Ensuring Uniqueness: Collecting iris biometrics for the Unique ID Mission

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1 Background

The goal of the Unique ID project is to issue a unique identity number to every resident in the country. The Unique Identification number (UID) will be linked to the resident's basic demographic and biometric details, and stored in the UIDAI central database.

Providing a unique identity to all residents, particularly the poor, would help ensure access for residents to services and resources such as health, education and welfare programs, as well as banking and insurance. It would allow governments to confirm that key services were delivered to the poor and eliminate the leakages and duplicates across government databases; the universal identity number would also ensure that people would not be denied services due to the lack of identification documents.

Ensuring the uniqueness and inclusiveness of the number are therefore, overarching priorities for the UIDAI. The collection of an individual's biometric attributes, and linking it to their UID, becomes essential to ensuring the uniqueness of the UID.

However, as we collect biometric information, we need to ensure that certain concerns are addressed. The biometric information collected must be sufficient and effective for de-duplicating the identity of the resident – if it cannot de-duplicate the resident effectively, the biometric information becomes useless in ensuring the uniqueness of the number, and in accurately authenticating the individual before they can access services.

The biometric attributes should also be easy and cost-effective to collect and de-duplicate, for all ages and income groups, in order to ensure that UID enrolment and authentication is inclusive of the poor. And finally, to ensure that various agencies and systems can use the UID in identity verification, the capture and use of biometric information for the number must be standardized.

The UIDAI considered all these factors before taking a decision on the biometric information it would collect. It constituted the Biometric Committee on September 29, 2009 under the chairmanship of the Director General, NIC to recommend the biometric standards for the project. The committee, during its deliberations, undertook wide consultations with biometric experts and academics on the information it should collect, and the potential costs.

Based on the report of the Biometric Committee, and an evaluation of the potential costs and benefits of the various biometrics, the UIDAI decided to collect iris biometrics from residents, in addition to all ten fingerprints and face photograph.

This is the first time that iris will be collected on a national scale in our country, and we therefore, provide an assessment of the factors that led to this decision, as well as an overview on a fast-maturing, and effective new biometric technology.

2. The need for iris in the UID Project

2.1 Ensuring uniqueness

The Biometrics Committee played a key role in helping the UIDAI determine the biometrics to be used in UID enrolment, and the standards to be adopted. The Committee submitted its report on 7th January 2010 to the Chairman of the UIDAI[1]. Prior to recommending the type of biometrics to be captured, the Biometrics Committee debated a key challenge that the UIDAI faces – that of ensuring the uniqueness of biometrics across a population of 1.2 billion people.

To ensure uniqueness, the UIDAI has to minimize the false acceptance rate (FAR) in its biometrics. However, the Biometrics Committee noted that the approach using fingerprint biometrics alone, in addition to face, faces two challenges in ensuring uniqueness and low FAR within the Indian environment – the varying quality of fingerprints, particularly among poor residents; and the scale of the database, at 1.2 billion records[2]. Both these challenges could make uniqueness in biometrics difficult to achieve.

The risk that fingerprinting may not be sufficient to ensure uniqueness is not a risk that can be ignored, particularly when enrolling residents on such a large scale. The cost and logistics of going back and re-enrolling residents, in case the biometrics set is insufficient, would be unacceptable.

The addition of iris to finger and face biometrics would help the UIDAI achieve accuracy rates that go beyond 95%, and would ensure very low FAR. This will also make the UID number highly robust, and enable the number to be used in a wide variety of applications that require high security, such as in financial transactions.

