IARPA Nail-to-Nail Challenge Rules & Regulations

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Background

The IARPA Nail-to-Nail (N2N) Fingerprint Challenge seeks to identify fingerprint collection solutions able to acquire nail-to-nail image capture of the friction ridge surface without the need of a human operator. Collection of N2N, or rolled, fingerprint images allows for improved recognition performance in live and forensic matching scenarios. Traditionally, fingerprints can be grouped into three types: plain (or slap), rolled (or nail-to-nail), and latent (i.e., those found at a crime scene which must be developed through dusting, fuming, or other techniques). Plain prints represent information from only the center portion of the finger pad, whereas rolled prints represent information around the entirety of the finger pad, from one nail edge all the way around to the other nail edge. Latent prints are those left behind on a surface when the person is no longer present. Latent prints are typically partial or degraded in quality, due to the nature of how they are left behind or imprinted, unwittingly, on an object's surface.

In traditional matching scenarios where plain or rolled prints are compared against one another, the larger surface area translates into more discriminative information for matching. For forensic applications, the larger surface area in the reference image increases the likelihood of obtaining sufficient overlap when matching partial latent fingerprints. Plain prints are easy to collect and typically don't require operator assistance to produce good quality images for matching. While N2N prints provide superior information for matching, they are more difficult to collect than plain and require physically rolling the finger across a flat surface, often requiring assistance from a human operator.

Having an operator involved in the process constrains the feasibility of collecting rolled prints in a variety of environments and operational scenarios. Removing the human-in-the-loop from this process through advanced collection and processing techniques will allow better fingerprint data to be collected, leading to improved recognition performance, while reducing the time and cost of collection.

Overview

The goal of the N2N Fingerprint Challenge is to improve biometric fingerprint collection and recognition systems by eliminating plain fingerprint captures. This challenge seeks to identify solutions which can perform live capture of N2N fingerprints without requiring a human operator[1] for the purposes of matching against other latent or live capture of fingerprints. This unassisted N2N collection will allow for more distinguishing data to be collected while also alleviating the time and cost associated with using human operators. The developed system should collect fingerprint data that performs as good as, or better than, existing operator controlled N2N fingerprint collection approaches. Performance of the developed N2N collection systems will be evaluated using data collected from a live test using human subjects and encompasses both live and latent fingerprints. The participant collected data will be compared against "gold standard" N2N and latent data using conventional fingerprint recognition algorithms. Participants will be judged based on traditional biometric performance measures in addition to speed of the collection process. Participants are not required to develop algorithmic/software techniques to match N2N or latent data.

Participants are expected to design a system that will perform live capture of fully cooperative subjects. It is expected that subjects will be in close proximity to the device, as such, contactless or standoff systems are not required, but are still in scope if they meet the requirements for N2N collection. Systems may be facilitated by an observer, but the observer may not physically interact with the subject. Additionally, mechanical arms or other devices which "roll" the finger as a human operator traditionally would are out of scope but other mechanical components may be allowed. The N2N Challenge is a three stage process: 1) registration and feasibility review 2) system build and judging, and 3) Live Test: evaluation of performance.

Challenge Stages and Prizes

The following three (3) stages are anticipated as part of the N2N Prize Challenge:

Stage 1: Registration and Feasibility Review

Participants will fill out a registration form providing information about their proposed solution. The application will require the following sections:

- **Abstract** - brief description of what you plan to build
- **Solution Description**
  - Anticipated hardware and software components
  - High Level system diagram
- **Usability** – how will the user interact with the device?

[1] A human observer will be allowed and will be able to operate the computer, give instructions, and verbally interact with the participant, but cannot touch the participant, pick up the device during operation, or place the device on the participant.

- **Innovation** – what's the novelty of this solution, has it been tried before?
- **Safety Assessment** – are there any components (electrical components, illuminators, etc.) in your design which may cause safety concerns with human subjects testing?

Applications should not be more than 2 pages and should describe the anticipated solution with as much detail as possible. The government will provide informal feedback on the application to the applicants.

All Stage 1 Registrations need to be submitted to Challenge.gov by **March 17, 2017**.

