A New Look at Old Abe's Color Guard

Researchers combine classic and cutting-edge techniques to reexamine the identities of soldiers in an iconic image

By

Tyler Phillips[1], Xukai Zou[2] and Kenneth E. Byrd[3]

[1]Department of Computer & Information Science
School of Science
Indiana University Purdue University Indianapolis
723 W. Michigan St.
Indianapolis, IN, 46202
phillity@iupui.edu
(317) 903-9808

[2]Department of Computer & Information Science
School of Science
Indiana University Purdue University Indianapolis
723 W. Michigan St.
Indianapolis, IN, 46202
xzou@iupui.edu
(317) 278-8576
https://science.iupui.edu/people/zou-xukai

[3]Department of Anatomy and Cell Biology
Indiana University School of Medicine
MS-5035
635 Barnhill Drive
Indianapolis, IN 46202
kbyrd@iupui.edu
(317) 274-3355
https://medicine.iu.edu/faculty/15052/byrd-kenneth/

*Address all correspondence to Tyler Phillips - phillity@iupui.edu, (317) 903-9808

Technical Supplement

Abstract

Many images of the American Civil War exist today and allow us to gain insight into the lives' of those involved in the conflict. Unfortunately, these images also pose questions as many of the soldiers they depict are unidentified or identified with unknown reliability. One such image is that of the Wisconsin Infantry Color Guard and their bald eagle mascot "Old Abe." One of the men in the color guard has been identified as George W. Riley due to an inscription on the back of the image. We perform state-of-art biometric-facial analysis of this soldier and several candidate identities. Through this biometric analysis and corroborating historical documents, we present compelling evidence that this soldier is not George W. Riley, but is more likely Walter J. Quick.

Introduction

One of the most famous historical images of the American Civil War is that of the 8th Wisconsin Infantry Color Guard and their famous bald eagle mascot "Old Abe" taken shortly after the fall of Vicksburg, Mississippi during July 1863 [1] [2].

The "Old Abe" 8th Wisconsin Infantry Color Guard image (Original glass plate negative from the J. Mack Moore Collection and on display in The Old Court House Museum Vicksburg, MS) contains 8 soldiers. The on print made from the photograph (in the A. G. Weissert collection) contains inscriptions on the back indicating the identity of 6 of the 8 soldiers (Figs. 1 and 2). The third solder from the right is noted as "George Reily" (likely George W. Riley). The reliability of this inscription is uncertain and the true identity of many of the soldiers, including the third soldier from the right, remains a mystery.

Our research proposes to answer the following question: can careful research and modern biometric-facial recognition techniques be used to determine the true identity of unknown individuals in historically significant images? Such analyses have importance to both historical and forensic researchers [3][4][5].

We were able to obtain peacetime (1865) image of Riley to use in our experiment (see. Fig. 3). This image was provided courtesy of the Wisconsin Veterans Museum.

Recently, in addition to George W. Riley several other candidates from the 8th Wisconsin have also been proposed as the possible true identity of the third soldier from the right. One strong candidate of particular interest is Walter Quick. A 1918 newspaper article titled "About 'Old Abe'" mentions that Quick (by his own account as he was alive at the time) was a part of the color guard which Old Abe was carried alongside [6]. We were able to obtain one 1905 post war image of Quick in old age (see Fig. 4). This image was provided by Quick's great-great-grandson Jason Quick.

Another interesting candidate we considered in our analysis was Burnett Demarest. Demarest was a company C man who obtained the rank of lieutenant during the war. Demarest less likely a real candidate as the identity of the third soldier, and he was used primary for validation purposes within our experiment. We were able to obtain one wartime (1861) and one peacetime image (1865) of Demarest to use within our experiment. These images were provided by the Wisconsin Historical Society and Wisconsin Veterans Museum, respectively.

