Long-Range 3D Face Collection
1/2012 - 5/2012

FINAL REPORT

For:
ManTech International Corp.

Dr. Bojan Cukic, PRINCIPLE INVESTIGATOR
Dr. Jeremy M. Dawson, Co-PI
Simona Crihalmeanu, Nathan Kalka, Co-PIs

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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 200, reduced to 100 based on initial evaluation of SVI image quality and hardware performance. Data collection took place between 1/25 and 5/25/2012, 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. An outdoor location adjacent to the Engineering Research Building and Evansdale Library was chosen to provide unobstructed views of facial images up to 100m away from the imaging devices. 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. Sony DEV 5 digital recording binoculars
3. Digital SLR camera
   a. Outdoors: Canon 5D MkII digital SLR camera with a Canon EF 800mm f/5.6L IS USM Autofocus Lens
   b. Indoors: Canon 5D Mk II digital SLR camera with a Canon EF 70-200mm (f/2.8, image stabilized) lens

Images of these devices are shown in Fig. 1.

Figure 1: Imaging Devices: prototype SVI stereoscopic binoculars (left), commercial Sony 3d binoculars (center), 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 Canon 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 3 different poses: -45 deg, 0 deg, and 45 deg. A schematic view of the indoor photo collection is shown in Fig. 2.

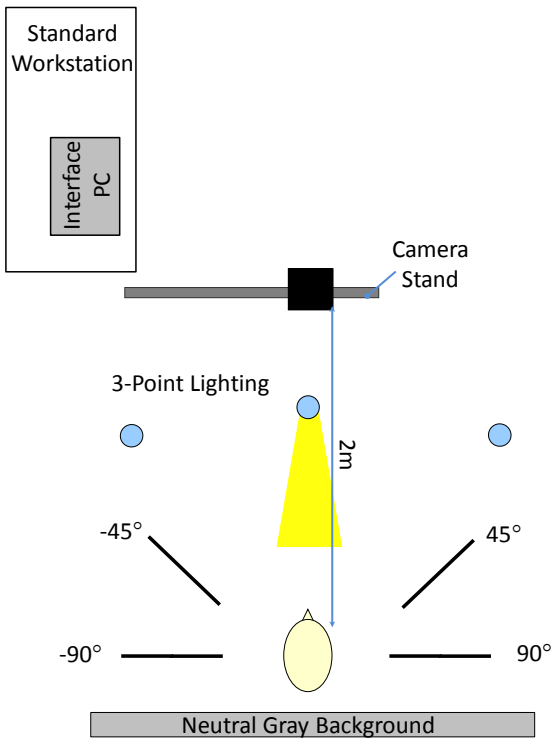

Figure 2: Photo station layout.

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

The SVI binoculars have preset focal distances of 50, 75 and 100m. Images were captured at these locations to offer evaluation of SVI image quality and steroscopic 3D performance at varying distances. 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.

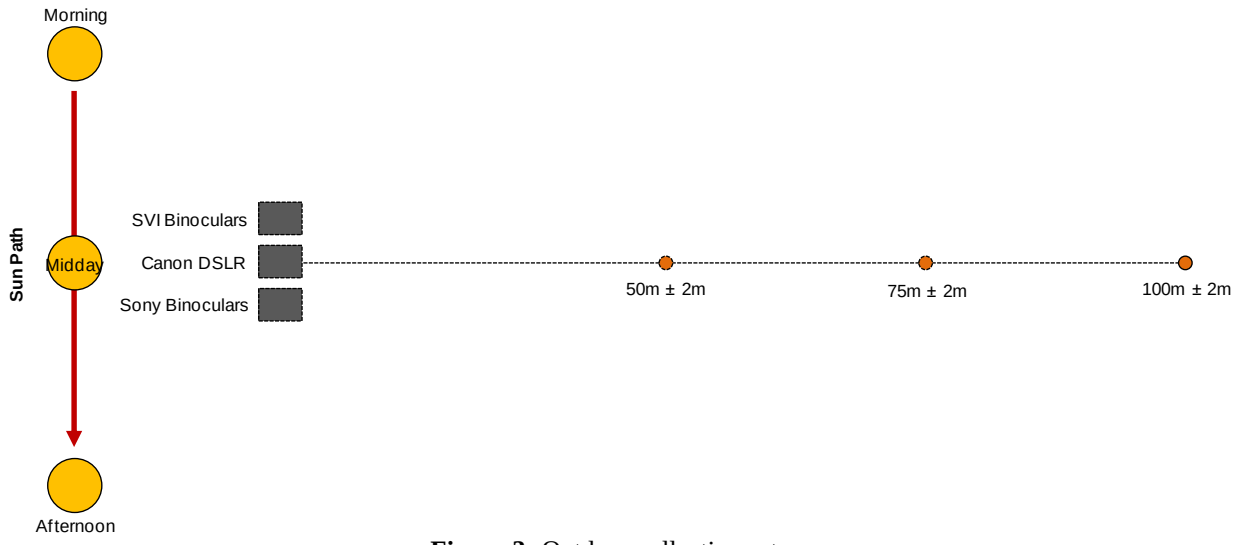

Figure 3: Outdoor collection setup.

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.

Early evaluation of the SVI hardware by Azimuth, Inc. indicated that the optimal image focus distance for the preset could lie within +/- 2m of the present distance, and that the presets buttons may be mislabeled. In order to assure that in-focus SVI images were acquired at each location, image distances of 48, 50, 52, 73, 75, 77, 98, 100, and 102 meters were used in the data collection.

The optimal exposure value for the SVI binoculars was determined to be preset 7. This value was increased to 8 or 9 on cloudy days to improve image quality. Otherwise, the exposure and gain settings on the SVI system were not varied. The Canon camera was set to 'full auto' mode to accommodate varying outdoor lighting levels. The Sony binoculars were operated on factory settings.

2.3 Data Types & Organization

The following data was collected from each participant:

- Indoor photos (image distance = 2m), low-compression JPEG format:
  - ground truth image of participant holding random ID number
  - 3 images of frontal (0 deg) pose
  - one image 45 deg
  - one image -45 deg
- Outdoor photos/video
  - SVI binoculars
    - images captured at 48, 50, 52, 73, 75, 77, 98, 100, and 102m
    - 3 images at each distance for each of the 3 image presets (total of 81 SVI images per participant)
    - all images in SVI proprietary VUR format
  - Canon Camera with 800mm lens
    - 3 images at 50, 75, and 100m distances, raw CR2 & low-compression JPEG formats
  - Sony binoculars
    - one 5 sec video at 50, 75, and 100m distances (M2TS format)
    - 3 still images at 50, 75, and 100m distances, JPEG format (*NOTE: these still images were added appx. halfway through the collection at the request of Azimuth. As a result, not all participants have these images*)

The file structure for the dataset is as follows:

- Date
  - Random ID
    - Canon (outside images)
    - Face (inside images)
      - Canon EOS 5D Mk II
        - Raw
        - one ground truth image
    - Sony
    - SVI
      - 48
        - Preset 1
        - Preset 2
        - Preset 3

      (same for all of the following folders)
      - 50
      - 52
      - 73
      - 75
      - 77
      - 98
      - 100
      - 102

Due to operator error and sensor malfunction, some data may be missing or corrupted. A list of errors and missing data was provided as an addendum to the dataset upon delivery to ManTech.