Consequently, the Biometric Committee, following consultations with international experts, recommended that combining the use of two biometrics – fingerprints and iris – would help ensure the uniqueness and accuracy of biometrics in the Indian context. The report stated, 'fused score of two uncorrelated [biometric] modalities will provide better accuracy than any single modality.'[3]

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[1] The Biometrics Committee report is available at:
http://www.uidai.gov.in/documents/Biometrics_Standards_Committee%20report.pdf

[2] Page 4, Executive Summary, Biometrics Committee report

[3] Page 5, Executive Summary, Biometrics Committee report

The relevant recommendation of the Committee dealing with iris reads as follows:

"While 10 finger biometric and photographs can ensure de-duplication accuracy higher than 95% depending upon quality of data collection, there may be a need to improve the accuracy and also create higher confidence level in the de-duplication process. Iris biometric technology, as explained above, is an additional emerging technology for which the Committee has defined standards. It is possible to improve de-duplication accuracy by incorporating iris. Accuracy as high as 99% for iris has been achieved using Western data. However, in the absence of empirical Indian data, it is not possible for the Committee to precisely predict the improvement in the accuracy of de-duplication due to the fusion of fingerprint and iris scores. The UIDAI can consider the use of a third biometric in iris, if they feel it is required for the Unique ID project."

It is clear from the above that while the Committee unequivocally recognized the potential improvements in accuracy through the addition of iris as well as the need for the iris biometric, it left the final decision on this to the UIDAI. In view of this, the UIDAI reviewed the report of the Committee and took a conscious and considered decision to incorporate iris into the UID biometric set.

2.2   Ensuring inclusion

The addition of the iris to the biometric information the UIDAI collects is also important to ensure the inclusion of the large part of the population. There are two important challenges of inclusion that the UIDAI faces:

Ensuring the inclusion of poor residents: India faces unique challenges in collecting biometrics from its rural population and the poor. The poor, due to occupations that usually involve physical labour, have fingerprints that are worn out and difficult to capture[4].

Experts estimate that the challenges in collecting the biometrics of the poor would be lower in the case of iris devices. The iris does not get worn out with age, or with use. It even remains unaffected by most eye surgery. Consequently the use of iris biometrics would help ensure that poor residents are not left out of UID enrolment.

Ensuring the inclusion of children: Collecting and de-duplicating the biometrics of children is a challenge – face and finger biometrics are not stable until the age of 16. The lack of de-duplication of a child's biometrics would require that the child's UID be linked

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[4] Page 30, Annexure II, Biometrics Committee report; Also see IDC & Acuity Market Research Reports

to the parents' UIDs in the database and the child's ID is not issued on the basis of de-duplication of his/her biometrics. This however, increases the risk of duplicates/fakes among UIDs for children. Such UIDs would represent a significant proportion of the UIDs issued, since the percentage of population below 15 years of age is 35.3% as per the 2001 Census.

The iris presents a potential means to issue the majority of children a unique number linked to their biometrics, since the iris stabilizes at a very young age. Unlike finger-prints, the iris is said to be fully developed at the time of birth itself.

The limitation on iris capture of a child only due to the requirement for a child to follow the instructions of keeping his/her eyes open before the iris camera. On an average, the age at which the child can understand and follow such instructions will be around 4 years.

If we use iris, we would be able to reduce the size of our inaccurate UID sub-set (due to the inability to de-duplicate) from 35% to 11% (the percentage of population below four years of age as per the 2001 Census). This will be a significant gain in terms of accuracy.

2.3 Other benefits

There are other additional benefits from collecting iris, along with face and fingerprints. These include:
i) **Comfort**: The addition of iris as a third biometric would not be intrusive. As is visible from the photographs below – taken at one of UIDAI's biometric test centres in Andhra Pradesh – iris capture also does not involve physical contact with the resident, making it a comfortable experience.

Iris image capture is normally done at a distance of 18" to 24", and the image can be taken quite quickly, in less than fifteen seconds per image. The experience is similar to having the resident's photograph taken, except that the camera is brought closer to the face during capture of the image.