We have gathered these confirmed images of Demarest, Quick, and Riley in order to determine which of the three candidates is most likely the third from the right (we here deem the unknown soldier). We used both traditional and state-of-art biometric techniques in order to make statements about the relative probability of each of the three candidates.

Materials and Methods

In order to make a statement regarding the probability that George W. Riley is indeed the unknown man (vs. other likely candidates), we performed facial analysis of the "Old Abe" Color Guard image, the J. Burnett Demarest 1861 image, the J. Burnett Demarest 1865 image, the George W. Riley 1865 image and the Walter Quick (Old Age) 1905 image. We made use of the OpenCV [7] and Dlib [8] open-source computer vision libraries in order to perform a comparative experiment.

I. Segmentation, Alignment and Normalization

Our first step was to perform segmentation of areas of interest within our input images. We began by manually cropping regions of the images which contained faces. We chose to include most of the soldier faces within the Old Abe Color Guard image (not just the mystery man face) in our analysis. These additional soldiers were used primarily for validation purposes. Sets of multiple copies of many of the resulting cropped face images were also used in our analysis. Each set (multiple copies of a single face image) contained copies of a facial image at varying image qualities (Fig. 5).

Next, we performed alignment on each of the facial images. In order to accomplish this task, we first fit 68 facial landmarks to each facial image using Kazemi's regression tree method [9]. We were able to make use of Dlib's open-source Kazemi model [10] which was trained using the iBUG 300-W alignment benchmark dataset [11]. Next, we used each image's facial landmarks surrounding the eyes in order to compute eye centroids. Based on the locations of these centroids, we performed an affine transformation (translation, rotation and scaling operations) on the image. The transformation aligned each of the images such that: the eyes appeared in approximately the same location within each of the images (translation), the angle between the eye centroids was minimized in each of the images (rotation) and the distance between the eye centroids were approximately the same within each of the images according to an input scaling factor (scaling). We used two different scaling factors in order to generate a tightly and loosely aligned set of output images (Figs. 6 and 7).

Finally, in an attempt to further normalize the tightly aligned set of images, we generated two more sets of images. In one set of images we manually cropped and removed the facial area below the nose in each image (“no beard” set). In the second set of images we manually removed the regions of the images containing the eyes (“no eyes” set) as shown in Figure 8 and Figure 9.

II. Feature Extraction

After aforementioned preprocessing of the facial images, we performed feature extraction. We chose to include three feature extraction methods in order to perform a comprehensive comparison between the candidate faces and the unknown soldier face.

The first method we used, Bio-Inspired Features (BIF) [12] [13], is a more traditional computer vision/signal processing based technique. Features are extracted by applying a Gabor filter bank to an image. The filter bank is applied in bands (Gabor filter pairs). A variable number of bands can be applied at a variable number of orientations on the image. The filter pair within each band slightly overlap. The results of the filter pairs are combined using a max operation. The combined result is then analyzed using its integral image representation (see [14]). Using the integral images, the mean and standard deviation are obtained for several regions (the size of which depends on a given pooling grid parameter) of each band feature. The computed standard deviations of all the bands and rotations are finally combined into a single feature vector. As suggested by the original BIF paper [12], we chose to apply 6 bands at 10 rotations.

One unfortunate aspect of the more traditional BIF method is that it suffers from variation in illumination, variation in location of facial features within the image and variation of image quality. Since the testing image sets were quite unrestrained in terms of illumination and image quality (and had minor inconsistences in facial feature location after alignment), we chose to further normalize the images as part of our second method. Our second method involved first normalizing test images using Contrast Limited Adaptive Histogram Equalization (CLAHE) [15] followed by BIF feature extraction. CLAHE works much like simple histogram equalization, except it is adaptive in that it splits the image into several blocks and uses several corresponding histograms. CLAHE is also contrast limited in that amplification of darker regions is limited. After applying CLAHE normalization, we performed BIF feature extraction as before using 6 bands at 10 rotations.