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 and videos 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 gift cards upon completion of data collection and that if they choose to not complete the study they will not receive the gift cards.

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.

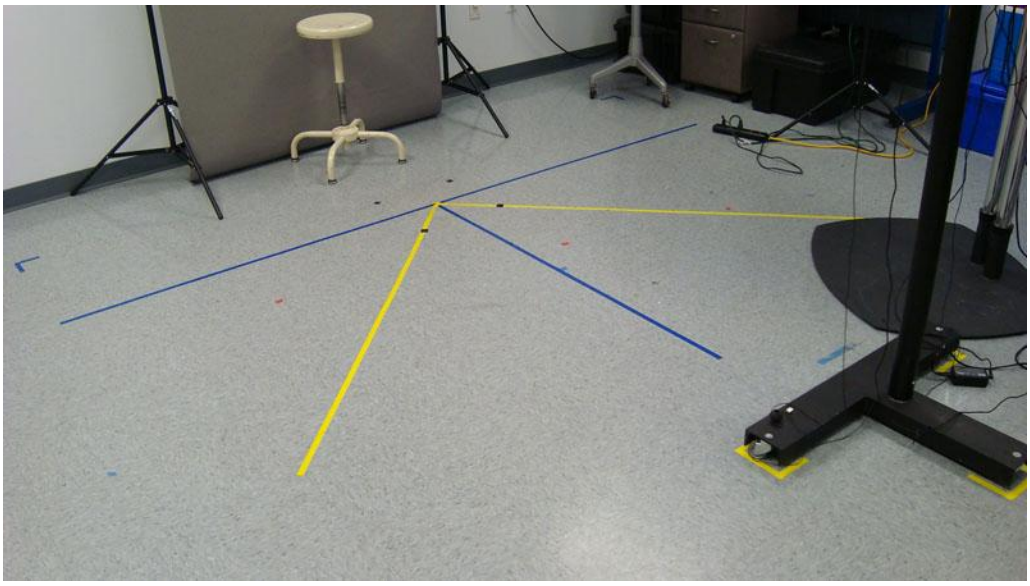

Figure 4: Pose angle indicator lines.

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 only. All further photos must be taken without glasses.

Figure 5: Ground truth photograph.

3) Begin the photo capture by taking a ground truth photo. After capturing the Ground Truth photo, the participant will remain facing the camera for the -90 degree photo. Then they will turn to align with the left-most yellow line on the ground for the second photo, face the camera for the third photo (0 degrees), turn to 45 degrees for the fourth photo, and back to facing the camera again for the final photo. No profile photos are required for this collection. Foot placements for these shots are shown in Fig. 6.

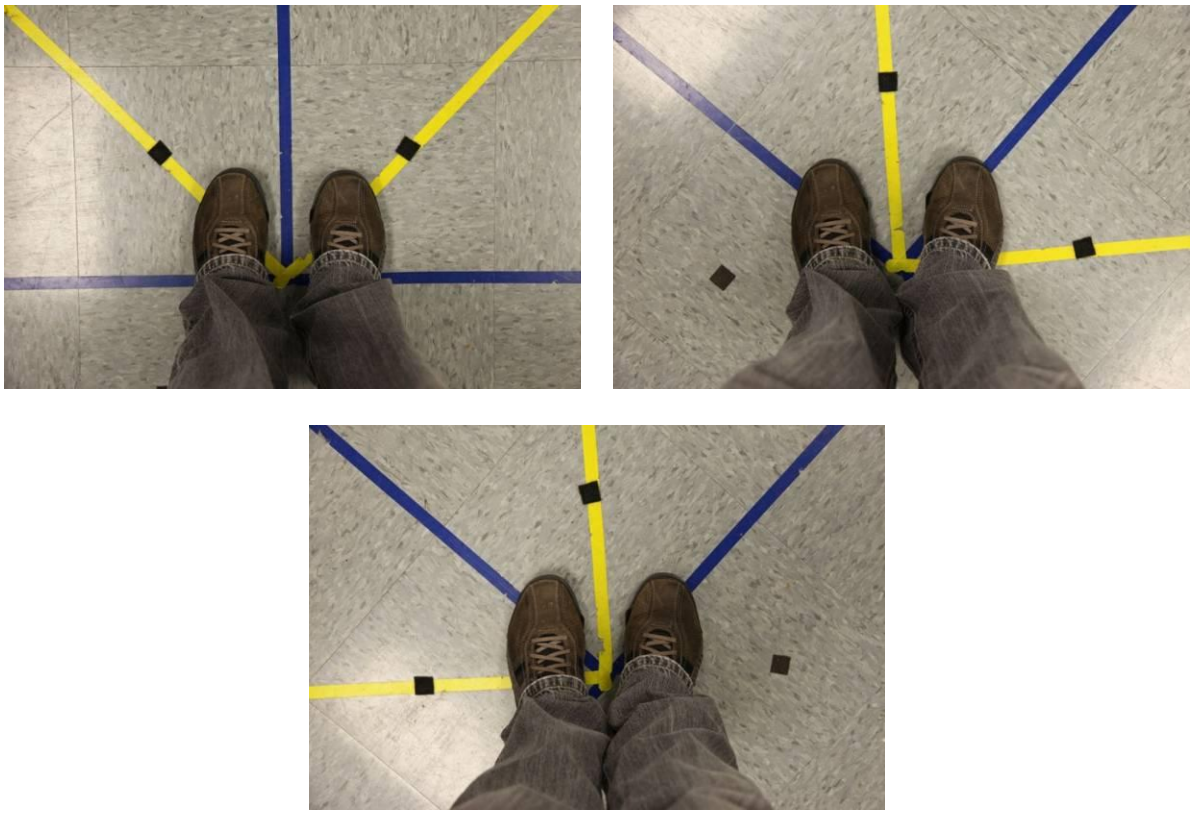

Figure 6: Proper foot placement for all pose angles.

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 ~30 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 power supply and USB cable for data transfer
- Canon Mark II camera with 800mm lens
- Sony Digital Recording Binoculars
- 3 tripods
- Computer for data transfer
- 3 cones
- 1 chair (this chair is used to reduce position shifting by the participant during the lengthy collection session; note that you should repeatedly ensure that the participant's face is well aligned with the SVI reticule)

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 left, Canon in the center, and Sony on the right (if facing the participant). *Note: A power supply will be necessary for the SVI camera*

2. Standing behind the Canon place the range finder such that it is aligned with the lens of the camera
3. Have someone walk in a straight line away from the camera till the range finder reads 50m, place a cone. Repeat for 75m and 100m. Setup layout is shown in Fig. XX. *Note: Be sure no objects are obscuring any camera's field of vision*.
4. Set SVI camera to the appropriate gain and manual settings for the weather conditions: 7 for sunny days, 8 or 9 for overcast or cloudy days.
5. Check that the Canon is set to automatic focus, full-auto operation (green square on selector knob). The camera is set on a ten second delay to allow the tripod to settle after pressing the capture (shutter) button.