Only minimal instructions – 'look at the camera, keep your eyes open' – are required to take an iris image.

ii) **Ease of use**: Both fingerprint devices and iris devices are not difficult to use with a trained operator. Newer iris devices however, are also auto-focus and auto-capture and will prevent the operator from taking an out-of-focus image.

iii) **Reducing risks in execution**: UID enrolment will take place on a large scale and in diverse environments across the country. While the enrolment processes and systems will be standardised, the UIDAI cannot guarantee high quality across its thousands of enrolment points. Collecting iris in addition to fingerprints will help limit the risk of low quality in the biometric data collected.

iv) **Reducing technology risks**: There are significant technology risks in the UID project – there are for instance, no examples to follow, with no previous such technology implementations of this scale. The project also pushes the boundaries of existing de-duplication and authentication technologies, due to the project's unprecedented size.

While ten fingerprints, when collected with care with special emphasis on quality can give us high accuracy, this faces some uncertainties, considering the technology challenges stated above. The use of iris as an additional (and uncorrelated) biometric mitigates the project's technology risks considerably.

v) **De-duplication Process:** During the deliberations of the Biometrics Committee, it was pointed out by experts that iris de-duplication is today, much faster than finger-print de-duplication. More importantly, multi-modal de-duplication, while keeping iris as the primary means of de-duplication, can be made to work much faster than single mode de-duplication. Given the flexibility that the UIDAI wants on de-duplication, and the possibility that the

UIDAI may like to reduce the time taken to achieve universal coverage, the speed of finger-print de-duplication should not become a limiting factor in project implementation.

vi) **Applications:** The requirement of uniqueness and accuracy in UID-linked biometrics is a function of the applications which utilize the residents' data. The applications that use the UID would be many and varied – as an example, an application may use UIDs to monitor the coverage of immunizations, and may not require very significant accuracy. However, if UIDs are to be used to authenticate financial transactions and micro-payments, then even a small percentage of inaccuracies in UID-linked biometric data may make the data unusable for these purposes. Hence, compromises made on uniqueness and accuracy may limit the use of the UID in critical applications.

vii) **Security:** It is highly desirable to have access to an additional biometric trait, from the viewpoint of national security. It is possible to disguise facial features, and mask fingerprints through cuts and bruises. It is much harder to alter iris along with the face and fingerprint. Iris use has consequently become more common in national security and border control applications worldwide.

viii) **Future development of identity systems**: The use of biometric systems for verifying identity is growing rapidly around the world, and both fingerprint and iris vendors are expanding their market. The use of both iris and fingerprint within the UID project will ensure that the number is still usable, if either technology gains ground for identity verification in the future.

It is for the reasons stated above that the UIDAI has decided to include iris along with face and fingerprints, in its biometrics.

3 Iris Technology

3.1 Overview

While the benefits of using iris biometrics are important to consider, not much is known about how iris biometrics systems function. Here, the paper provides an overview on iris biometrics and the technology that is used.

The iris of the eye is a protected organ, which controls the diameter of the pupils – the centre part of the eye – and the amount of light entering the eye.
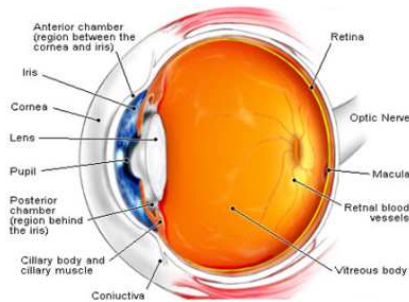
Figure 1: The iris of the eye

Figure 2: The eye structure

The front, pigmented layer of the iris, seen in Figure 1 above, contains random patterns that are visible and highly stable. These patterns are also highly intricate, and unique to every individual. The iris faces very little wear, and can consequently serve as a secure, always available passport that an individual can present for verification.

The field of iris biometrics has seen significant research and investment over the last decade, and at this point, iris capture has become a mainstream technology with wide acceptance. In India, over 50 million people have been enrolled using iris recognition systems in Andhra Pradesh and Orissa. Feedback on these systems has been positive both from enrolling agencies and state government officials. Mexico is also using iris for its version of Unique ID to deliver public benefits to its entire population.