The third method, FaceNet [16], differs from the previous two methods in that it is a state-of-the-art deep learning technique. FaceNet is a deep learning convolutional neural network (CNN) technique proposed by a group of Google researchers in 2015. The FaceNet CNN is a one-shot model that takes facial images as input, performs several convolutions on the input image at each level of the network in order to extract features of interest and finally maps the image to a 1x128 feature vector. The FaceNet CNN was trained using segments of over 200 million matching/non-matching face patches. During training, the network employs a novel triplet loss method in which groups of three face patch features are used. These groups are comprised of two matching and one non-matching face patch features. One of the matching face patch features is used as an anchor. The distance between this anchor patch feature and the other matching face patch feature is minimized. Meanwhile, the distance between the anchor face patch feature and the non-matching face patch feature is maximized. The resulting Euclidean distance between FaceNet feature vectors is directly proportional to facial dissimilarity. Furthermore, the FaceNet method has the advantage that it can be used for both facial verification (one-to-one comparisons) and recognition (one-to-many comparisons). FaceNet has been shown to be an extremely accurate verification and recognition technique as it performs nearly perfectly on the Labeled Faces in the Wild [17] and YouTube Faces [18] facial recognition/verification benchmark datasets [17]. We were able to make use of an open-source FaceNet model [19] provided by OpenCV.

Experimental Results

Our experiment primarily consisted of comparing the facial images' feature vectors in terms of Euclidean distance. We performed comparative tests for each set of facial images (cropped, loosely aligned, tightly aligned, no beard and no eyes) and for each feature extraction method (BIF, BIF+CLAHE and FaceNet). We listed our average (several resolutions of each facial image are considered) Euclidean distance results for each of the candidate faces with the unknown face.

Our BIF results suggest the unknown soldier is most similar to Demarest 1861, then Quick, then Riley and least similar to Demarest 1865. (see Table 1).

Our BIF+CLAHE results suggest the unknown soldier is most similar to Quick, then Riley, then Demarest 1865 and least similar to Demarest 1861 (see Table 2).

Finally, our FaceNet results suggest the unknown soldier is most similar to Quick, then Demarest 1865 then Riley and least similar to Demarest 1861 (see Table 3).

It should be noted that the recorded values are Euclidean distances. Therefore, lower distance scores denote closer matches (i.e. a distance of 0 is a perfect match). Also, there are a few considerations that must be made when comparing the results of the three methods. The reliability of each of the methods is not necessarily the same. In general, the reliability of the methods in order of greatest to least is FaceNet, then BIF + CLAHE and finally BIF. Since the BIF and FaceNet feature vectors are of different sizes (BIF is 1x25960 is and FaceNet is 1x128) and denote different features, the BIF Euclidean distances are much greater than the FaceNet distances. This does not necessarily mean that the BIF matches are not as "close" as the FaceNet matches in general. These greater Euclidean distances are somewhat due the contents/size of the

BIF feature vector. Since the more traditional BIF method can suffer from variation in illumination, variation in location of facial features within the image and variation of image quality, the greater Euclidean distances may also be due to some of these factors. The CLAHE normalization, in general, serves to accentuate some differences between images and raise Euclidean differences.

It should also be noted that the Burnett Demarest 1861 image is not of very high quality. The image seems to be quite degraded and contains many spots (possibly water damage) and marks (small lines across the image in various places). We performed no image restoration techniques as part of this experiment.

Analysis and Discussion

Although there is some variation in the results of our three methods, all three of the result sets suggest that the unknown soldier is less likely to be George Riley than one or more of the other candidate soldiers.

The less reliable, more traditional BIF method indicates that the unknown soldier face is over 32.7% more similar to the Demarest 1861 and Quick faces than the Riley face. This result is consistent with the other two methods in pointing to Quick as a more likely match than Riley. Unlike the other two methods (which place Demarest 1861 as least likely), BIF suggests Demarest 1861 as the most likely match. This inconsistency is most likely due to the limitations of the traditional BIF method. Without the CLAHE normalization, the BIF method suffers greatly from inconsistencies in facial image lighting, facial pose and image quality. The very low quality Demarest 1861 most likely accentuates these weaknesses in the BIF method.