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

At Distance = 48m

1. Have the participant, starting from the 50 m cone, take 2 large steps towards the cameras and sit in the chair. (Level the chair as best you can)
2. Have the participant hold sign reading "48" at chest level. *Note: be sure the sign is not casting a shadow on or obscuring the face*
3. Take the SVI Images
    a. Set camera to preset 1 (see Fig. 7 for button diagram)
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 9 images

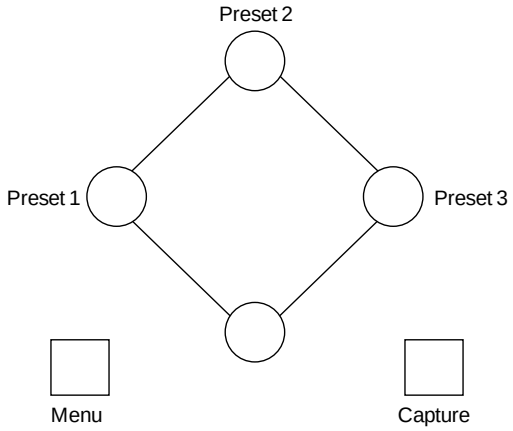

Figure 7: SVI button layout.

At Distance = 50 m

1. Have the participant move, with the chair, to the 50m cone and hold the sign reading "50" at chest level
2. Collect the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 18 images
3. Take Canon Images
    a. Look through the viewfinder and center the participant's face in the center box
    b. Press the capture button half way till the image focuses and the red dot in the center box lights up
    c. Take image
    d. Repeat b & c 2 times
4. Sony
    a. Check that it is on 3D video setting
    b. Center the participant on the screen
    c. Zoom in all the way, keeping the participant centered
    d. Record for 5-7 seconds
    e. Switch setting to 2D still mode
    f. Check that participant is centered
    g. Take 3 still images

At Distance = 52 m

1. Have the participant, starting from the 50 m cone, take 2 large steps away from the cameras and sit in the chair. (level the chair as best you can)
2. Have the participant hold sign reading "52" at chest level.
3. Take the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 27 images
4. Transfer all SVI images using the 'SVI Flashdownload' software
5. All files from the SVI camera will be placed in the 'vucommand' folder. Check that 162 files are present. If any files are missing find what number(s) are missing files and see Table 1 to determine which images need to be retaken. These files will need to be

transferred to their permanent location before another data transfer, or they will be overwritten.

Table 1: SVI Transfer File Numbers

	48m, 73m, 98m	50m, 75m, 100m	52m, 77m, 102m
Preset 1	1-3	10-12	19-21
Preset 2	4-6	13-15	22-24
Preset 3	7-9	16-18	25-27

At Distance = 73 m

1. Have the participant, starting from the 75 m cone, take 2 large steps away from the cameras and sit in the chair. (level the chair as best you can)
2. Have the participant hold sign reading "73" at chest level.
3. Take the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 9 images

At Distance = 75 m

1. Have the participant move, with the chair, to the 75m cone and hold the sign reading "75" at chest level
2. Collect the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 18 images
3. Take Canon Images
    a. Look through the viewfinder and center the participant's face in the center box
    b. Press the capture button half way till the image focuses and the red dot in the center box lights up
    c. Take image
    d. Repeat b & c 2 times
4. Sony
    a. Check that it is on 3D video setting
    b. Center the participant on the screen
    c. Zoom in all the way, keeping the participant centered

d. Record for 5-7 seconds
e. Switch setting to 2D still mode
f. Check that participant is centered
g. Take 3 still images

At Distance = 77 m

1. Have the participant, starting from the 75 m cone, take 2 large steps away from the cameras and sit in the chair. (level the chair as best you can)
2. Have the participant hold sign reading "77" at chest level.
3. Take the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 27 images
4. Transfer all SVI images using the 'SVI Flashdownload' software
5. All files from the SVI camera will be placed in the 'vucommand' folder. Check that 162 files are present. If any files are missing find what number(s) are missing files and see Table 1 to determine which images need to be retaken. These files will need to be transferred to their permanent location before another data transfer, or they will be overwritten.

At Distance = 98 m

1. Have the participant, starting from the 100 m cone, take 2 large steps away from the cameras and sit in the chair. (level the chair as best you can)
2. Have the participant hold sign reading "98" at chest level.
3. Take the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 9 images

At Distance = 100 m

1. Have the participant move, with the chair, to the 100 m cone and hold the sign reading "100" at chest level
2. Collect the SVI Images
    a. Set camera to preset 1

b. Center the participant's face inside the reticule
c. Press capture button and wait till light turns green and count increments by 1
d. Repeat steps b & c 2x
e. Set camera to preset 2
f. Repeat steps b & c 3x
g. Set camera to preset 3
h. Repeat steps b & c 3x
i. Check that the SVI has captured 18 images

3. Take Canon Images
    a. Look through the viewfinder and center the participant's face in the center box
    b. Press the capture button half way till the image focuses and the red dot in the center box lights up
    c. Take image
    d. Repeat b & c 2 times
4. Sony
    a. Check that it is on 3D video setting
    b. Center the participant on the screen
    c. Zoom in all the way, keeping the participant centered
    d. Record for 5-7 seconds
    e. Switch setting to 2D still mode
    f. Check that participant is centered
    g. Take 3 still images

At Distance = 102 m

1. Have the participant, starting from the 100 m cone, take 2 large steps away from the cameras and sit in the chair. (level the chair as best you can)
2. Have the participant hold sign reading "102" at chest level.
3. Take the SVI Images
    a. Set camera to preset 1
    b. Center the participant's face inside the reticule
    c. Press capture button and wait till light turns green and count increments by 1
    d. Repeat steps b & c 2x
    e. Set camera to preset 2
    f. Repeat steps b & c 3x
    g. Set camera to preset 3
    h. Repeat steps b & c 3x
    i. Check that the SVI has captured 27 images
4. Transfer all SVI images using the 'SVI Flashdownload' software
5. All files from the SVI camera will be placed in the 'vucommand' folder. Check that 162 files are present. If any files are missing find what number(s) are missing files and see Table 1 to determine which images need to be retaken. These files will need to be transferred to their permanent location before another data transfer, or they will be overwritten.

After completing the outdoor session, instruct the participant to go back to the remuneration area to turn in their consent for and receive their gift cards.

2.4.5 Post-Processing

After the data collection is completed, all images taken by the Canon camera are transferred from the CF card and placed in the folder of the participant that they belong to. All images from the Sony binoculars are transferred from the Sony SD card onto the computer in the same manner.

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. 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.

For the indoor ground truth photos, the participant may not have remained centered in the image throughout the photo session. If this occurred, the Autocropper tool could not be positioned correctly. To enable proper photo composition (i.e. eye location), the image was first shifted in Photoshop before cropping was performed.