De-duplication through iris has been carried out on a large scale – one implementation that de-duplicated the entry of immigrants into a country has carried out five trillion iris comparisons since 2001. In Andhra Pradesh, the government has carried out 6.26 quintillion matches in two months for its PDS programs in 2009.

According to one research firm, iris is the fastest growing segment of biometrics market and will have the largest market share in next ten years. Responding to the increased demand, the technology has become rapidly cheaper, with a friendlier user experience.

3.2   How do we capture the iris image?

The capture of the iris image is identical to taking a regular photograph, except that it operates in the infrared region, nearly invisible to our eye. The figure below (Figure 3) shows the process for capturing the iris image. The camera captures the image of the iris; the image generated is permanently stored in the database, and is used for matching while verifying the identity of the resident, as well as for de-duplication.

Figure 3: Iris capture sequence

3.3 Devices used for iris capture

The devices that are used for capturing the iris image depends on the purpose – whether it is for enrolling a resident, or for identity authentication. There are two main types of devices that are commonly used: hand held and wall mounted.

Wall mounted devices, which are an older version of the iris device, are usually used for access control applications. Newer, hand held and mobile devices are used for e-governance applications, and for iris enrolment. The devices presently being tested by the UIDAI are mobile devices suitable for enrolling people in rural and remote areas.

Figure 4: Mobile iris device   **Figure 5: Iris and face camera**

4   Questions surrounding the adoption of iris

4.1 Questions surrounding iris technology

There are however, some questions and concerns around iris, which are explained below.

i)   **Is there a risk of vendor lock-in in the UIDAI project?**: A concern that has been expressed about the use of iris, is that the technology is a proprietary one – the fear is that once the UIDAI selects a vendor, it will be permanently tied to the company, and unable to migrate to a different vendor in the future due to prohibitive switching costs. In this scenario, where the UIDAI is locked-in, the vendor can then charge unreasonable prices for maintenance and upgrades, and be negligent in providing support.

The UIDAI however, doesn't expect such problems with iris technology. The UID Authority had carefully evaluated the available choices among existing iris technology vendors, and concluded that lock-in can be avoided. The UIDAI intends to adopt a three-pronged approach to avoid lock-in:

- *The use of standards*: The International Organization for Standardization (ISO) has published the iris image standard (ISO 19794-6), and the majority of iris vendors support this standard, thus ensuring interoperability for images. The National Institute of Science and Technology (NIST)[5]reports that, "The interoperability of standardized iris images in I R E X is better than that reported for standard fingerprint minutiae templates." The UIDAI is capturing and storing all iris images as ISO standard-compliant, using open standard PNG format. With the iris images not tied to any vendor specifications, UIDAI can use any iris software vendor and replace one vendor with another without a problem.

- *Use of multiple iris capture devices*: There is significant competition in the iris field – the industry has over a dozen vendors spread across the US, Europe and Asia. Several large fingerprint vendors are also leaders in iris, including L-1, Sagem and CrossMatch. The UIDAI is conducting its Proof of Concept (PoC) studies with iris capture devices made by four different vendors, and will be testing several more devices in the laboratory. The UIDAI will encourage open competition in the field of iris capture devices, and will not depend on any single, or any single group of vendors.

- *Active promotion of new vendors*: The base technology that is used in iris capture is also used in several unrelated applications. There are consequently, numerous vendors which are capable of making iris cameras. The Indian industry has a unique opportunity to capture this market, particularly considering that India will be becoming the largest consumer of biometric devices with the UIDAI project. The UIDAI is promoting and actively growing this eco-system, with the goal of creating several new vendors in the next few years.

