

An Evaluation of Fingerprint Image Quality of an Elderly Population vis-à-vis an 18-25 Year Old Baseline

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Purpose

The purpose of this study was to compare the utility quality of fingerprint images between two populations in order to assess potential factors affecting image quality.

What are Fingerprints?



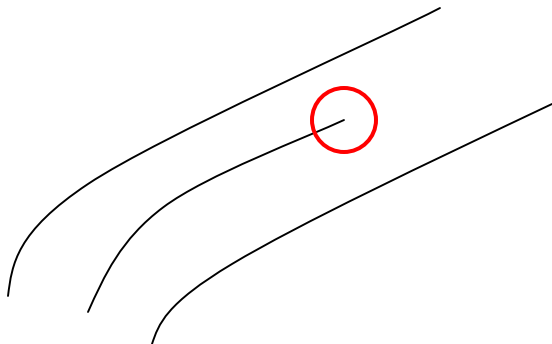
Fingerprints are the flow-like features (ridges & valleys) found on human fingers (Jain, Hong, Pankanti, & Bolle, 1997)



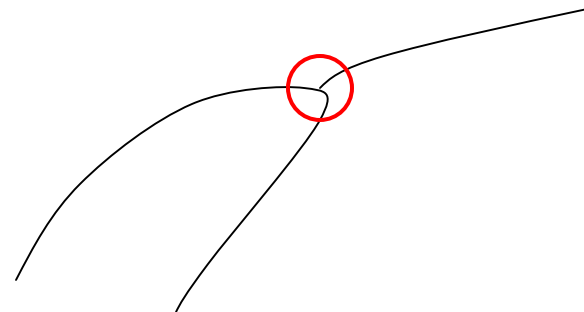
What Makes Fingerprints Unique?



- The use of fingerprints as a means of identification were first used by the Chinese in 500 B.C.
- Modern fingerprint classifications were established in the late 19th century.
 - 1888: Sir F. Galton introduced minutiae point classification for single fingerprints - “Galton Features”
 - Minutiae Points
 - Local ridge features that appear as either ridge endings or ridge bifurcations



Ridge Ending



Ridge Bifurcation

- 1899: E. Henry introduced a method for indexing fingerprints – The “Henry System” of classification.



a) Left Loop



b) Right Loop



c) Whorl



d) Arch



e) Tented Arch

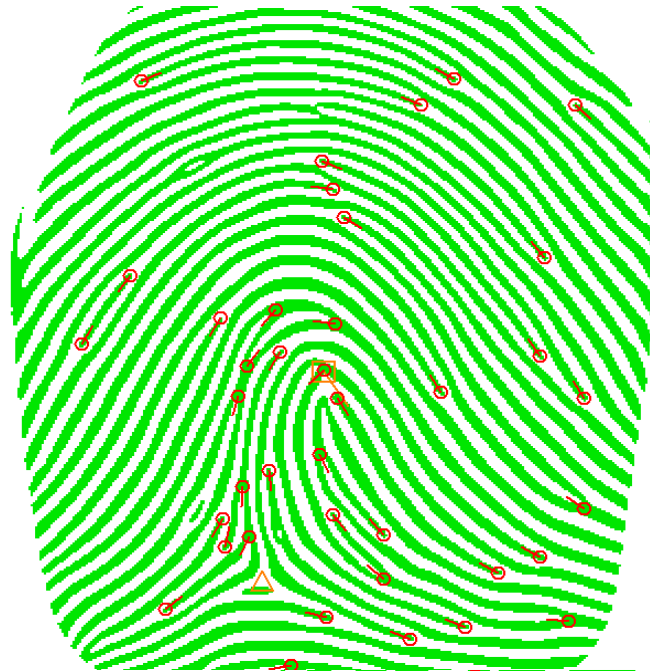


- Putting both the “Galton Features” and the “Henry System” together, a fingerprint can be accurately identified.