Stage 2: Development and Judging

Builders will have until July 2017 to develop their solution for the N2N challenge. Builders will be asked to submit sample fingerprint imagery from 3 subjects collected from their systems along with a short video of the system as a "proof of build" and certification to attend the Test and Evaluation (T&E) event taking place in September 2017. Devices will also be judged for safety at this time. Builders who do not provide certification of intent to attend the T&E event will be automatically disqualified from moving to Stage 3. Winners may continue to further refine their devices prior to the live test.

Winners will be selected to participate in the Live Test. The videos produced by the builders will be evaluated along with an updated abstract and sample imagery to determine participants selected for the next stage.

The submissions will be judged by a 3 person United States Government (USG) team based on their content and not the quality of the video production. The sample imagery may be used to confirm image standard compliance and interoperability with the USG API used for evaluation. Additionally, the sample imagery will be used to determine a cursory measure of image quality. The Judges will select the Stage 2 winners based upon their assessment of the viability, novelty, and operational usefulness of the technology.

Stage 3: Test & Evaluation and Prize Awards

The government will conduct a test where human subjects will present finger biometrics to the maker's developed system. To support testing, prize participants are responsible for operating their own capture device during the testing, ensuring safety and IRB compliance of the developed system with testing staff, and providing collected data in the specified format described in the N2N Fingerprint Image Format document for evaluation.

In the event that a participant is unable to produce a Print Data Set due to unforeseen circumstances, invited participants may still be eligible to receive a prize for completing Stage 2 on the individual assessment of IARPA.

Testing will include collection of baseline data using current "gold standard" techniques for N2N, using a skilled operator, and latent fingerprints which will be collected by the government team. Two baseline systems will be used to collect N2N data by the government. Prize participants will collect N2N data from subjects without an operator. To be eligible to proceed to the evaluation stage and win the awards, makers are required to produce N2N data on 90% (less than 10% Failure to Acquire [FTA]) of the subjects provided without throwing away or filtering unacceptable data. Participants are not allowed to

intentionally throw away data that the system accepted and captured. Captured data must include prints for all ten fingers to be considered complete. Please note that prize participants are only required to provide N2N live data and will only be assessed on their N2N submissions. All captured data must be provided and the amount produced will be determined by the total number of subjects who interacted with the device. Makers must keep up with the pace of test subjects (approximately 5 minutes per subject to collect all required data) and ensure their collection process does not hinder the overall collection, impacting other participants.

Makers will need to operate their device in the Maryland Test Facility (MdTF). At the facility, each team will be provided with a 3'x6' table, a 6-plug power strip, and a network cable to hook up to the test facility network. All equipment for testing must fit on or under the provided table. Makers will need to configure their device to send images to the facility collection API, which will also be used to calculate time per each participant.

Upon conclusion of the government evaluation of data provided by the participants from the testing stage, one (1) Grand Prize, three (3) categorical prizes, and approximately twelve (12) print provider prizes will be awarded as follows:

Prize	Amount	Criteria	Constraint
Grand Prize: Best Useable Matching System	$100K	Best Latent Matching system	• No more than 20% slower than existing approaches • N2N matching no worse than 2% of legacy/baseline • Latent matching performance no worse than 2% of legacy/baseline • 90% of subject data captured
Gallery Accuracy Prize	$25K	Best N2N match performance	• Must be no slower than existing approaches • 90% of subject data captured
Latent Accuracy Prize	$25K	Best Latent match performance	• Must be no slower than existing approaches • 90% of subject data captured
Speed Prize	$25K	Fastest N2N capture time	• Latent matching must be within 80% of the N2N baseline method • 90% of subject data captured
Print Provider Prize x 12	$8K	Providing data to share with the public	• Captured data from the live test must be made open-source and available to the public
Master Builder Prize x 12	$2k	Participants in the Live Test	• Winners of Stage 2 that participate in the Live Test

Performance will be measured based on the False Negative Identification Rate[2] (FNIR) measured at a fixed False Positive Identification Rate[3] (FPIR) of 10^{-1}. In the case of a tie in performance between two participants, NIST's Fingerprint Image Quality (NFIQ) 2.0 values and feature values will be used to determine the winner. Time will be measured from the start of the interaction with the live test subject until the print package is delivered to the Facility Server.

