. With the new system, there was no need for the subject to stand at +/- 3m. The average duration per subject dropped down to about 20 minutes.

Another feature added to the newer version was the wireless functionality. The camera could connect to a computer via a wireless USB dongle. This feature posed new problems compared to the onboard memory storage built into the older version. On many occasions, the camera would disconnect from the workstation or it would send corrupted data either from a driver error or outside interference. The cause of many of these problems was not repeatable in some circumstances. From an operational standpoint the newer system was a large improvement from the previous version but there are still many issues that need to be addressed.

### Operator 3

While I did not work in the previous collection where the SVI was also used, I was present during most times data was being collected for this one. The general set up was good, and was designed to really help the users get quick efficient data. Out of all the equipment used during the collection, the main issues arrived from the SVI camera – computer interface.

The SVI camera worked well when functioning properly. We would receive random camera errors, or dongle connection issues at times in the middle of collecting or when we first started the camera, which slowed things down extremely. We would have to cycle the power and application once or several times, until the camera would work. It is unknown why these errors would occur, since at times it would occur with no movement or change in the entire system. Even with these, the overwhelming largest issue was the exposure rate necessary for the camera when tripod mode was off. The extended exposure required a large amount of light and limited the times of day we could even collect data. Any overcast, early morning, or late afternoon times were almost certain to fail with this setting on the camera. Even with these errors though, the camera did perform well when it worked. It was very simple for users and easy to troubleshoot if there were any issues.

The software along with wireless usb dongle connection used to take images from the SVI, was a very helpful tool. It allowed administrators to easily see the taken images, provide camera feedback, and give a useful interface for immediate data organization. As previously mentioned though, there were at times some connection issues as well as unexplained camera errors that could've been software based. The only other issue with the application was the displayed window relationship to the saving of the images. If a

picture was taken while the application was snapped to the right side of the screen, only the left side camera picture would be saved. This required users to make sure that when taking photos the application was in full screen. These issues though were very minimal and did not affect time of participation or necessary debugging effort.

The Canon camera with Sigma lens was flawless. It was extremely user friendly, and even had automatic focus to help cut out user focusing error. No one in the entire group had any issues or errors with the camera for the entirety of the collection.

Overall the system set up was very efficient and was weighted towards usability, making it very simple and accommodating to the administrators of the collection. All issues that ever occurred, mainly with the SVI camera-computer, with system were able to be fixed within the day at the most extreme case. That being said, the only area where improvement could make a large and noticeable difference would be in the SVI camera operation and computer interface. Eliminating or reducing these factors would help the overall efficiency of collecting data.

#### Operator 4

The SVI camera had some major changes from the last prototype that was used in the previous collection. One upgrade that I observed was the use of the wireless dongle to communicate with the software on the laptop. Another huge improvement from the last prototype consisted of not clicking a preset button at every distance where a picture was taken. These two changes made the collection much faster and easier. The Canon seemed to operate just about the same from what I remember from the last collection.

The SVI camera worked very well once it started working properly. Usually the first attempt at taking images for the day failed and it took several minutes to reset. When capturing the image failed in this manner, it produced two images that looked like white noise. First we would recycle the power and attempt to take the picture again with it able to focus on something and the same output was produced. When that didn't work, the whole computer had to be restarted and the dongle taken out and plugged in again. Most of the time, just one total reset of the setup worked, however there were a few occurrences where it had to be done more than once. When nearing the end of the collection, the weather proved to be a problem while it was overcast. It could be around 2:30pm and the handheld mode would not work because it kept giving the not enough light beep pattern. This forced us to use the Tripod Mode for the three pictures when the handheld mode should have been used.

The software used to take the images for the SVI worked great except for one flaw. I think it would be nice to be able to see both of the full images that were taken (Left and Right) at the same time in the GUI. The left picture was fine, however only the left portion of the right picture was shown on the screen. Other than this, I think it is very easy to use and navigate the software.

In conclusion, the improvements from the first prototype to the second prototype were excellent in my opinion. The system as a whole was much easier to use compared to the last collection that was done. By not clicking a preset button and keeping track of which one to press probably was the best improvement from the last prototype. This made a huge difference in the amount of time the collection took to complete.