Right Loop



Right Loop with
minutiae points



Fingerprint Recognition Applications

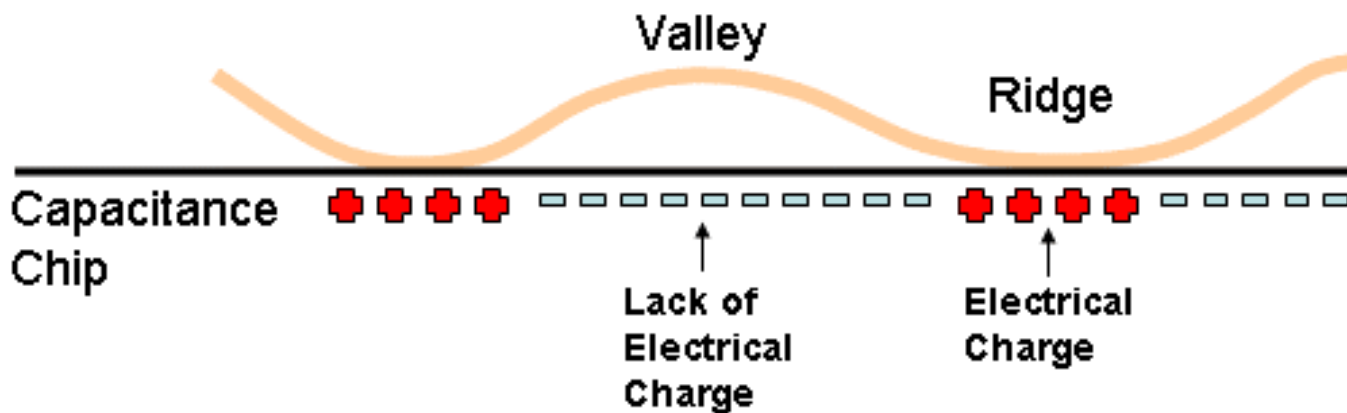


- Financial Services (Credit Union)
- Health Care (Hospitals)
- Telecommunications (Cell Phones)
- Government (Social Services)
- Electronic Commerce (Credit Card)



