OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE

(U) N2N Fingerprint Grand Challenge

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Disclaimer

- This Participants' Day Webex is provided solely for information and planning purposes
- The Participants' Day Webex does not constitute a formal solicitation for a challenge, proposals, or proposal abstracts
- Nothing said at Participants' Day changes the requirements set forth in the future prize challenge

Participants' Day Goals

- Familiarize participants with IARPA's interest in research in N2N (Nail to Nail) fingerprint collection and recognition
- Provide answers to participants' questions
  - This is your chance to alter the course of events
- Give you time to get started developing your entry and form a team

Important Points

- Participants' Day slides and Webex will be posted on iarpa.gov
- Please save questions for the end
- Discussions with PM allowed
- Name/email list of those interested in teaming provided to the group **with your permission**
  - E-mail N2NChallenge@iarpa.gov with the subject line "N2N Please Share my Info" and what information you want shared.

Questions

- Please e-mail us your questions throughout the talk to

  N2N_Challenge@iarpa.gov

  with the subject “Webex Question”. We will be answering all of the questions at the end of the session.

N2N Challenge Introduction

N2N Challenge Goal

- The goal of the N2N Fingerprint Challenge is to improve live and forensic biometric fingerprint recognition via improved fingerprint capture technologies. This will be accomplished by testing a N2N live fingerprint capture device that does not require a human operator, capable of biometric recognition as good or better as the existing standard, and does so in the same or less time as the existing approaches.

Fingerprint Capture Terminology (1)

- Live Capture– Representations of the fingerprint captured directly from the fingerprint
  - Can include both ‘Live Scan’ (Electronic) or Ink on Paper

- Forensic / Latent Capture– The capture of impressions or remnants of fingerprints left behind on other objects

Images of specific vendors technologies is not an endorsement of those technologies, and shown for informational purposes

Fingerprint Capture Terminology (2)

- Plain or Flat (Slap) Capture – Captures a portion of a fingerprint (typically the bottom)
  - This is typically accomplished by presenting one or more fingerprint(s) against a flat surface. It may also be accomplished using non-contact techniques
- N2N (Nail to Nail) (Rolled) Capture – Captures the entire fingerprint friction ridge surface from one nail bed to the other
  - Typically accomplished by 'rolling' the fingerprint across a flat surface
  - Includes the bottom (Palmar surface of the distal phalange), sides, and tip of the fingerprint

Slap Print

N2N 'Rolled' Print

Fingerprint Capture Terminology (3)

- Contact Capture – Requires physical contact between the fingerprint and a surface
- Contactless Capture – Creates a fingerprint image without physical contact between the fingerprint and sensor, i.e. air is between them
  - Air gap may be as little as ¼ of an inch, or over hundreds of meters
- Standoff Capture – Specifically refers to capturing fingerprints at a distance
  - For our purposes here we'll define this as over 5 feet

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Subject Interaction Terminology (1)

- Cooperative – Subject actively assists and participates in collection process
  - This is the typical live fingerprint capture scenario

- Semi Cooperative – Subject neither actively assist nor actively opposes capture
  - This is common for a surveillance situation and some standoff applications

- Non Cooperative – Subjects are actively resisting capture (subversive)

Capture Facilitation

- Operator Facilitated – A human being who physically assists with capturing the fingerprint sample
  - In the case of N2N rolled fingerprint this is a person who physically holds the subjects finger and rolls it over a surface
- Observer Facilitated – A person who observes, and may give verbal instructions/advice, to someone who is having their fingerprints captured but does not physically interact with the subject
- Non Facilitated – A fingerprint capture scenario that is entirely autonomous.
  - The system may itself give instructions/prompts to the subject but does so without any human being helping the subject