- *Standard Bio-APIs:* With a view to avoid vendor lock-in and achieve inter-operability and pluggability, ISO has come up with a Bio-API standard (ISO/IEC 19784-1 (2006)) which standardizes the interface among biometric devices and other components of the software. These standards are being used in the UIDAI PoCs, and will also be used at the Pilot and implementation stages. This means that our enrolment software will remain unchanged, and the UIDAI would be able to plug in any biometric device (finger-print or iris) as and when we need it.

ii) **Is iris a new, untried technology?**: There is some worry that iris technology is new and untested. While fingerprint recognition is over 150 years old, iris matching was patented only forty years ago. However even in

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[5] NIST Interagency report 7629

this short span of time, iris has got a reputation for high accuracy, and is widely used in security and access control applications where accuracy is paramount. Iris technology has been used both in India and internationally with success. The UK, Canada, US and the UAE are using iris extensively for identity verification and de-duplication at their borders.   In Andhra Pradesh, the Ministry of Civil Supplies has implemented iris technology across its database of ration card holders, with anecdotally low reject rates and high enrolment. This has been supported by experiences with iris in Orissa, within a pilot for the UNFWP program. As NIST[6] reports, "Iris recognition [matches] the level of technical maturity and interoperability of fingerprint bio- metrics, and has affirmed the potential for using iris biometrics...for large-scale identity management applications."

iii) **Is manufacturing capacity available for iris capture devices?**: As iris is a relatively new technology and its usage is limited, the manufacturing capacities in existence today is not significant. Hence, the concern is that if iris is included in the biometric set for UIDAI project, there will be a large demand for iris capture equipment which won't be fulfilled, and the implementation will be affected due to the limited production capacity in the industry.

However manufacturing capacity of iris vendors is at present, determined by existing demand. The UIDAI project would create substantial, new demand for iris devices, and the manufacturing capacity will go up over the coming years. This will also present Indian vendors with an opportunity to enter this space, and has the potential to make India a hub for biometric device manufacturing. The exponential use of consumer grade digital cameras has also helped reduce the manufacturing cost and complexity of iris camera.

iv) **Will collecting iris biometrics be expensive?:** A concern with iris has been on cost. However, the current high prices for iris technology are a result of low volume and its use in cost insensitive security applications. Considering the large demand that will come from India for iris devices and software, the UIDAI expects the prices for iris devices and software will fall rapidly. The UIDAI, taking into account expert assessments, expects iris software to be less expensive by 30-50% compared to fingerprint matching software.

When it comes to enrolment, logistics (travel, manpower etc.) contributes to the major part of the enrolment cost. The cost of the biometric capture devices (equipment and its operation) is not a substantial portion of the cost. A rough estimate puts the incremental cost for iris enrolment in 2010 is to be Rs. 4.4 per enrolee, which will fall over the next few years as the project scales up[7]. The estimated incremental cost is less than Rs. 3 for the iris device, Rs. 0.75 in labour cost and Rs. 0.75 for software cost per enrolee.

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[6] NIST Interagency report 7629

[7] See Annexure A for cost estimates.

Considering the risks discussed previously and the value addition that iris inclusion provides, the additional cost is definitely acceptable for a project of this size and importance. In fact, the cost-benefit ratio, if computed rigorously, will be overwhelmingly in favor of including iris in the biometrics set for the UIDAI. At a macro level, the use of iris will add an estimated Rs. 500 Crores to the project cost. This is well worth the improvements and value addition that the iris biometric will provide.

v) **Will agencies be required to use iris reader devices to authenticate residents?**: It would not be necessary for agencies to authenticate residents through iris. The use of iris biometrics in the UID project is primarily required for a) inclusion of the poor, and b) for de-duplicating the resident before enrolment, which requires extremely high accuracy since the biometric record is compared to the entire database (1:N comparison).

For authentication, the use of fingerprinting will be sufficient, since the comparison would be between the biometric collected by the agency, and the UID-linked biometric in the database (1:1 comparison). However, having iris in our database will enable any future iris-based authentication systems – such as at the airports and other high security areas.

vi) **Is iris difficult to capture?:** One apprehension that exists is that the iris is difficult to capture and the failure to register rate (FRR) are very high. This concern is also based on the fact that earlier iris capture devices were relatively primitive and inconvenient to use. During the last couple of years however, there have been significant improvements in camera quality, and there are now autofocus cameras available which capture the iris image more or less the same way a picture is taken by a normal digital camera.