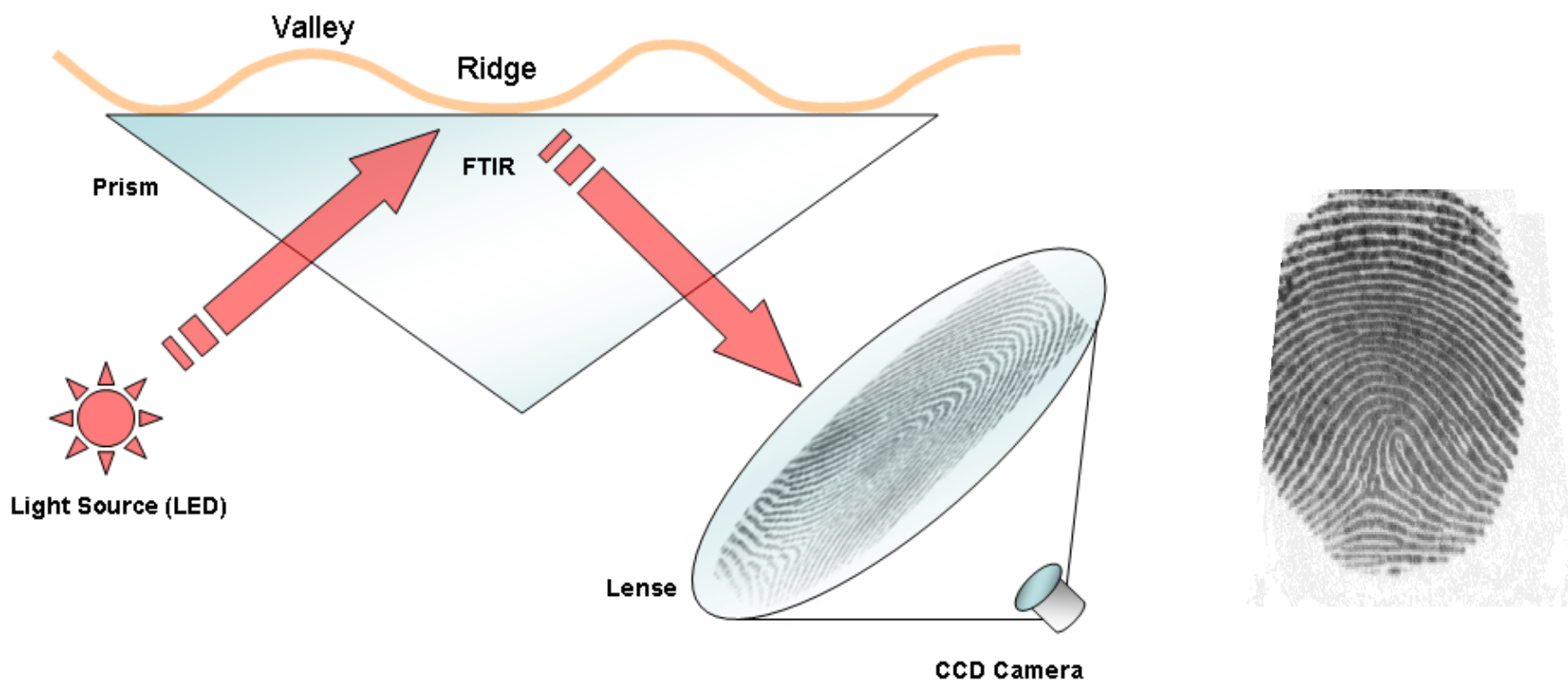
Fingerprint Technologies

- Capacitance
 - Presence and absence of electrical charges measured by a silicon chip
 - Presence = Ridge
 - Absence = Valley