Slap & N2N vs Latent Recognition

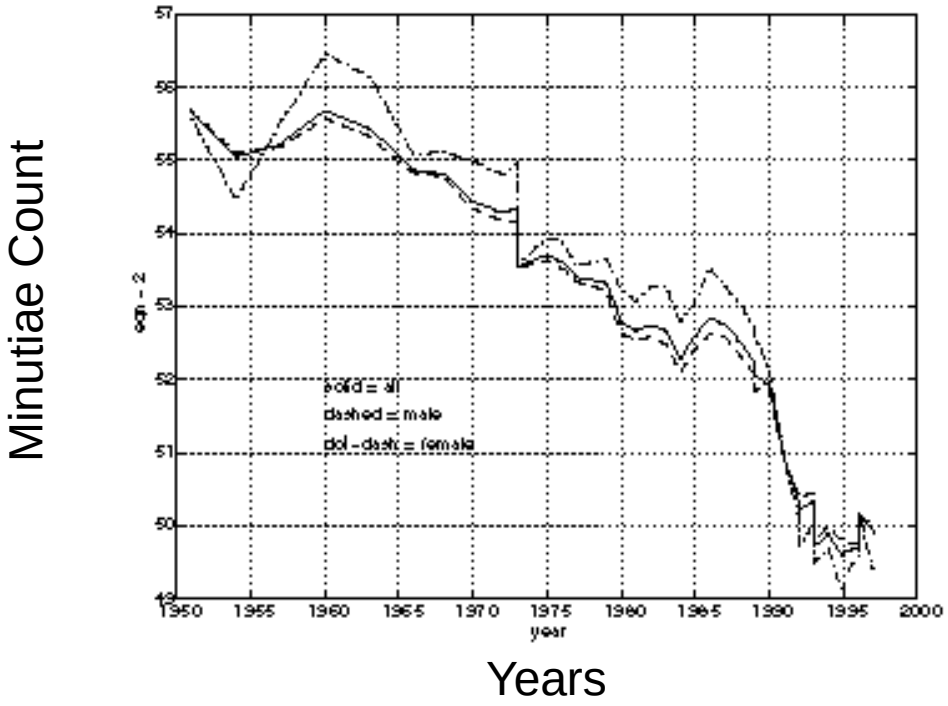
- N2N has significantly higher biometric matching performance than slap for recognizing live or latent fingerprints
  - If the latent fingerprint impression is from the side and the slap is from the bottom it can be impossible to recognize a latent fingerprint
  - Even if a slap/plain fingerprint contains overlap with the latent there will be less surface to compare resulting in lower recognition performance

N2N 'Rolled' Print

Slap Print

Modern N2N fingerprint repository quality has decreased

- Quality of prints stored in the FBI national repository, as reflected by minutiae count, has gone down by 10%



Known ways to improve fingerprint recognition using existing technology

- Eliminate plain fingerprint capture and only capture N2N
  - Reason for improvement: N2N has significantly more surface area allowing for greater discrimination
  - Limitation: N2N requires more time, and typically a skilled operator to capture. Many government use cases are unwilling or unable to spend the extra cost.
- Improve quality of N2N captured
  - Reason for Improvement: Higher quality fingerprint N2N capture provides greater fidelity and therefore improved accuracy
  - Limitation: Better training, and may take more time requiring lower quality prints captured initially to be retaken

In Scope For Participants

- Live Capture N2N
  - Fully Cooperative, Semi-Cooperative
- Contact, Contactless, and Standoff
  - Note, subjects can be in close proximity and will be fully cooperative **contactless or standoff is NOT required**
- Observer Facilitated or Non Facilitated
  - Reminder: Observer facilitated means someone can give instructions, but may not physically interact with the subject

Out of Scope For Participants

- Latent print collection
- Operator facilitated capture
  - No physical interaction between operator and subjects
  - No expert human to determine if data should be accepted or retaken. Retaking data is acceptable, but must be determined autonomously by the system.
- Robot to ‘Roll’ finger as a human would

Considerations

- Capture order and quantity
  - Capturing a single finger at a time is fine, but must ensure sequencing in design (i.e. which finger is which)

Goal of N2N Fingerprint Grand Challenge

- Improve biometric fingerprint recognition using technology by developing a live capture system for N2N fingerprint capture that does not require a human operator while performing as good or better than existing operator captured N2N fingerprint approaches
  - Elimination of human operator can encourage existing users of plain fingerprint capture to migrate to N2N
  - By eliminating the human operator we reduce training needs and mistakes that result in lower quality data being enrolled into the system