The BIF+CLAHE method indicates that the Quick face is greater than 4% more similar to the unknown face than the Riley face. Unfortunately, even with the help of CLAHE normalization, BIF still suffers from inconsistencies in pose, illumination and quality of facial images.

The most reliable, state-of-art FaceNet method indicates that the Quick and Demarest 1865 faces are 26.5% and 10.6% more similar to the unknown soldier face than the Riley face respectively. This result is quite significant as Euclidean distance directly encodes facial similarity of FaceNet feature vectors. The result is also significant because FaceNet has been shown to be very accurate in extremely unconstrained environments [16].

It is true that this experiment is quite constrained. Only one test image at varying qualities was used to extract data about the unknown soldier. Within this image the unknown soldier’s eyes, forehead and hair are occluded, each being valuable biometric features that can allow more accurate analysis. Likewise only a small set of training images are used. The Burnett, Quick and Riley training images also contain some issues. The Burnett 1861 image is quite degraded with many spots and marks. Within the Walter Quick (Old Age) image, the eyes are occluded and there are a few slight image quality issues (spots around and above left eye).

Despite these limitations, our experiment does suggest that the mystery soldier is not more likely to be Riley than the candidate faces. In fact, across all three of our experimental methods, Quick was found to be more likely than Riley. Especially noteworthy is FaceNet placing Quick 26.5% more similar to the mystery soldier than Riley. Based on these results it can be concluded that the true identity of the unknown soldier is more probable Quick than Riley according to both traditional and state-of-art biometric techniques.

Lastly, family history and obituary information provided by a descendant of Walter Quick suggests that Walter was indeed a member of the "Old Abe" color guard [20]. In addition, Civil War image researcher Scott Fink recently communicated that the facial expression for the unknown soldier image is the same as that of Walter Quick in old age [21]. The facial expression seen in both Walter Quick and the unknown soldier is largely produced by the corrugator supercilli muscle located between the eyes at the brow line and can express sadness or fear; such facial expressions develop in childhood and frequently last into old age [22].

Conclusion

We have provided compelling evidence that the unknown soldier in the Old Abe Color Guard image is not George W. Riley as indicated on the back of the original photograph. We evaluated the relative likelihood that the unknown soldier is Burnett Demarest (1861), Burnett Demarest (1865), George Riley and Walter Quick (Old Age) using traditional and state-of-art biometric techniques. Both traditional and state-of-art biometric techniques strongly suggest that Riley is most likely not the true identity of the unknown soldier. Furthermore, we have shown that Walter Quick is more likely the unknown soldier's true identity with a staggering 26.5% greater FaceNet feature similarity than that of Riley and the unknown soldier.

Acknowledgements

We wish to thank the following individuals for their time, assistance, suggestions, input, and very kind help: Samantha Wolf, Reference Archivist at the Wisconsin Veterans Museum; Lisa Marine, Image Reproduction & Licensing Manager at the Wisconsin Historical Society; Theodore P. Savas of Savas Beatie LLC Publishing; Scott T. Fink, Olney, Maryland; Dr. Kurt Luther, Assistant Professor of Computer Science and History, Virginia Tech University; Jason Quick, Denver, Colorado and great-great-grandson of Pvt. Walter Quick.

This work was partially supported by an IUPUI School of Science Near the Miss grant and an NSF Cybersecurity Innovation for Cyberinfrastructure grant (NSF #1839746).

Figures

Figure 1 – Photograph in A. G. Weissert collection and made from original glass plate negative, J. Mack Moore Collection, The Old Court House Museum Vicksburg, MS. Courtesy of Wisconsin Veterans Museum, Madison WI (WVM.0021.I027).