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. Fig. 8 indicates that participation peaked after marketing events, and waned significantly during the final months of April and May due to Spring recess and final exams. This reduction in participation is illustrated as a flattening of the cumulative growth in Fig. 9. Fig. 10 indicates that Caucasians make up over half of the participants at 55%, followed by Asian Indians (21%) and Asians (12%). This ethnicity distribution is consistent with the WVU student population. Fig. 11 indicates that the majority of participants were in the 20-29 age range, making up 89% of the total. Fig. 12 shows that male participation was greater than female for all ethnicities except Asians, were the male/female participation was equal.

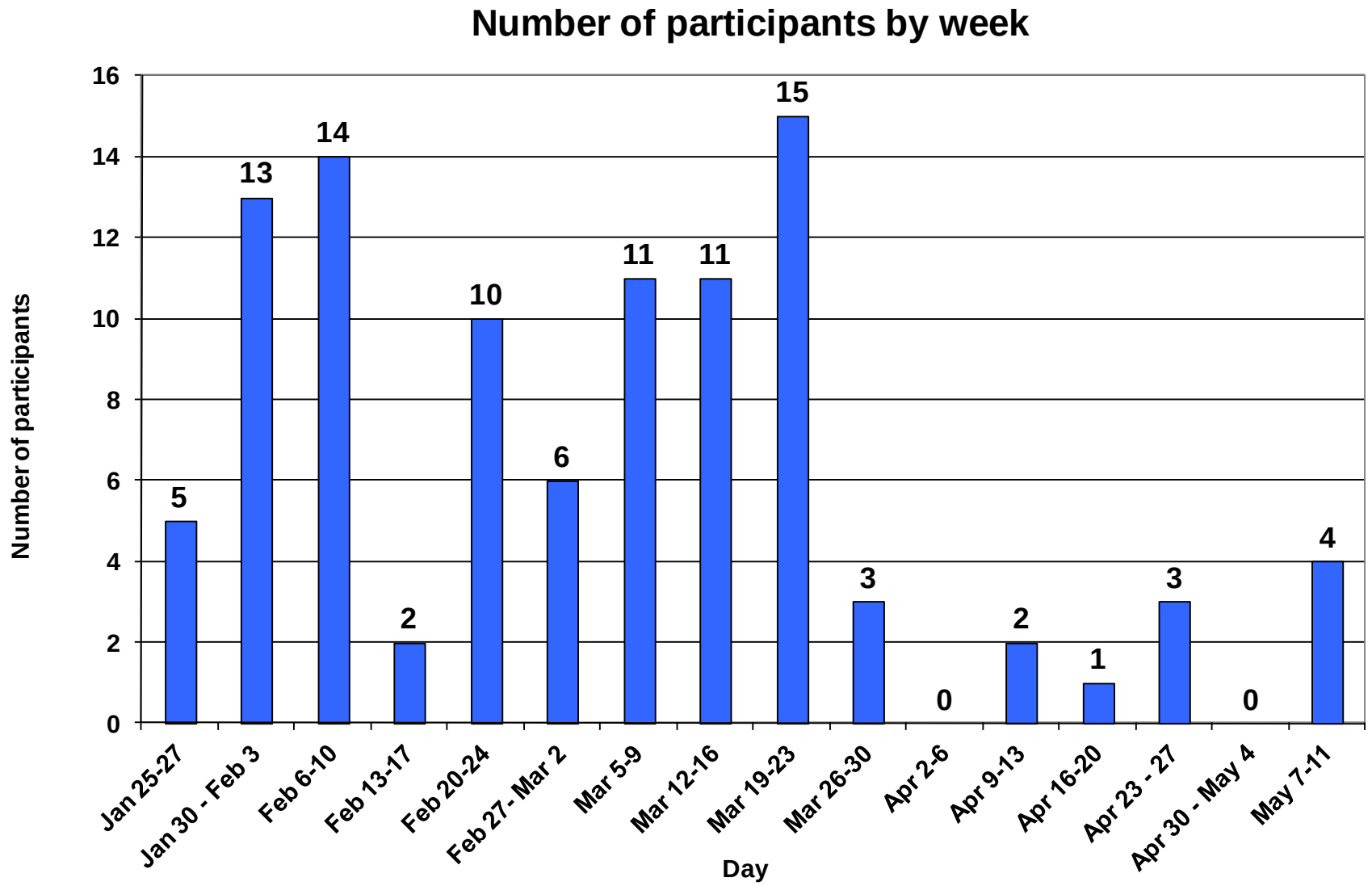

Figure 8: Number of participants by week.