Government Use Cases

- The government has all of the following use cases

		Probe		
		Live N2N Capture	Live Slap Capture	Forensic (Latent) Capture
Gallery	Live N2N Capture	✓	✓	✓
	Live Slap Capture	✓	✓	✓
	Forensic (Latent) Capture	✓	✓	✓

N2N Challenge Experiment

Test Environment

- All prize challenge capture devices and legacy/baseline devices will be co-located at the same facility. The same subject pool will be used on all devices and captured as close in temporal proximity as possible (same day)
- This is currently planned to take place at the Maryland Test Facility (MDTF) in the DC metro area

Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Week one	Legacy Setup	Legacy baseline A, latent capture, optional participant setup/testing (No official participant prize data captured)			
Week two	Legacy baseline b, prize performer data captured				Takedown / disassembly

- Schedule is notional, nominally planned for summer 2017
- Must be ready to start capturing data by noon Monday of week two

US Government Team Responsibility

- Provide human subjects for testing of all devices,
  - Anticipated to be between 300 to 500 subjects representative of the population at large, in terms of age, gender, and ethnicity
- Provide Prize Participants
  - Table and 2 chairs for setup
  - 120V Power Strip
  - Climate Controlled 'Office' indoor environment
  - Timing / User ID recording system.
- Facilitate IRB approval for facility
  - Will require prize participants support
- Facilitate safety review
  - Will require prize participants support, you are still responsible for ensuring safety

Prize Participant Responsibilities

- Operate your own capture device during the test to capture the data
- Cooperate/Coordinate with the US Government team to ensure safety and IRB compliance of the overall test
- Provide collected data to government team in their specified format for testing

Data collected

- Baseline Legacy (BL)
  - Gold standard rolled 10 print enrollment with skilled operator A (BL_N2N_A)
  - Gold standard rolled 10 print enrollment with skilled operator B (BL_N2N_B)
  - Latent Collection via gold standard methods (BL_L)
  - Government may collect other data not used in challenge
- Prize Participant (PP)
  - Collect N2N using no skilled operator and whatever hardware/software the prize participant provides (PP_N2N)

Collection Time

- We time how long it takes to capture each session of N2N data which will be a factor for the prize challenge
  - Legacy N2N time for the US Government captured data will be referred to as M_L_T (Metric Legacy Time)
  - Performer N2N time will be referred to as M_P_T (Metric Performer Time)
  - Prize challenge metric/test: lowest median time to acquire fingerprint
    - $Median \times (1 + |skew|)$
    - *Tie-breaker: Lowest median time to capture a fingerprint*

Recognition Criteria

	BL_N2N_A (10 Print Legacy Baseline Operator A)	**BL_L** Baseline Latent Set
BL_N2N_B (10 Print Legacy Baseline Operator B)	Metric Legacy Gallery Biometric (**M_L_GB**)	Metric Legacy Latent Biometric (**M_L_LB**)
PP_N2N (Prize Performer)	Metric Prize Participant Gallery Biometric (**M_P_GB**)	Metric Prize Participant Latent Biometric (**M_P_LB**)

- FNIR @ FPIR = 10^{-1}
- *Tie-breaker: Average NFIQ 2.0 values and NFIQ 2.0 feature values*
  - *Frequency Domain Analysis_Standard Deviation*
  - *Frequency Domain Analysis_Mean*
  - *Ridge Valley Uniformity_Mean*
  - *Ridge Valley Uniformity_Standard Deviation*
- False Positive Identification Rate (FPIR) = fraction of searches for which there is no mate in the enrolled set (N), but a candidate above a certain similarity threshold (T) was incorrectly returned at or above a pre-specified rank (R).
- False Negative Identification Rate (FNIR) = the fraction of searches for which there **is** a mate in the enrolled set (N), but the mate was not returned at a pre-specified rank (R) above a certain known similarity threshold (T).

