Mugshot Compliance for Face Image Quality

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***Abstract*— Mugshots taken by the Indiana Department of Corrections (IDOC) were analyzed for face recognition image quality. The mugshots provided by the IDOC was an assortment from different times and locations. 9,291 images were run through BSPALabs PreFace in the NIST Mugshot Best Practice Profile to observe compliance with ANSI/NIST-ITL 1-2000. Previous study done by Hale et al. revealed the noncompliance of IDOC images for NIST approved mugshots. The current test replicates Hale et al.'s methodology with latest update to the PreFace image quality analysis program in order to observe current compliance.**

Keywords—Mugshot, biometric, face recognition, image quality

I. Introduction

Biometrics is the multidisciplinary science of human identification through unique and measurable biological and physiological variations. Since the early days of human history, prehistoric individuals marked their walls with handprints and coins of antiquity were adorned with the faces of rulers. These were the methods to identify and authenticate, to associate value and communicate information quickly and intuitively. Many new biometric modalities have emerged, but the face is still in common usage, either digitally or personally.

In law enforcement, biometrics has provided a quick and accurate solution for identifying criminals. As technology improves, such as digital information processing and the Internet, complexities develop on both sides of the law. It is easy to upload and open large databases on criminals, but to funnel down to a single individual is still a challenge. A fugitive can still hide within the digital realm until he can finally (if even possible) be identified. Certain standards pertaining to mugshot compliance were set aside by ANSI/NIST-ITL 1-2000 [1], for the purpose of normalizing and unifying mugshots. With all mugshots complying with a single standard, it would be easy for face recognition to acquire fugitives, both digitally and physically. But the introduction of any standard does generate the problem of total compliance. Both law enforcement and biometric scientists must ask themselves, "do mugshots, past and present, comply with the ANSI/NIST-ITL 1-2000 standard?"

II. Literature Review

A. Biometrics in Law Enforcement

Biometrics has had a long presence in law enforcement. Fingerprinting and mugshots are the legacy of biometric development for law enforcement. Allan Pinkerton, founder of Pinkerton's Detective Agency, developed a collection of mugshots which were used for wanted posters. These face images were artist renditions, newspaper clippings, and other sources, but none to any set standard [2].

B. Bertillon Metholodogies

In 1882, Dr. Alphonse Bertillon was made Chief of the Identification Bureau, which was connected with the Préfecture de Police in Paris. While there, he implemented his Bertillon system of identification, based on unique features that can be physically quantified [3]. The Bertillon system was the precursor to modern law enforcement biometric use, and set aside the first rules for criminal mugshots. Prior to Bertillon's tenure, portraits were taken of arrested individuals by the Préfecture de Police, but not to any unified standard. By 1888, the Bertillon system was used through Europe, the British Empire, the United States, and Russia [4, 5].

As technology improves so does quality of life, convenience, and the speed of daily transactions. The law enforcement community will also use new and constantly improving technology to carry out their duties. Information technology can now help law enforcement agencies communicate faster and more effectively, transfer and share large amounts of information, and to identify individuals faster.

C. Hale et al.'s Modern Challenges

ANSI/NIST-ITL 1-2000, was created for the purpose of cooperation across agencies, with one standardize way of communicating criminal justice information. Adherence to information standard is imperative in contemporary law enforcement, as criminals themselves are becoming technologically sophisticated. The modern criminals utilize online anonymity, online distance transactions, and "burner phones" to shield their identities[6]. As a result, a technology arms race happens between the law and the lawless, and the police reinforce the thin blue line with constant improvement on their technological arsenal. Before police only needed to exert spatial control with beat patrols and roaming cruisers, but

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the modern police must establish digital control as well. The location of a fugitive or a missing child, crime statistics by location and time, or digital records that provides evidence, information is critical to law enforcement. Ergo, the quality of information that is stored or captured must be to the highest within capabilities.

For good performance in face recognition, it is important to enroll high quality face images into the system [7]. Law enforcement agencies would need good quality faces for the mugshots they capture. This is imperative for their database to be effective. It is for this reason Hale et al. sough to evaluate the mugshot capture process [1].

III. Methodology

The image quality analysis was computed through BSPALabs Aware PreFace v5.3.6, a face profile analysis tool. Face images are analyzed and scored on various quality metrics for compliancy with different standards. For this study, the compliance to NIST Mugshots Best Practices was tested. A sample of 9291 mugshots were ran through Aware PreFace to test for compliancy. Batches to 999 images were ran to avoid image quality analysis software from crashing. The data is an amalgam of various mugshots from police departments within the state Indiana, given to the Purdue International Center for Biometric Research (ICBR) for study by the Indiana Department of Corrections (IDOC). The original dataset consisted of 49,694 mugshots, used by Hale et al, for a previous study on face image quality in mugshots [1]. This study tests but a sample from Hale et al's work to see if the results are replicable. This study also analyzes the overall compliancy of mugshots provided to the establish NIST standards.