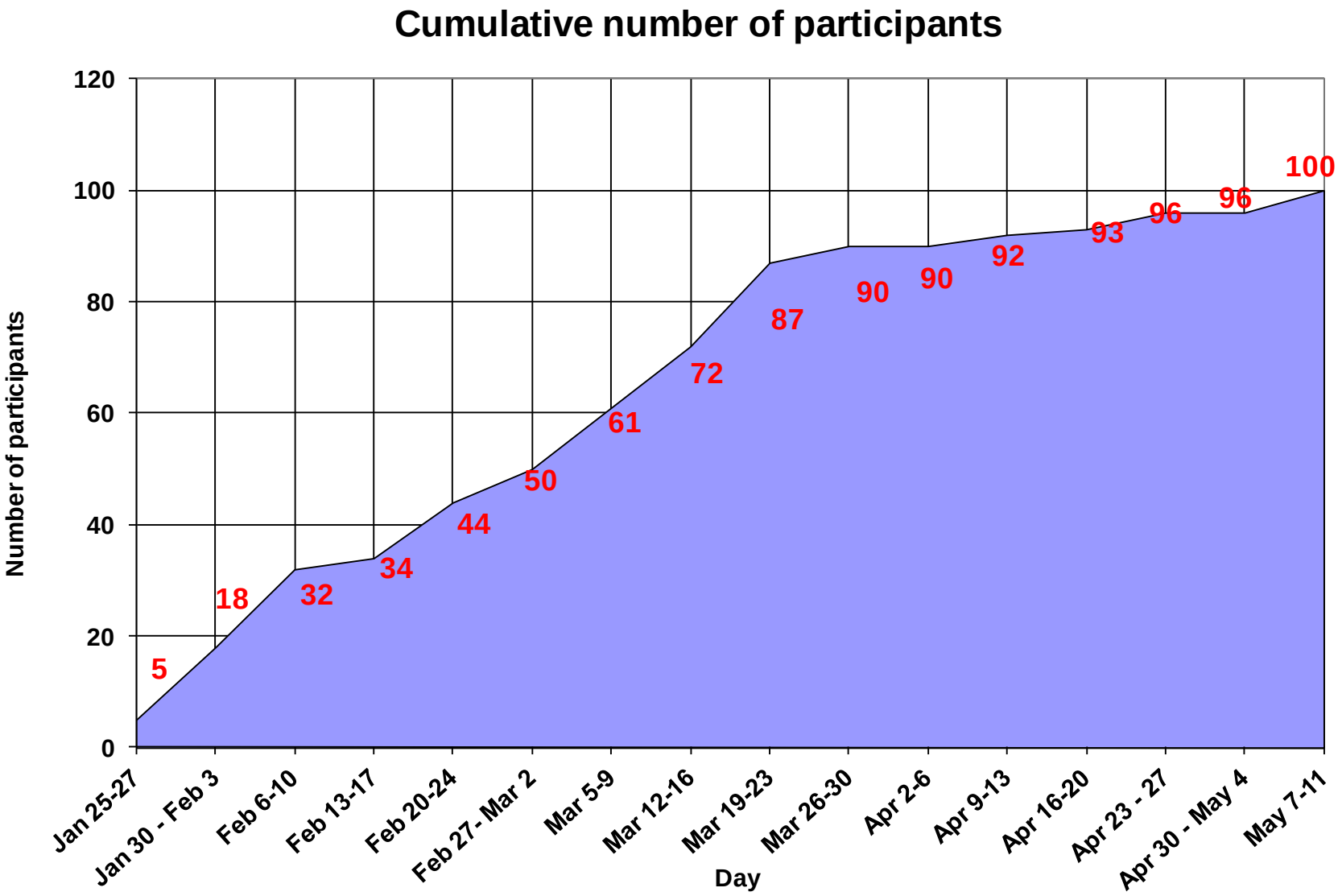

Figure 9: Cumulative participation.

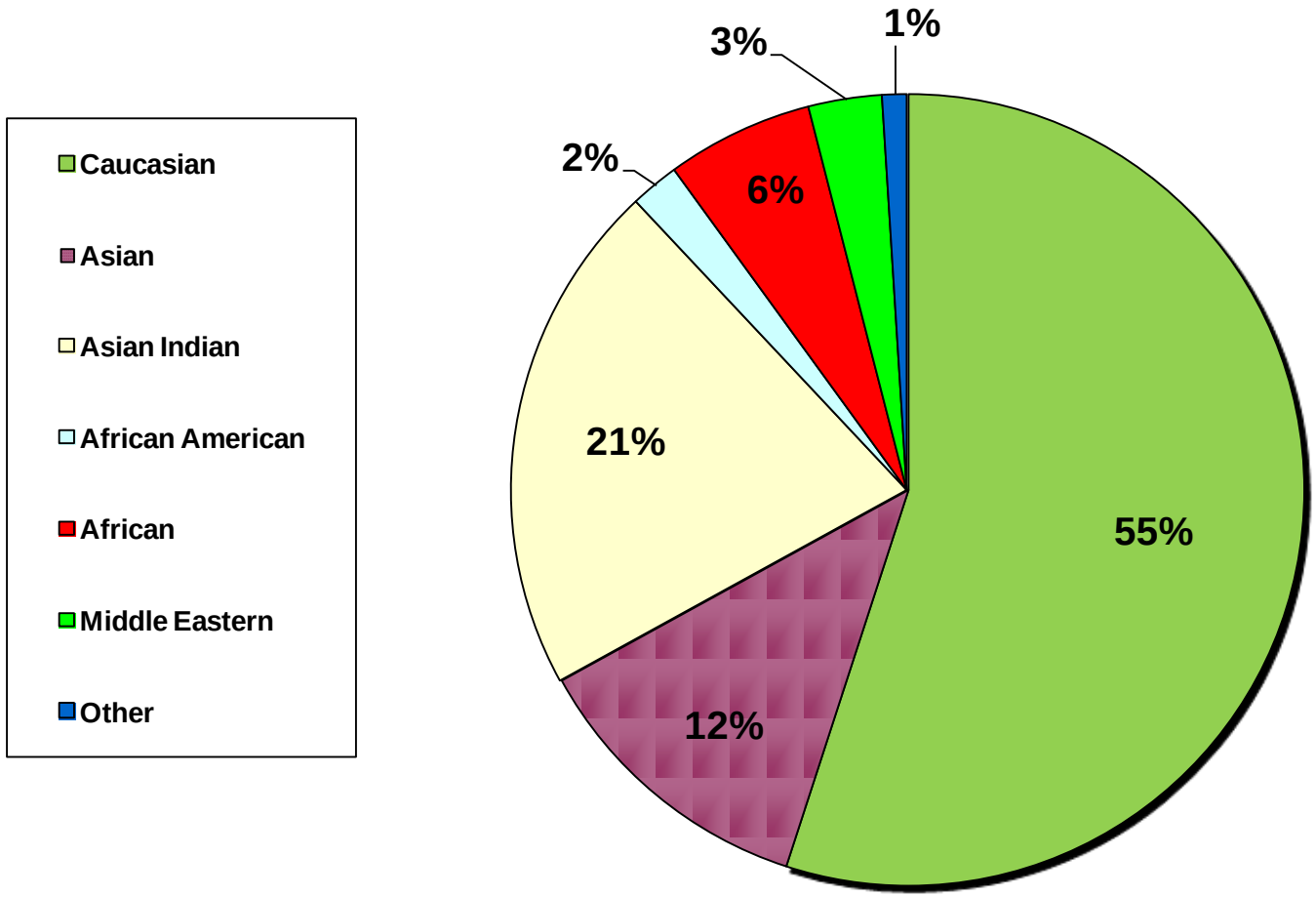

Figure 10: Participant ethnicity.