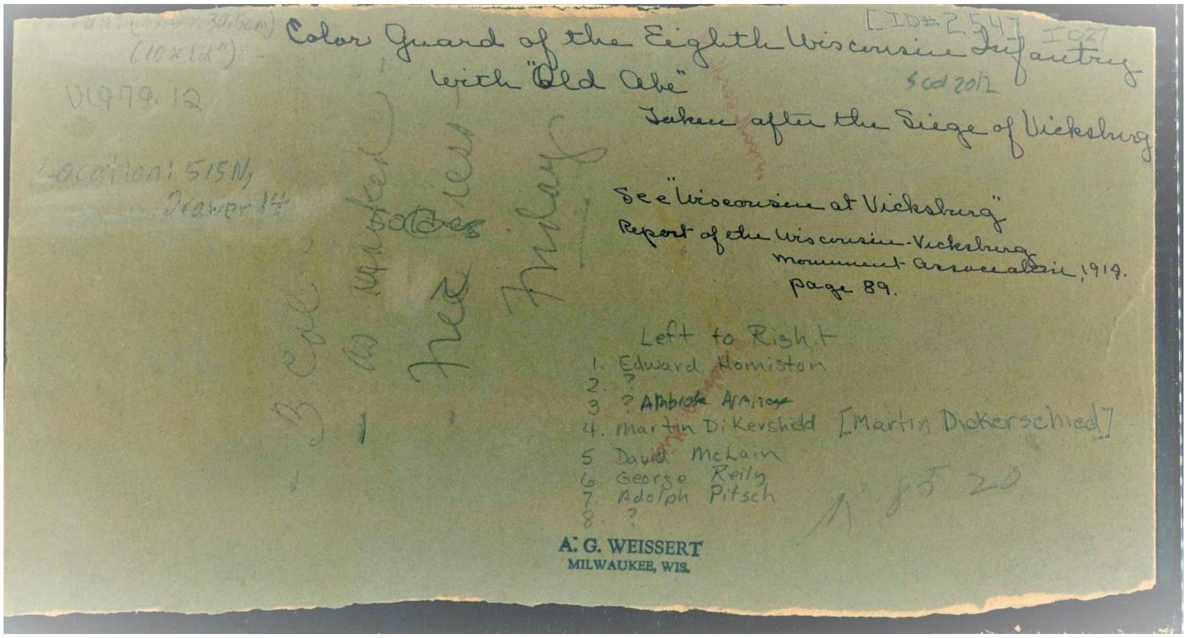

Figure 2 – Reverse of above Figure 1 photograph. Note "Left to Right" inscription for members of 8th Wisconsin Infantry Color Guard and "George Reily" [sic] notation. Courtesy of Wisconsin Veterans Museum, Madison WI (WVM.0021.I027).

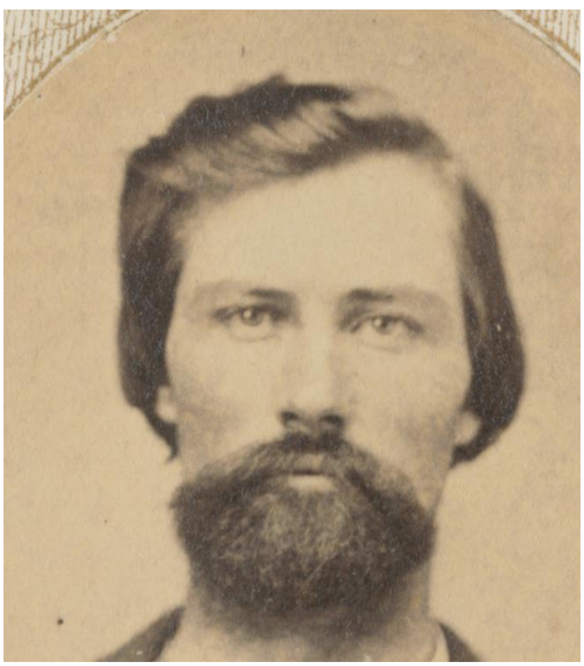

Figure 3 – 1865 image of George W. Riley; courtesy of the Wisconsin Veterans Museum, Madison (WVM.0004.I091).