In the event that no competitor achieves the Grand Prize, a portion of the purse will be allotted to the second and third place winners for each category. Each second place winner will be awarded $15k and each third place winner will be awarded $10k. Additional incentives for participants will include the benefit of keeping all the N2N data collected using their system and will also have the opportunity to request a subset of the latent fingerprint data from the Live Test. All test subjects are thoroughly screened for quality and diversity, providing a rich source of data to support each competitor's future research and design. Participants will also have an opportunity to demonstrate their systems to a select number of government representatives on the final day of the challenge as an added promotional benefit.

Rules

- All participants will need to fill out a registration form providing responses to the Judging Criteria below.
- All participant applications will be reviewed by USG technical experts and feedback on feasibility will be provided to the participants, however, all participants responding to all aspects of the application will be allowed to participate in Stage 2 of the challenge.
- Prior to Stage 3, participants will be asked to submit a progress report and video of the solution built towards the original application specifications. These reports will be judged based on the Judging Criteria below and Stage 2 – Master Builder prizes of $2k awarded. Only Stage 2 prize winners may participate in Stage 3.
- All participants in the Stage 3 Live Test will be required to attend, with their device, the Testing and Evaluation Event held in the D.C. area at the Maryland Test Facility. All costs pertaining to participation such as travel and lodging fees for the Live Test will be the responsibility of the participant.
- Devices will need to be shipped to a Challenge POC located within the United States, or transported by hand with the participants. Cost for shipment or transport of the device to and from the site is the responsibility of the participant.
- All Participants must provide their data collected during the Live Test for evaluation and scoring. To receive the $8k Print Provider award, participants must provide their collected data from the testing event for non-commercial, public use by the research community.
- Participants will not be required to provide subjects for testing.

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[2] 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).

[3] 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)

- Participants must keep up with pace of testing (approximately 5 minutes per subject) and produce 90% of the data presented by all test subjects to be eligible for prizes in Stage 3.
- Participants must provide individual samples of all 10 fingers and labeled according to the standardized numbering sequence in the N2N Image Format Specifications (NIFS) document.
- Data must be provided in a standardized image format as described in the N2N Image Format Specifications (NIFS) document.
- If participants would like to also provide custom matching algorithms, data may be provided in proprietary format in addition to the standard format is also produced.
- Participants are not required to provide matching algorithms, but if they choose to do so, they must be compatible with the NIST API. Further, it is the responsibility of the performer to work with NIST ahead of time to get the algorithms running on NIST systems. If NIST is unable to get the algorithms running in a timely manner with a reasonable amount of effort, NIST reserves the right to default to the standard algorithmic matchers and image formats being utilized for everyone else. **The following rules apply only if you plan to provide non-standard image data and matching algorithms:**
    - Refer to NIST GitHub for more information on the NIST API. We will set up an e-mail alias for API questions.
    - Submission must be at NIST and working 2 months before the test for enrollment of large gallery background (if necessary). We can adjust based on the background enrollment set size. Details will be on the NIST GitHub page.
    - API and associated details will be hosted (updated as necessary) on GitHub. Submissions will be sent to e-mail alias at NIST or IARPA.
- Participants not providing algorithms will be assessed using fully automated state-of-the-art N2N and latent matchers against baseline gold-standard data
- Participants are not responsible for or allowed to collect baseline physically rolled N2N or latent data during the evaluation.
- Sensors shall not have encoded information other than images collected in the standardized image format. Participants providing fingerprint template generation and matching algorithms shall not encode non-image information (finger positions, subject IDs, etc.) into proprietary data output from the sensor. The submitted algorithms shall not down-select the background enrollment set based on properties of the image (sensor device, etc.). Any evidence of this or other non-foreseen methods to artificially increase performance in the software portion of the test will result in immediate disqualification from the test and forfeiture of all awards. Prize Challenge awards will be awarded according to the guidelines in Stage 3 of the Challenge Stages and Prizes.
- Participants must connect their system to the Facility API to send images in real time to the servers and to track performance metrics throughout the Live Test
- Evaluation is expected to take 2 months to complete, after which awards will be announced
- Participants must provide IARPA and partners with required information to confirm safety of devices prior to the Live Test in order to participate.
- Participants who have not received permission from the IARPA designated IRB to participate will not be allowed to participate.
- Participants are required to obtain Human Subjects Training certification for all individuals participating in the Live Test.