IV. Results

Of the 9291 mugshots subjected to Aware PreFace, 149 were not able to be processed, leaving 9142 mugshots with extracted image quality. Among all the metrics, only Image Format and Percent Facial Saturation were compliant. Centerline Location Ratio was the only metric to be absolutely non-compliant, where no mugshot complied with the NIST standard. Results are shown in Figure 1.

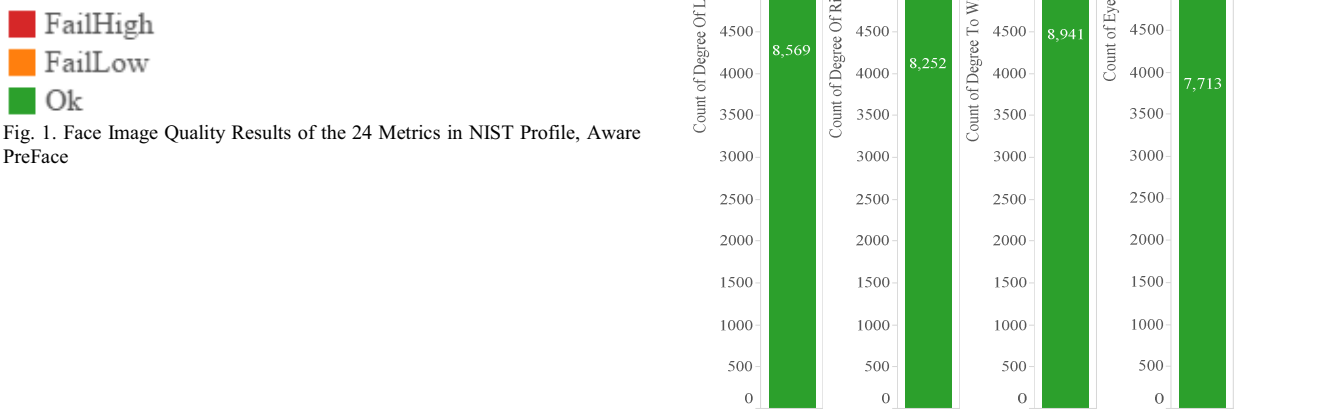
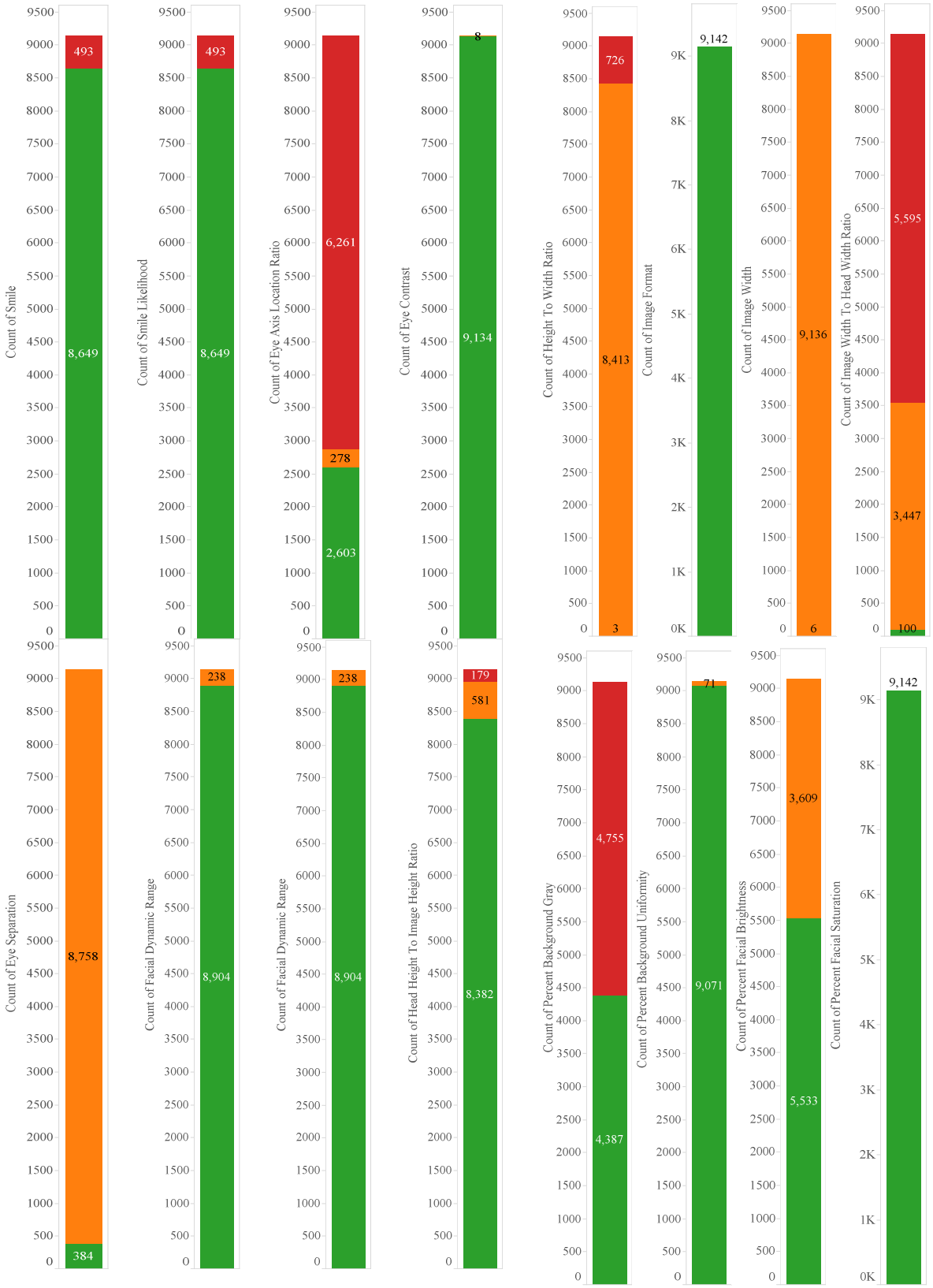