Figure 4 – 1905 (old age) image of Walter Quick; courtesy of Jason Quick.

Figure 5 - Manually Cropped Images: Unknown and candidate facial images after manual segmentation and scaling operations.

Figure 6 - Tightly Aligned Images: Unknown and candidate facial images following alignment using facial landmarks surrounding the eyes and an affine transformation (translation, rotation and scaling). A greater scaling factor is used to achieve a more "zoomed in" result.

Figure 7 - Loosely Aligned Images: Similarly to loosely aligned images, tightly aligned images were obtained using facial landmarks and an affine transformation. A lesser scalar factor is used to achieve a more “zoomed out” result.

Figure 8 - No Beard Images: Lower facial regions were manually removed in order to mitigate the effect of different facial hair styles.

Figure 9 - No Eyes Images: Eye regions were manually covered in order to mitigate the effect of variation in illumination between facial images.

Tables

METHOD 1: BIF

Subject	Cropped	Loosely Aligned	Tightly Aligned	No Beard	No Eyes
B. Demarest 1865	176.7082609	191.5363869	120.814916	120.3155631	170.2992057
B. Demarest 1861	149.3180272	122.495904	102.4859061	91.64922864	104.1318826
G. Riley	188.7279362	154.5684559	118.3143724	153.3343426	158.7684889
W. Quick	152.8899217	127.3402229	104.0877093	91.00012793	104.6402661

OVERALL BIF

Subject	Mean	Standard Deviation
B. Demarest 1865	155.9348665	33.1944352
B. Demarest 1861	114.0161897	22.63323442
G. Riley	154.7427192	25.00120066
W. Quick	115.9916496	24.4203115

Table 1 – Method 1: BIF calculations.

METHOD 2: BIF + CLAHE

Subject	Cropped	Loosely Aligned	Tightly Aligned	No Beard	No Eyes
B. Demarest 1865	312.1822	356.5657258	318.0072227	318.087376	287.3332803
B. Demarest 1861	321.6480064	349.1109806	378.8560262	373.628914	291.4112076
G. Riley	319.0902954	335.3314651	314.6633071	316.3407261	297.6488148
W. Quick	310.3141554	331.4264203	305.3611077	302.8789364	268.5315327

OVERALL BIF + CLAHE

Subject	Mean	Standard Deviation
B. Demarest 1865	318.435161	24.80257327
B. Demarest 1861	342.931027	36.66884377
G. Riley	316.6149217	13.41672153
W. Quick	303.7024305	22.65367478

Table 2 – Method 2: BIF + CLAHE calculations.

METHOD 3: FACENET

Subject	Cropped	Loosely Aligned	Tightly Aligned	No Beard	No Eyes
B. Demarest 1865	0.745512346	0.627924257	0.879558256	0.798159898	0.962788994
B. Demarest 1861	0.82158497	1.003662565	0.923345455	0.957336045	0.832405405
G. Riley	0.802236301	0.801185523	0.991325773	0.910930758	0.933757508
W. Quick	0.787690258	0.800475868	0.593015119	0.579757198	0.750406245

OVERALL FACENET

Subject	Mean	Standard Deviation
B. Demarest 1865	0.80278875	0.127840955
B. Demarest 1861	0.907666888	0.079060736
G. Riley	0.887887173	0.083946242
W. Quick	0.702268938	0.107475726

Table 3 – Method 3: FaceNet calculations.

References

[1] Richard H. Zeitlin, Old Abe The War Eagle: A True Story of the Civil War and Reconstruction, (1986) State Historical Society of Wisconsin, Madison.