- IARPA reserves the right to terminate participation at any point if they are not confident the device is safe to utilize on a human being at their sole discretion.
- IARPA reserves the right to exclude any results it feels are inconsistent with the intent of these rules at its sole discretion.
- Foreign Nationals may be present at the Live Test, if a competitor has concerns around their device and issues such as export control, these concerns should be sent in the initial application to determine if accommodations can be made.

Payment Terms

Participants need to submit a W-9 tax form, or a W8-BEN form in order to receive payment. Participants are responsible for all taxes incurred from the acceptance of Prize funds.

Stage 2 Judging Criteria

1. **"Proof of Build" Video** (55%) - Post build video showing system and demonstration of collection
2. **Sample Images Quality** (40%) - Image quality of standard output images assessed using a standard image quality metric tool standard fingerprint image quality measures
3. **Updated Abstract** (5%) – An updated abstract based on the final build of the device
4. **Safety Certification** – Devices must pass Safety Certification in order to be eligible to win Stage 2.

Intellectual Property

Makers will retain the rights to their Intellectual Property for their devices and algorithms. IARPA will use information submitted through the challenge and application process to understand the technology.

- IARPA will have the rights to utilize all data provided for USG testing purposes.
- Stage 2 winners who agree to have their data shared publicly with the research community will grant the government the right to publicly share the data. This is a requirement to win the Stage 2 – Print Provider prize. Participants are **NOT** required to allow their data to be shared publicly.
- Challenge participant names, titles, general technology descriptions, photographs, and abstracts for their submissions may be utilized in challenge-related media and promotional materials or for other internal government uses. No sensitive intellectual property information will be shared in this manner.

Who is Eligible to Participate?

Eligibility

To be eligible to win a prize under this competition, an individual or entity:

1. Must have completed and submitted a registration form on http://challenge.gov/challenge/nail-to-nail-n2n-challenge;

2. Must create an account on Challenge.gov, and must have entered a submission on Challenge.gov, including a complete application package, under these rules promulgated by IARPA;
3. Must have complied with all the requirements under the Federal Register Notice and these rules;
4. Must be (1) an individual or team each of whom are 18 years of age and over, or (2) an entity incorporated; and
5. May not be a federal entity or federal employee acting within the scope of their employment. An individual or entity shall not be deemed ineligible because the individual or entity used federal facilities or consulted with federal employees during a competition if the facilities and employees are made available to all individuals and entities participating in the competition on an equitable basis.

Federal grantees may not use federal funds to develop challenge applications unless consistent with the purpose of their grant award. Federal contractors may not use federal funds from a contract to develop challenge applications or to fund efforts in support of a challenge submission.

Employees of IARPA their affiliates, and/or any other individual or entity associated with the development, evaluation, or administration of the competition as well as members of such persons' immediate families (spouses, children, siblings, parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in the competition.

Entrants must agree to assume any and all risks and waive claims against the federal government and its related entities, except in the case of willful misconduct, for any injury, death, damage, or loss of property, revenue, or profits, whether direct, indirect, or consequential, arising from their participation in a competition, whether the injury, death, damage, or loss arises through negligence or otherwise.

Entrants must also agree to indemnify the federal government against third-party claims for damages arising from or related to competition activities. Entrants are not required to obtain liability insurance or demonstrate financial responsibility in order to participate in the competition.

By participating in the competition, each entrant agrees to comply with and abide by these rules and the decisions of IARPA and/or the individual judges, which shall be final and binding in all respects.

By participating in the competition, each entrant agrees to follow all applicable local, state, federal and country of residence laws and regulations.

Companies / Teams

Companies, Universities, Individuals, and Teams of makers are able to participate in this challenge. You will need to elect a team leader, who will be the main POC for communications.