Fig. 1. Face Image Quality Results of the 24 Metrics in NIST Profile, Aware PreFace


Count of Smile
493
8,649
Count of Smile Likelihood
493
8,649
Count of Eye Axis Location Ratio
6,261
278
2,603
Count of Eye Contrast
8
9,134
Count of Height To Width Ratio
726
8,413
3
Count of Image Format
9,142
Count of Image Width
9,136
6
Count of Image Width To Head Width Ratio
5,595
3,447
100
Count of Eye Separation
8,758
384
Count of Facial Dynamic Range
238
8,904
Count of Facial Dynamic Range
238
8,904
Count of Head Height To Image Height Ratio
179
581
8,382
Count of Percent Background Gray
4,755
4,387
Count of Percent Background Uniformity
71
9,071
Count of Percent Facial Brightness
3,609
5,533
Count of Percent Facial Saturation
9,142

V. Conclusion and Ongoing Work

There are 24 metrics for the NIST profile in Aware PreFace, and only 2 remained compliant among all mugshots. The results reaffirm Hale et al's findings, there were outstanding issues with mugshot compliance by the IDOC. The inability to process 149 mugshots is also concerning. Image quality information was completely non-extractable, which poses a problem if the images are required for use in a face recognition system. Even though 13 of the image quality metrics showed high compliances, there were still images that were noncompliant. This in turn can compromise the overall effectiveness of the face recognition database [8].

Face recognition has traditionally been seen as the more problematic biometric modality. With face recognition, the way the face image is acquired can determine a lot of the performance problems. Analysis of the face images within the dataset also brings to light Hale et al's assertions regarding the way law enforcement interaction with biometrics. Figures 2 through 5 show a myriad of challenges associated with face recognition, such as isometric deformation from smiles, occlusion from glasses or jewelry, and interoperability issues with image size consistency. Figures 6 and 7 show law enforcement specific factors, in this case older mugshots taken on film and hand held placards. Contemporary police record keeping will have everything digitized, .jpg replacing film and database queries replacing placards. Evidence provided by Gao et al. shows that scanning photos for use in a face recognition system yields poor image quality [7]. Integration of older mugshots on film will pose a challenge for law enforcement biometric use and data accessibility.

Fig. 2. Example of Isometric Deformation (smiling)

Fig. 3. Example of Occlusion (glasses)

Fig. 4. Example of Size Consistency Issue

Fig. 5. Example of Background Consistency Issues

Fig. 6. Example of Legacy Images

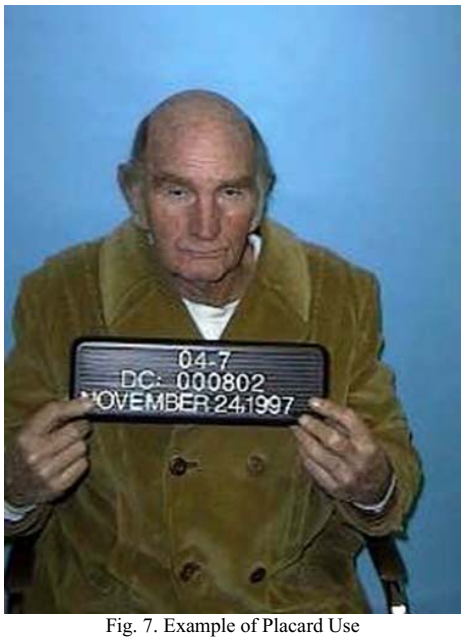


Fig. 7. Example of Placard Use

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