- Optical
 - Frustrated Total Internal Reflectance is captured by a CCD camera



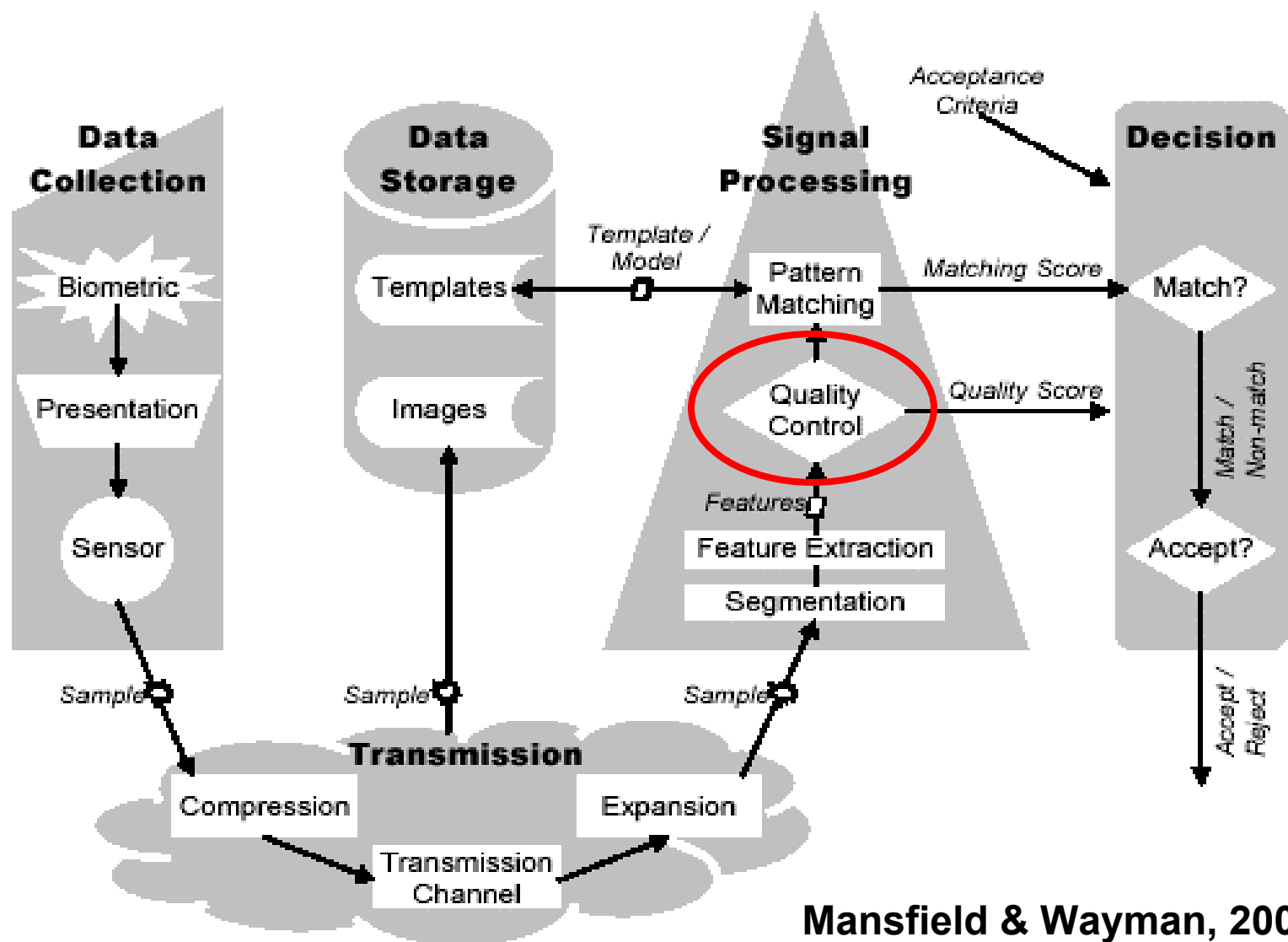


- Other
 - Ultrasonic
 - Thermal
 - Swipe
 - Radio frequency
 - Touch-less



Image Quality

- What is image quality?
 - Fidelity quality
 - How well fingerprint images from one individual match at different times, regardless of usability.
 - Utility quality
 - Fingerprint quality is viewed from a system standpoint; is the quality high enough in order to continue.



Mansfield & Wayman, 2002



- What affects image quality?
 - Condition of fingerprint
 - Dry
 - Wet
 - Creased/Wrinkled
 - Abraded
 - User habituation
 - Familiarity with device
 - Technology used (capacitance, optical)
 - Inherent weaknesses of technology
 - Ergonomics of device
 - Ease of use
 - Alignment



- Issues with poor image quality
 - Increased failure to enroll (FTE)
 - Increased failure to acquire (FTA)
 - Increased false reject rates (FRR)
 - Increased false accept rates (FAR)

These issues have implications

- Genuine user rejected (Type I error)
- Imposter accepted (Type II error)



Participants & Demographics

	18-25 Years Old	62 Years and Older
Male	65	20
Female	14	41
Total	89	61

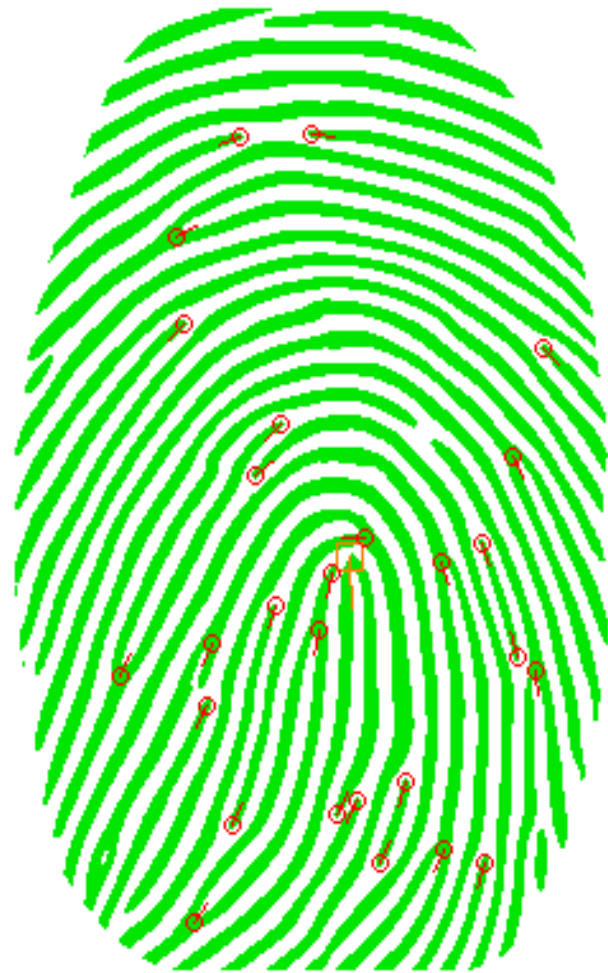
The 18-25 year old subjects were randomly reduced to the number of 62+ year olds in order to create groups of equal size for ANOVA, however the number of subjects used for the ANOVA of each index finger and device were different, since there were FTE's.