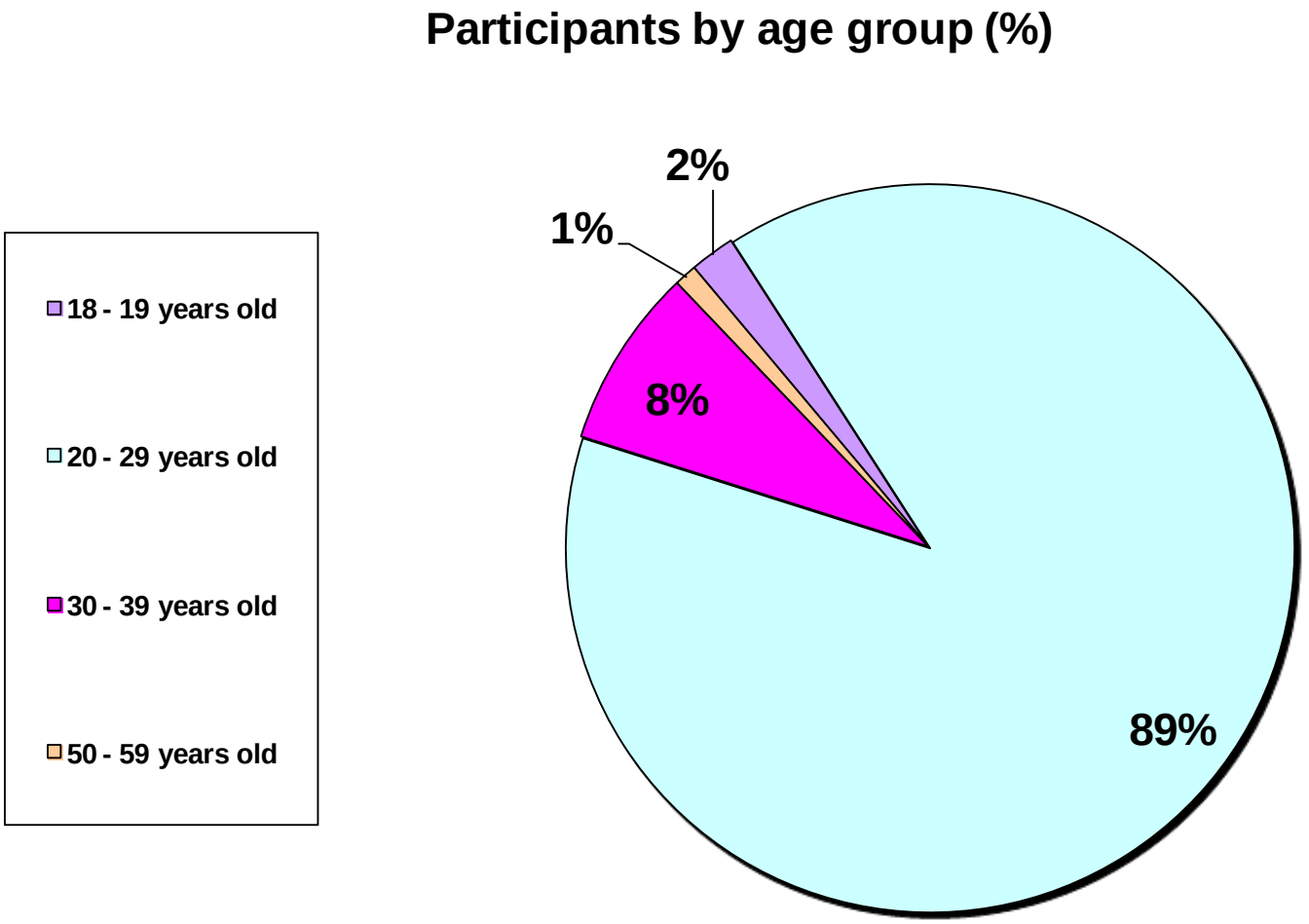

Figure 11: Participant age.

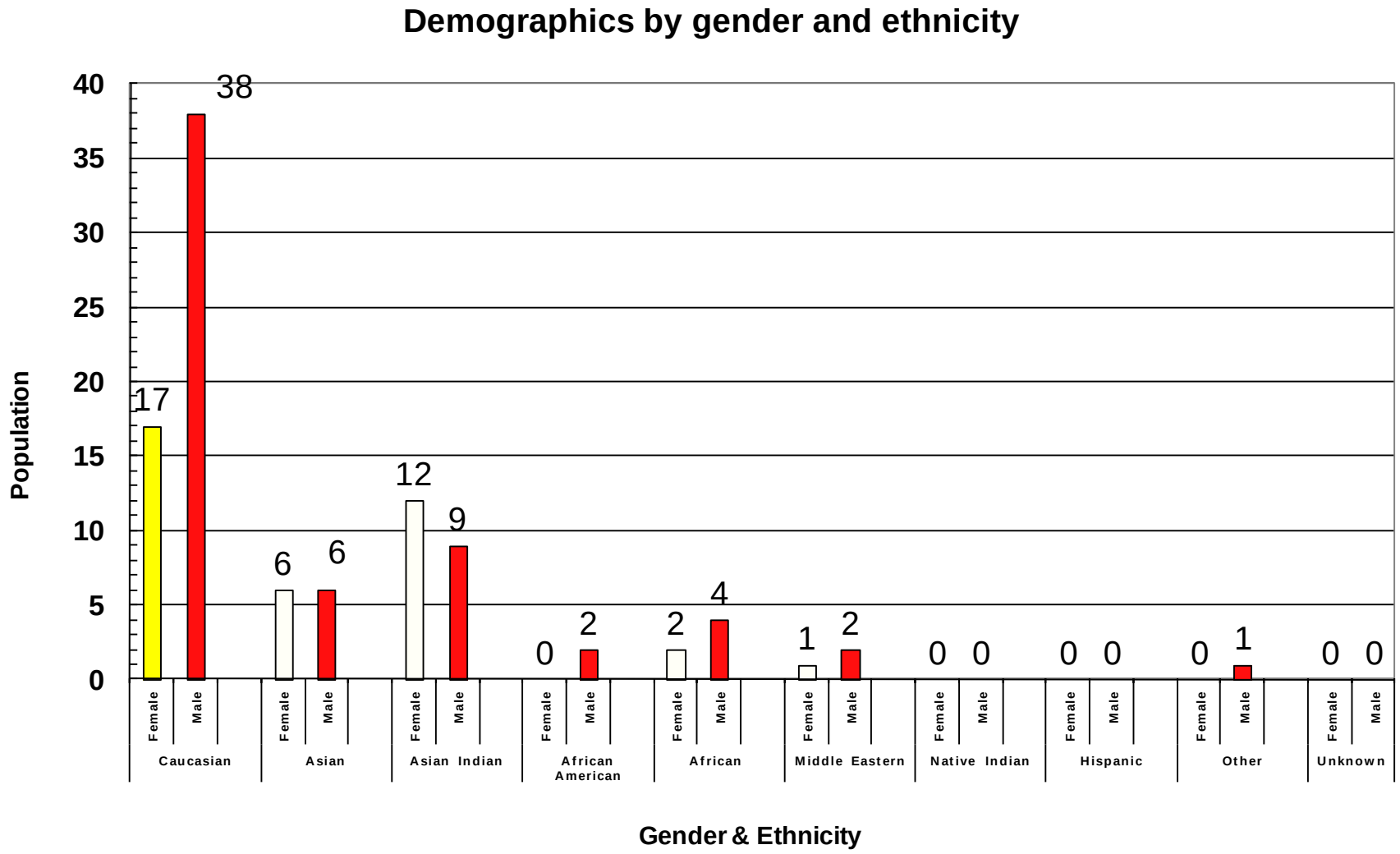

Figure 12: Breakdown of gender & ethnicity.

4. 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:

- How would you compare the image capture process between the Canon digital camera, the Sony binoculars, and the SVI binoculars? Include pros and cons for each system. Think about things like the user interface, image preview (or lack of), data transfer, etc.
- 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

By far the best quality images were taken with the Canon digital camera. Although the camera itself was a bit unwieldy, the picture quality was far superior to the Sony binoculars and the SVI binoculars. Having never had to adjust any of the settings on the digital camera, aside from the focus, I would say that it and the Sony binoculars were much easier to use than the SVI camera. Simply pressing one button to take a picture was easier than choosing the appropriate preset and then lining up the shot. Canon's digital camera's countdown feature was also quick handy for our purposes. Also, the boxes used to show the location of the center of the image on the Canon digital camera were much more indicative of the image position than the circle that was used on the SVI camera; I am indifferent about the image indicator for the Sony binoculars. In my opinion, the fact that the Sony binoculars can take video as well as pictures made it stand out. Although it couldn't zoom in very far, I think that it would be a much better option than the SVI camera for the average photographer, whether they are photographing people or wildlife or whatever.