[2] David McLain, "The Story of Old Abe." The Wisconsin Magazine of History, vol. 8, no. 4 (1925): 407-414.

[3] S. Fink "Behind the barricade: how diligent research revealed the identity of the Devil's Den sharpshooter". Civil War Times, June 2018, p. 28.

[4] V. Mohanty, D. Thames, and K. Luther "Photo sleuth: combining collective intelligence and computer vision to identify historical portraits". ACM Conference on Collective Intelligence (CI 2018), Zurich, Switzerland, 2018.

[5] V. Mohanty, D. Thames, and K. Luther. "Are 1,000 Features Worth A Picture? Combining Crowdsourcing and Face Recognition to Identify Civil War Soldiers". AAAI Conference on Human Computation and Crowdsourcing (HCOMP 2018), Zurich, Switzerland, 2018.

[6] Available at the Wisconsin Historical Society website: http://content.wisconsinhistory.org/cdm/compoundobject/collection/quiner/id/19197/ (page 125)

[7] https://opencv.org/

[8] http://dlib.net/

[9] V. Kazemi and J. Sullivan, "One millisecond face alignment with an ensemble of regression trees," 2014 IEEE Conference on Computer Vision and Pattern Recognition, Columbus, OH, 2014, pp. 1867-1874.

[10] https://github.com/davisking/dlib-models/

[11] C. Sagonas, E. Antonakos, G, Tzimiropoulos, S. Zafeiriou, M. Pantic. 300 faces In-the-wild challenge: Database and results. Image and Vision Computing (IMAVIS), Special Issue on Facial Landmark Localisation "In-The-Wild". 2016.

[12] G. Guo, Guowang Mu, Y. Fu and T. S. Huang, "Human age estimation using bio-inspired features," 2009 IEEE Conference on Computer Vision and Pattern Recognition, Miami, FL, 2009, pp. 112-119.

[13] Spizhevoi, A. S., and A. V. Bovyrin. "Estimating human age using bio-inspired features and the ranking method." Pattern Recognition and Image Analysis 25.3 (2015): 547-552.

[14] P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simple features," Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. CVPR 2001, 2001, pp. I-511-I-518 vol.1.

[15] Stephen M. Pizer, E. Philip Amburn, John D. Austin, Robert Cromartie, Ari Geselowitz, Trey Greer, Bart Ter Haar Romeny, John B. Zimmerman, Adaptive histogram equalization and its variations, Computer Vision, Graphics, and Image Processing, v.39 n.3, p.355-368, Sept. 1987

[16] F. Schroff, D. Kalenichenko and J. Philbin, "FaceNet: A unified embedding for face recognition and clustering," 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Boston, MA, 2015, pp. 815-823.

[17] G. Huang, M. Ramesh, T. Berg, E. Learned, "Miller. Labeled faces in the wild: A database for studying face recognition in unconstrained environments", Technical Report 07-49 UMass, 2007.

[18] L. Wolf, T. Hassner and I. Maoz, "Face recognition in unconstrained videos with matched background similarity," CVPR 2011, Providence, RI, 2011, pp. 529-534.

[19] https://docs.opencv.org/trunk/db/d30/classcv_1_1dnn_1_1Net.html

[20] Quick Family History book, p. 266 and Walter Quick obituary, Shawano County Journal, Oct. 2, 1913; provided by Jason Quick to Kenneth E. Byrd by emails of March 16, 2018 and April 10, 2018.

[21] Scott Fink email to Kenneth E. Byrd, July 18, 2018.

[22] D.L. Neumann, R.C.K. Chan, G.J. Boyle, Y. Wang, and H.R. Westbury “Measures of empathy: self-report, behavioral, and neuroscientific approaches”, Measures of Personality and Social Psychological Constructs, Ed. Gregory J. Boyle, et al., Elsevier Science & Technology 2014, pp. 257-289.