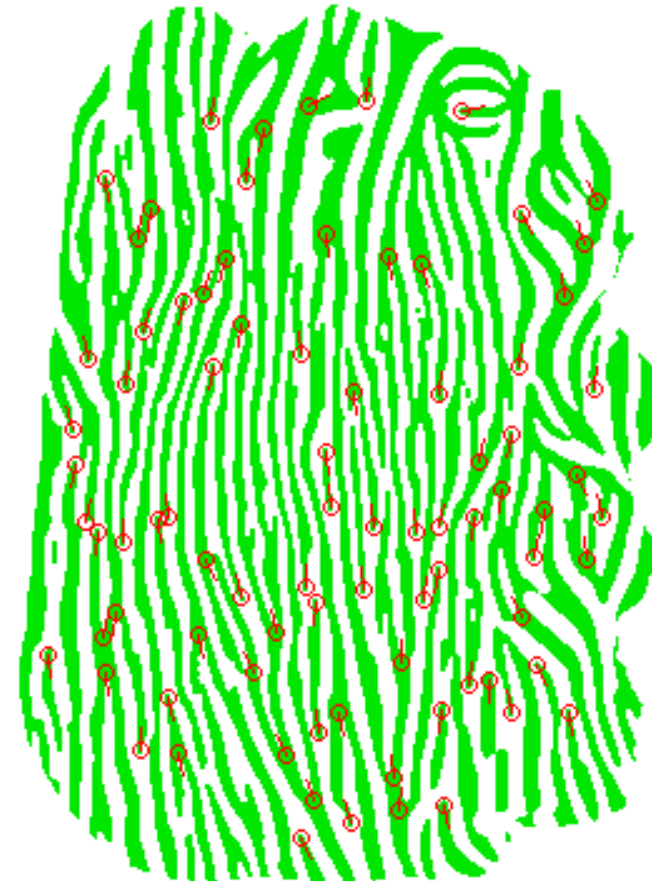
Results

Hypothesis 1

There is no statistically significant difference in the utility fingerprint image quality between the age groups 18-25 and 62+.



Example image of a 22 year old subject



Example image of an 81 year old subject




- Utility Quality

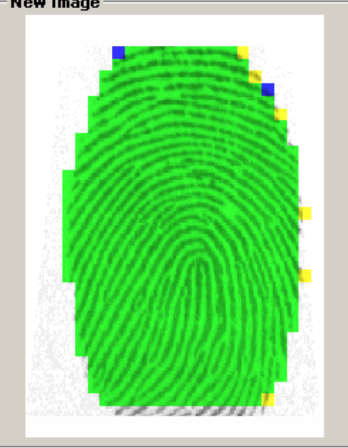
- Quantitatively describes the quality of an image from a system stand-point.

WSQ IMAGE QUALITY BY AWARE

Original Image



New Image



Seg
Crop
Color

Image Path: C:\Documents and Settings\Nat...

Too Light Too Dark Unclear Good

Quality Data

Score:	86
Minutia:	38
Core/Delta:	1


Centering Info

MinRow:	-30	MinCol:	6
MaxRow:	377	MaxCol:	293

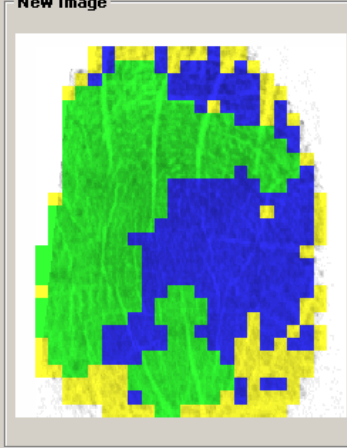
Change Centering

WSQ IMAGE QUALITY BY AWARE

Original Image



New Image



Seg
Crop
Color

Image Path: C:\Documents and Settings\Nat...