The SVI's compact size is probably the best thing it has going for it. The picture quality is not very good and there is no way to view the pictures that have just been taken while using the camera. Also, the three buttons that indicated the "presets" had no visible indication of what they were for – someone who has never used the camera before may not know what to do with those. There was no zoom function on the SVI binoculars (at least none that I could find). It would be nice if the camera could take video like the Sony binoculars. Transferring the data onto a computer is simple enough; I thought it was as easy as any other camera's data transferring software (although a drag-and-drop style of transferring would be easier to work with).

In order to make the SVI binoculars more usable, the user-interface needs to be more idiot-proof. I think the most helpful improvement would be a menu with easier navigation. A larger screen with a more readable font size for the words and numbers would also be really great. The ability to change the brightness of the screen would also be nice to have. At some points, while trying to adjust the settings, a picture of some squirrel would overtake the screen and then would not go away. A "Back" button would have been nice to have in that situation.

Something that I had particular trouble with when taking the photos with camera was placing the person in the image in the center of the circle. I felt like always had to compensate for the fact that I was only using the left lens by placing the person in the image a little left of center to make the images come out better.

In conclusion, the SVI binoculars could benefit immensely from a more user-friendly interface and better picture quality. Also, some improvements that take into account the way people use the camera would be fantastic. Canon's digital camera is pretty great as-is, and Sony's binoculars are easier to use than the SVI.

Operator 2

Working with these three cameras was an interesting learning experience. As a student worker with these systems, I quickly became aware of the differences between the systems including the positive and negative qualities of each. After repeated use, I was able to discover what changes to the systems I would think would create a user-friendlier unit.

The SVI binoculars were a light camera and simple to set up. It would a very useful mobile device. Unfortunately, the tripod used was often too high which made seeing the preset buttons and menu buttons impossible. It was hard to distinguish these by touch when changing presets. When capturing an image, a lack of a focus mechanism other than the delay often resulted in blurry pictures. Also, the square in the view that the subjects face was to be centered in was off-centered. This led to pictures that did not represent the image supposedly captured. This disconnect in image capture could not be seen until all the images were transferred to the computer. After this inconsistency was found and the user adjusted the camera's position accordingly, it was much simpler to capture the face of the subject. Lastly, the memory card had unclear directions for its insertion that eventually led to repeated unintentional damage to a sensitive part of the binoculars.

A change that would help make the system user-friendlier would include alterations to the button design such as putting a corresponding numbers of raised dots on the Preset One, Two, and Three buttons. Feeling one dot on Present One button and feeling two dots on the Present Two button would make switching between them much easier. A way to reduce the need for image recapture is to fix the alignment of the center box on the view screen. Seeing the captured image on a view screen directly after it is taken would allow for quicker data processing and a more convenient way of finding errors in images. The best fix would allow for the image to be displayed and then deleted if it needed to be retaken. Finally, an alternate method of storing memory would be desirable because the current system is very fragile.

Using the Canon digital camera was very simple. The camera has the ability to focus on the subject before image is captured. There was only one setting which was easier to use but not as practical for data analysis. The captured image was immediately displayed after it was taken which made it easier to discover pictures that needed to be retaken. The data transfer was quick and easy using the small SD card. It was heavy which made it an impractical mobile unit, but it was a useful stationary model.

The Sony binoculars were the easiest to use because the binoculars were used to record a five second video rather than capture several images like the other two systems. There was no immediate view of the resulting video, but it was easy to tell if the video needed to be restarted during the process (i.e. person walking in front of the binoculars). This system was the quickest in capturing its required data.

In conclusion, these were three very different systems each with their own positive and negative qualities. The Canon camera delivered clear images in a quick time and a easy transfer. The Sony binoculars were simple to use and allowed for quick retake of data. While the SVI system set-up often led to inconsistent results, it was able to capture the most data and could provide the most detailed data with the user's patience.

Operator 3

Sony & Canon Cameras:

The Sony 3D camera had an interface that was easy to use as well as clearly labeled buttons on the device describing their function. The image and video quality of the Sony camera is good. The Sony Camera has worked very well in both video as well as still image captures. The Canon camera in my opinion performed the best at still images, which would make sense since the resolution of those images as well as the lens system used surpass the other two camera's capabilities by a wide margin.

SVI Camera Analysis:

The SVI camera had a few issues with its operation. There was an issue when transferring images from the device to the collection computer in which some images from the collection set were lost in the transfer. This may have been caused by a bad sector on the Compact Flash (CF) card used in the camera and the camera's operating system may not be able to detect bad sectors on the card and save around those sectors to avoid loss of data.

Another issue I had with the camera was that the targeting reticle was not precise and if the targeting circle was placed over the participant's face the images taken would have the person's face off center. There were issues with the focus presets on the camera. In some cases, presets for 100m would work better than those used at 75m. This issue caused a lot of blurry photos and the only way to ensure that accurate photos were taken was to take multiple images with each preset for every distance the participant sat. Sometimes we had better results if the participant sat 2 meters behind or in front of the target mark for each distance again taken multiple times with each focus preset.

The SVI did have one advantage over the Sony 3D cam in that the viewfinder allowed the light through the lens to pass through to the user. I felt more comfortable looking through the device compared to the Sony, which has a virtual viewfinder and can sometimes be uncomfortable on the eyes. I found the Sony especially hard to work with when wearing my glasses because they caused exterior light to cause a glare on the viewfinder of the Sony 3D camera. I did not have any similar problems wearing glasses and working with the SVI camera.

Overall, I think the SVI camera needs much improvement in terms of ease of use. I feel that if the focus system were improved such that the user can manually focus the device or have more predefined focal presets, then the camera system would perform much better.

Operator 4

Pros and cons of the Canon Digital and Sony binoculars:

The Canon is an enormous camera when the 800mm lens is added to it. It takes amazing crystal clear images. For this collection it would be my guess the second easiest to operate. Reasons why it could be difficult to operate are because the wide range of options for it, which can be a good or bad thing for the user depending on their experience. The main con about this set up would be the lens, not very fun to hall around for a long distance.

The Sony binoculars were in my opinion the simplest to work with. I did expect the zoom setting to actually zoom in farther than what they did. Another noticed issue was if the temperature was rather warm (around mid 70's or higher) the binoculars would get warm and the image viewed would be blurry and a small error message would be blinking in the corner. Sony's binoculars were the only camera that seemed to be affected by the temperature. The other two cameras were also in the equivalent amount of light and heat but these factors did not affect with either's' performance. Although the screen was blurred, the data was not affected.

Pros and cons of the SVI camera:

The SVI is a very light weight camera. The three preset set-up is an interesting feature. This feature did make a difference on the images. Although there are no specific affects since the data has not been thoroughly analyzed, it was noted that the images were not the same when skimming through. For example, the participant was not all the time centered even while the camera or the participant had not moved. This showed that the presets did have an effect on the image output. The camera provided lots of data for each capture, which can be very useful for farther analysis.