- Upon submitting your Stage 2 package, you will need to provide a breakdown of all team members along with the percentage allocation between all team members
- Each team member will need to sign an agreement that they agree to distribution of prize funds
- Team Captain can enter in the information for a company instead of their personal information for tax purposes

Foreign Nationals & International Makers

All Makers are able to participate with this exception: residents of, Iran, Cuba, North Korea, Crimea Region of Ukraine, Sudan or Syria or other countries prohibited on the U.S. State Department's State

Sponsors of Terrorism list. In addition, Makers are not eligible to participate if they are on the Specially Designated National list promulgated and amended, from time to time, by the United States Department of the Treasury. It is the responsibility of the Maker to ensure that they are allowed to export their technology solution to the United States for the Live Test. Additionally, it is the responsibility of participants to ensure that no US law export control restrictions would prevent them from participating when foreign nationals are involved. If there are US export control concerns, please contact IARPA and we will attempt to make reasonable accommodations if possible. IARPA will not be held responsible for devices shipped or transported to the U.S. that are confiscated by local authorities or that violate local export laws.

General Liability Release

By participating in the competition, each entrant hereby agrees that:

1. IARPA shall not be responsible or liable for any losses, damages, or injuries of any kind (including death) resulting from participation in the competition or any competition-related activity, or from entrants' acceptance, receipt, possession, use, or misuse of any prize; and
2. Entrants will indemnify, defend, and hold harmless IARPA, Booz Allen Hamilton, NIST, Scitor, The Johns Hopkins University Applied Physics Laboratory, and ODNI from and against all third party claims, actions, or proceedings of any kind and from any and all damages, liabilities, costs, and expenses relating to or arising from entrant's participation in the competition.

Without limiting the generality of the foregoing, IARPA is not responsible for incomplete, illegible, misdirected, misprinted, late, lost, postage-due, damaged, or stolen entries or prize notifications; or for lost, interrupted, inaccessible, or unavailable networks, servers, satellites, Internet Service Providers, websites, or other connections; or for miscommunications, failed, jumbled, scrambled, delayed, or misdirected computer, telephone, cable transmissions or other communications; or for any technical malfunctions, failures, difficulties, or other errors of any kind or nature; or for the incorrect or inaccurate capture of information, or the failure to capture any information.

These rules cannot be modified except by IARPA. All decisions by IARPA regarding adherence to these rules are final. The invalidity or unenforceability of any provision of these rules shall not affect the validity or enforceability of any other provision. In the event that any provision is determined to be invalid or otherwise unenforceable or illegal, these rules shall otherwise remain in effect and shall be construed in accordance with their terms as if the invalid or illegal provision were not contained herein.

Warranties / Indemnification

By participating in the competition, each entrant represents, warrants, and covenants as follows:

1. The entrant – whether an individual, team or entity – is the sole author, creator, and owner of the submission;
2. The submission is not the subject of any actual or threatened litigation or claim;
3. The submission does not and will not violate or infringe upon the intellectual property rights, privacy rights, publicity rights, or other legal rights of any third party;
4. The submission does not and will not contain any known harmful equipment that can cause injury or long term risks of exposure in humans; and
5. The Submission, and entrants' use of the Submission, does not and will not violate any applicable laws or regulations, including, without limitation, applicable export control laws and regulations of the U.S. and other jurisdictions.

If the Submission includes any third party works (such as third party content, equipment, or open source code), entrant must be able to provide, upon the request of IARPA, documentation of all appropriate licenses and releases for such third party works. If entrant cannot provide documentation of all required licenses and releases, IARPA reserves the right to disqualify the applicable Submission, or seek to secure the licenses and releases for the benefit of IARPA, and allow the applicable Submission to remain in the Competition. IARPA also reserves all rights with respect to claims based on any damages caused by participant's failure to obtain such licenses and releases.

Entrants – whether an individual, a team or an entity – will indemnify, defend, and hold IARPA, Booz Allen Hamilton, NIST, Scitor Corporation, The Johns Hopkins University Applied Physics Laboratory, and ODNI from and against all third party claims, actions, or proceedings of any kind and from any and all damages, liabilities, costs, and expenses relating to or arising from entrant's Submission or any breach or alleged breach of any of the representations, warranties, and covenants of entrant hereunder.

IARPA reserves the right to disqualify any Submission that IARPA, in its discretion, deems to violate these Rules. IARPA also reserves the right to amend these rules throughout the duration of the contest should extenuating circumstances arise.