Too Light Too Dark Unclear Good

Quality Data

Score:	14
Minutia:	47
Core/Delta:	1

Centering Info

MinRow:	-18	MinCol:	-30
MaxRow:	329	MaxCol:	269

Change Centering



Results of Utility Quality vs. Age

52 subjects from each age group

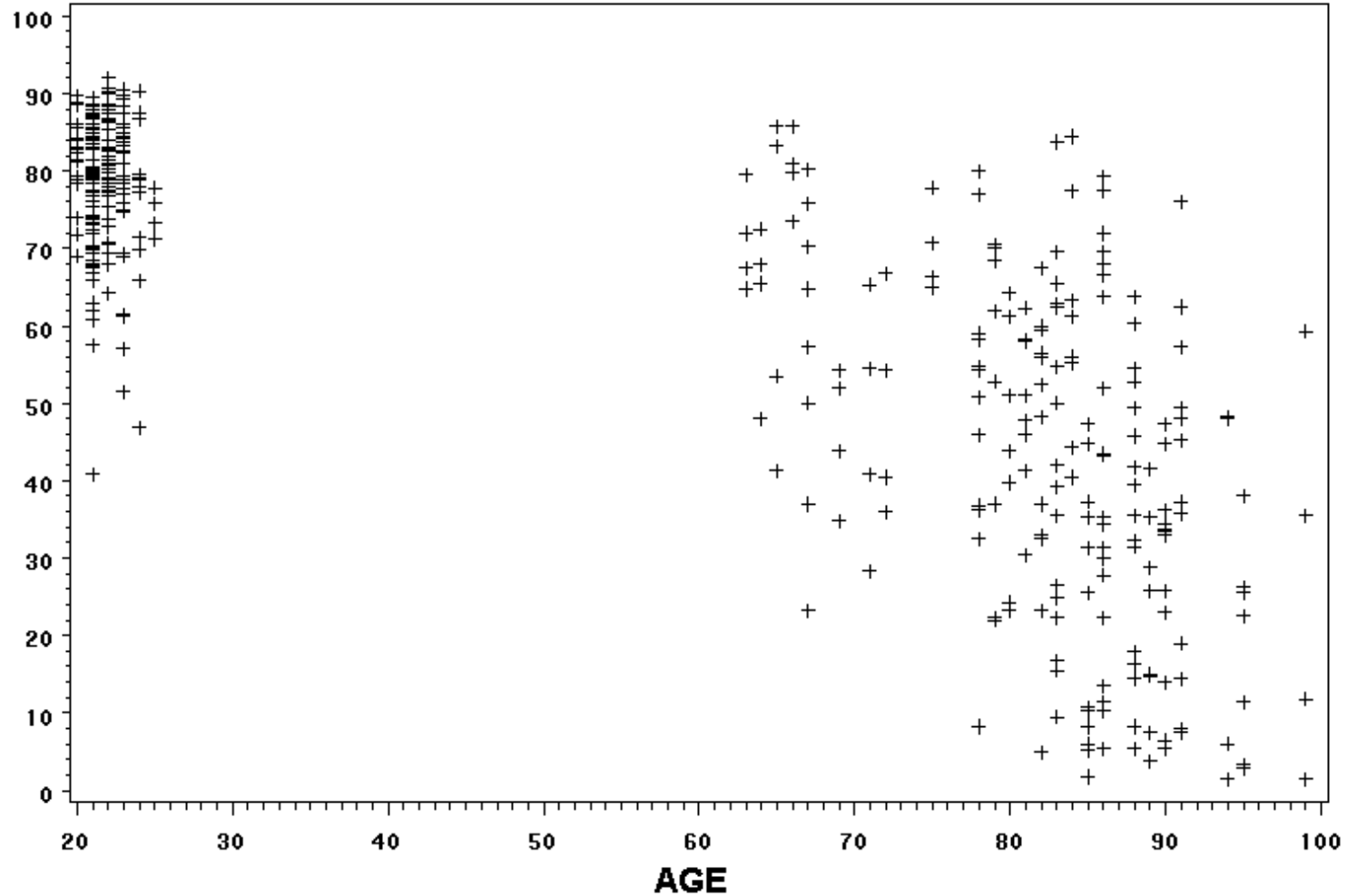
	Right Index	Left Index
Capacitance	F value = 100.16 p value <.0001*	F value of 116.75 p value <.0001*
Optical	F value = 180.44 p value <.0001*	F value = 203.89 p value <.0001*

* Significant at $\alpha = 0.05$



Plot of Utility Image Quality and Age

QUALITY





Outcome – Hypothesis 1 is **rejected** at $\alpha=.05$.
The data suggests that age has an affect on the image quality of each index finger, regardless of device used.



Hypothesis 2

There is no statistically significant difference between the fingerprint moisture content of the age groups 18-25 and 62+.