Eligibility to Participate

- In order to be eligible to participate you must be able to provide data on 90% (Failure to Acquire <10%) of the subjects the government provides
  - You must provide data on all subjects you capture
  - You'll have to be able to keep up with the pace of subjects, make sure your process does not take so long that you can't keep up with the rate of people
  - Sensor failure, or failure to be present are not acceptable reasons to have not captured the data
  - Given the prototype nature of the test we are allowing some room for mistakes, hence 90% of subjects vs 100% captured
    - May not intentionally throw away subject data, and if you capture it you must include it in your set, i.e. no 'cherry picking'

Prize: Gallery Accuracy $25,000

- This prize is for N2N matching
  - Winner:
    - Best N2N to N2N matching performance
      - Best M_P_GB
  - Eligibility Criteria
    - You cannot be more than twice as slow as existing approaches
      - M_P_T < 2*M_L_T
    - 90% of subject data captured

Prize: Latent Accuracy $25,000

- This prize is for best latent matching
  - Winner:
    - Best N2N to Latent matching performance
      - Best M_P_LB
  - Eligibility Criteria
    - You cannot be more than twice as slow as existing approaches
      - M_P_T < 2*M_L_T
    - 90% of subject data captured

Prize: Speed $25,000

- This prize is for fastest capture time
  - Winner:
    - Fastest N2N capture time
      - Best M_P_T
  - Eligibility Criteria
    - Latent matching must be within 80% of the N2N baseline method
      - M_P_GB > 0.8 * M_L_GB
    - 90% of subject data captured

Grand Challenge Prize: $100,000

- Best Useable Matching System
  - Winner:
    - Best Latent Matching System
      - Best M_P_LB
  - Eligibility Criteria
    - You must be no more than 20% slower than existing approaches
      - M_P_T < 1.2 * M_L_T
    - N2N matching performance must be no more than 2% worse than legacy/baseline
      - M_P_GB > .98 * M_L_GB
    - Latent matching performance must be no more than 2% worse than legacy/baseline
      - M_P_LB > .98 * M_L_LB
    - 90% of subject data captured

N2N Prize Grand Challenge Overview

Why participate?

- Be recognized as the worlds best
  - We will publicly announce the winners
- Win money!
  - $175,000 in prize money
- Gain test data to keep
  - The government is spending significant money and time to ensure that the baseline N2N and latent datasets are done according to best practices. This is your opportunity to get high quality legacy compatible data to test your technology with

How to participate

- Practical resource limitations affect how many prize participants we can accommodate. The facility can only physically accommodate ~12 participants.
- We anticipate requiring a minimal application process that will be used to ensure that all participants are qualified. Qualified applicants will be accepted on a first come first serve basis as will be defined in the application to be released.

Financial Support for Participation

- The government is willing to provide $10,000 to each selected participant in order to support the costs of participation.
  - In addition to being selected to participate, to receive the funds you must be willing to publicly share the data you collect with the research community. If you are not willing to share you may still participate (and are eligible for the prize money), but you may not receive the $10,000 for participation support
  - The funds are contingent on participation and providing the data you capture.

N2N Challenge Timeline

- Notional timeline, subject to change
- November 15, 2016 applications for participation and funds open
  - Acceptance is on a first come, first served basis until all spots are full. Qualified applications will be accepted in the order they are received.
- ~ June 2017, perform collection
- ~ September 2017 Announce winners
- Note: If no one wins the grand challenge in year 1, the government is considering running the challenge an additional year depending upon the results

Human Subjects Testing / Institutional Review Board (IRB)

- DHS S&T MDTF (Maryland Test Facility) is recruiting the subjects and facilitating the experiment. As such, you will be required to coordinate with them on IRB approval in addition to any approvals you need to do internally.

Partner Agencies

- DHS S&T
  - Maryland Test Facility
- NIST
  - Analysis of data
  - The data created by NIST may be subject to release under a Freedom of Information Act (FOIA) request.
    - Note, your raw data will not be released unless you give permission this is just the score table

Questions

- Please e-mail us your questions throughout the talk to

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  with the subject “Webex Question”.

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