Downfalls for the SVI included not all of the data transferring over to the command folder. We think it could possibly be bad cells on the card that could affect the data when moved. It was also noticed that this occurred usually in the middle of the transfer which often contained moving 27 images. Never was the very beginning or very end of the images missing. We also think that the circle to center the object is not correctly centered. It seemed that we got better centered image when the object was placed slightly to the left of the center of the circle.

Operator 5

The image capture process of the SVI, Sony, and Canon were very different. With the SVI the best part about the process was that there were many pictures being taken. This provided a good amount of data that could be used to test against other brands. Another good thing was how the camera kept track of how many pictures that were took. To better this feature, it would have been a good thing to show which button in the diamond shape they were being taken for. Another part of the SVI image capturing, a program had to be run to take the pictures off the camera. This presented problems by making the collection longer and not allowing more people to get the collection done. The Canon presented an easy process for the image

capturing with only taking three pictures. With the auto focus and just pressing one button to take a picture was user friendly. However, with only taking three pictures, the data base was smaller than the SVI which could cause a problem if the images had flaws. The Sony, in my opinion, had the best image capturing process because it was five seconds of recording and that was all. It was very user friendly by just zooming and recording. With recording instead of pictures, this made it to where the participants face would be very easy to see in at least one split second and being able to pull that from the video rather than depending on still pictures.

The SVI is designed cosmetically very proficiently with the square in the middle of the visual field. Placing the square in the correct place was very easy and taking the picture was easy because with the button on the top the camera didn't move when it was pushed. The flip up screen suited the camera well because it was out of the way and very maneuverable when closed and when open it provided a display.

The biggest challenges to operating the SVI system was keeping track of what button in the diamond shape was being used at that point in time. With going from one camera to another, it became confusing. Also, the SVI took a long time to take the picture with taking a right, left, log, etc. for every push of the button. Also with running the program after every 27 photos took up a lot of the participant's time and made the collection longer. Another problem with the system was separating the files into nine folders. Also in those nine folders were three more folders so therefore it took up more time than needed.

The SVI system should have a better user friendly in general. To do this a display should be on the screen for which button in the diamond shape that is being used, or a light could be under the button to show that it was in use. Another thing is that the card going in and out all the time made problems arise so the program was made to bypass the use of the card. Even though this worked, it also added unwanted time to the collection. The program to pull the photos off the camera could use some work to make it faster.

In conclusion, the SVI is a good system and is almost on equivalent to the Sony and Canon, it just needs the extra couple things to make it a better user friendly system to operate. Doing this would make the SVI binoculars a better competitor against the Canon digital camera and the Sony binoculars.

Operator 6

The StereoVision 3D camera has some falls, as expected with a prototype. One of the best things with this camera is the reticule to help the user center the subject for the photo. Another positive is the software to transfer the data from the camera to the computer. Although it took a long time to run, about five minutes for twenty-seven photos, and would sometimes skip photos during the transferring process, it was much easier to use then removing the compact flash card. When removing the compact flash card users often struggled with removing it and put the card back into the camera without getting the card off track and stuck in the camera. One feature I would like to see on the StereoVision is a continuous display of the current preset. Often users would forget what preset the device was on, making the capturing process longer because the user would have to check the presets to be certain they were correct.

As far as the quality of photos, users struggled to capture high quality photos due to the effects the sun had on the image. With the need for such a long range the collection had to be taken outside, we struggled with finding a location where we could capture images without shadows on the face. We tried to make adjustments the best we could to get minimal shading on the face, but there was still some degradation of quality of the images. On the topic of quality of the images, most images when looked at look as if they are slightly out of focus.

Comparing the SVI camera to the Canon with the 800mm zoom lens, although the SVI camera will result in a stereoscopic 3D image, giving the matching algorithms more data to work with, the images from the Canon have a much higher quality and the shading on the face seems less significant than on the SVI. Also the Canon has a higher forgiveness for errors, making the ability to capture a high quality image much easier. The Canon is also more user friendly with its automatic focus and ability to review the photos immediately, so the subject is not forced to repeat a session if the image quality is poor.

The SVI camera has similar features to the Sony 3D camera. A couple features that the Sony camera has that I think would be nice to have on the SVI is the ability to take videos along with stills and the option of manual zoom. The zoom on the SVI however is better in terms of how closely it can zoom in on the face, with the Sony you have to be fully zoomed in at all three locations and majority of the video is background.

The SVI has minimal background for all locations, which is a plus because that is less data that must be segmented out.

Overall I think the SVI needs some improvements, such as the ability to view the images on the camera after capture, the ability to see the current preset at all time, knowing which button is used for each preset, possibility of manual zoom, and the option for video.

Operator 7

The Sony binoculars seem to be an overall good quality camera. The user interface was quite easy to navigate through and was self-explanatory. As far as image and video quality, I did not get a chance to see any of the still images uploaded off this camera but the videos seemed to be good quality. Autofocus was quite nice. Data transfers with this camera were quick and easy. The one dislike I have is there is no way to preview the images or videos after taking them without downloading to the computer. As far as I am aware, there is no way to delete an image either without downloading. If someone would walk in front of the camera and we had to retake a picture, it would've been a lot nicer to be able to preview to see if the image needed redone and delete it.

The easiest camera to use was the Canon digital camera. If a picture needed reviewed or deleted a push of a button and it was done. Focusing the camera was easy as well. The image quality of the photos turned out excellent. Fine detail in the face could be seen in most pictures. Data transfers were a lot like the Sony, place the card in the computer and copy it. One thing I did not like was the timer on the images. It wouldn't have been a big deal if you were someplace with no foot traffic. Sometimes people would walk by at the last second and get in the frame, where if there was no timer that wouldn't be such an issue. The user-friendliness of the camera makes up for that.

I think the SVI binoculars have the potential to be a good quality camera. There are just a few things that need fixed. User interface wasn't bad. If the exposure need changed it could easily be done on the screen of the camera. If it was sunny or overcast the exposure could be adjusted accordingly. One thing that would help to adjust settings is a preview on the screen. It takes a lot of time to take a few pictures, download them, adjust settings, and check it again. Also, there is no display of what preset you are on. Another thing I noticed is that the camera is very sensitive to movement. If the user or participant moved in the slightest bit they would be out of frame. Again, a preview would help this situation because we would be able to redo any pictures without downloading them first. As far as quality of the images, they appeared to be a bit fuzzy at times. The quality wasn't as good as the Canon or Sony. My biggest problem with this camera is data transfer. When we took the card out to do data transfers it was quicker and we didn't seem to lose any data. The issue with doing that was is the card slot does not have any guides and the card can easily but inserted wrong and cause damage to the camera. Downloading straight from the camera is a good concept however it takes a very long time. Occasionally when downloading, images would get lost in transfer and would have to be retaken. I am not sure of what the issue could be but another way of transferring data from the camera to the computer would improve this camera a lot. In summary, add a preview option and preset display to the screen and design a better way to transfer data and this camera would be improved.