Results of Moisture vs. Age

52 subjects from each age group

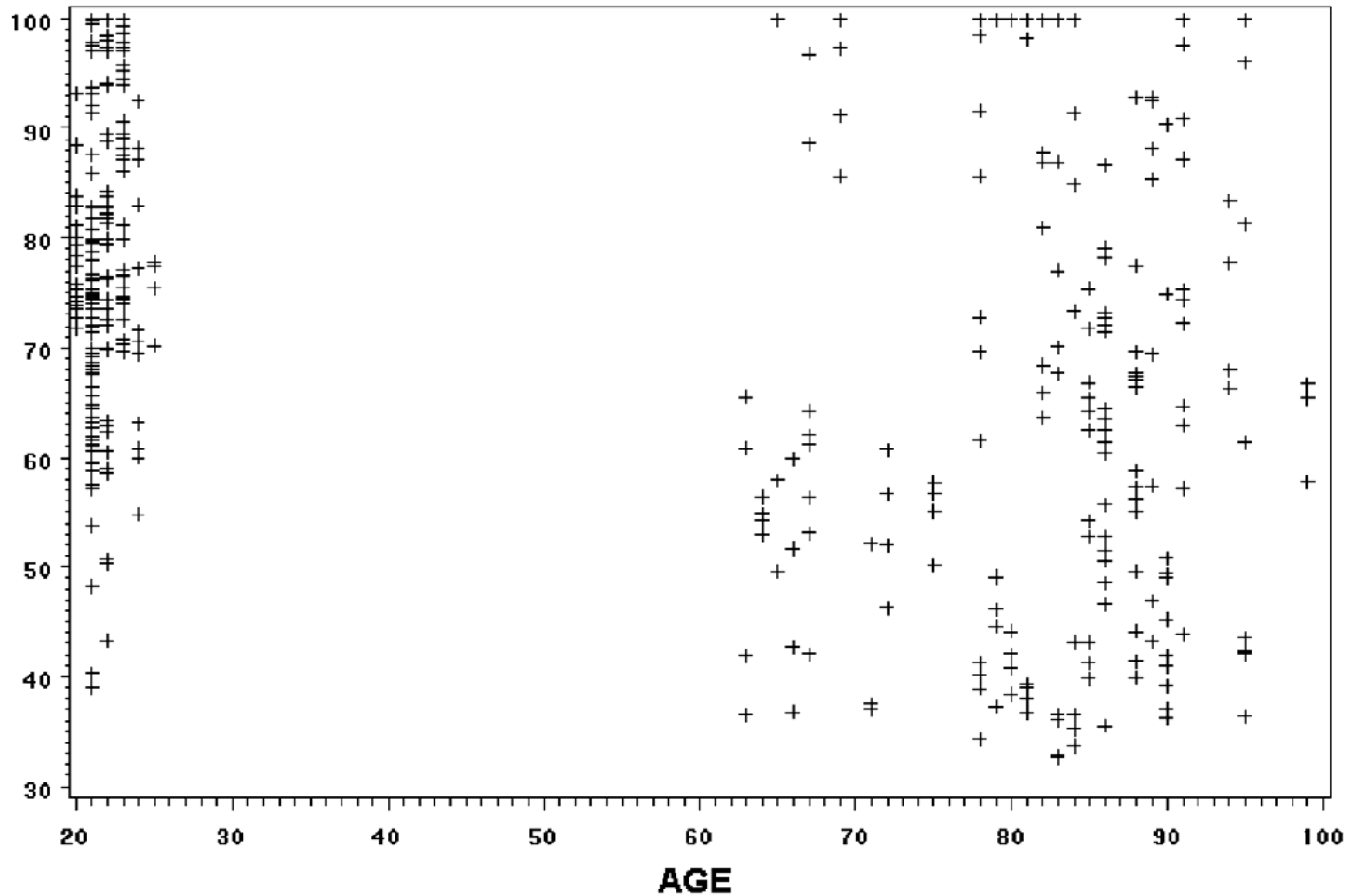
	Right Index	Left Index
Capacitance	F value = 9.10 p value <.0032*	F value of 2.93 p value <.09
Optical	F value = 18.22 p value <.0001*	F value = 10.13 p value <.0019*

* Significant at $\alpha = 0.05$



Plot of Fingerprint Moisture and Age

MOISTURE





Outcome – Hypothesis 2 is **rejected** at $\alpha=.05$ for each index finger on the optical device and for the right index finger on the capacitance device. However, hypothesis 2 is not rejected for the left index finger on the capacitance device.

Conclusion



Image quality is arguably the most important aspect of a fingerprint recognition system. The implementation of a fingerprint system in public settings, such as point-of-sale or airport identification, would likely fail if the system discriminates against certain populations that are prone to have poor utility fingerprint image quality.



Next Step

Develop a publicly available standardized fingerprint dataset that incorporates an equal number of fingerprint images in each of the varying levels of utility quality.

QUESTIONS

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