The Andhra Pradesh government for example, captured about 50 million iris images with earlier cameras without any serious difficulty. Ease of use of iris capture cameras has improved even further today.

It is mistakenly thought in some quarters that iris capture will be opposed due to religious/ethnic sensitivities or due to other reasons rumors of laser beams going into the eye and damaging it). This has not been found to be true in the real world, and no such cases have been reported in the use of iris capture. In fact, in countries such as the UAE where there are strong cultural sensitivities, iris is being widely used in national programs.

4.2 Future Trends

In the last four years, organizations such as the Federal Bureau of Investigation (FBI), Department of Home Land Security (DHS) and National Institute of Science & Technology (NIST) have dramatically increased research and funding for iris. NIST has

also started several new initiatives on standardization, characterization and interoperability conformance. The vendors have responded with friendlier, easy to use devices, public support of standards and publication of performance benchmarks. We anticipate better, cheaper devices and faster algorithms in 2010.

5 Ongoing Implementations

Mexico's Social Security System

Mexico is the first large country that has collected fingerprint, iris and face biometrics of the entire adult population, in order to provide social benefits. Prior to 2009, Mexico has had a comprehensive social security program for its residents which used their version of a unique ID number, which included fingerprints of two fingers.

In 2009, Mexico decided to add full biometric data to their Unique ID project, and awarded the contract in December 2009 and January 2010 to a group of companies for the collection of 10 fingerprints, dual iris and face photograph.

Mexico's reasons for including iris in its program have been uniqueness, ensuring the inclusion of the poor and high accuracy.

The UAE guest worker program

The UAE guest worker program is the largest national deployment so far of iris technology. The program has deployed iris-based enrolment and identity verification across the country's 17 air land and sea ports, and is now in its third year of operation. The program reports zero false matches.

Other implementations

Canada, UK, Netherlands and Singapore now use iris for border control and immigration. The FBI in the USA has also begun collecting and storing iris images along with fingerprint and photo.

6 Conclusion

The adoption of new technology – including useful, socially conscious kinds – tends to come with popular concerns and questions. Most of these concerns arise due to unfamiliarity with the technology, and it is necessary to address them carefully and thoroughly. Similar concerns have arisen in India as the government first begins to collect iris biometrics on a national scale.

The decision to include iris in the UID initiative was a considered one, and took into account the critical needs of the project in ensuring the uniqueness of the number, and also so that residents are not excluded from enrolling for the UID. By guaranteeing the universality and uniqueness of the UID, the initiative can have a substantial, transformational impact in the lives of residents.

For residents, the UID can eventually become the single source of identity verification, and they will be spared the challenge of repeatedly providing supporting identity documents each time they wish to access services such as obtaining a ration card, a driving license, and so on. The UID number would give residents mobility of identity, since the number can be used anywhere in the country. The number will also help improve access for the poor and underprivileged to services such as banking, education and healthcare.

The UID will be vital to fulfilling the government's vision for development – to ensure that even as we grow, we broaden access to the economy and to our markets for our residents. The UID would help us ensure that access to opportunity is not a privilege, but a right. It would offer residents across India the security of our welfare systems, as well as the opportunities of our markets. The effective implementation of a number – one which guarantees both uniqueness, and inclusiveness – will mean a fundamental transformation in our potential for equitable growth, and in the lives of Indians across the country.

7 Annexure A

Cost estimation of iris use in UIDAI

The UIDAI estimates that the total incremental cost of iris capture and de-duplication to be less than Rs. 4.4 per person. This cost can be further broken down into three segments:

Cost component	Cost per enrolment (in Rs.)
Capture device	2.9
Additional labour for iris capture	0.75
De-duplication software cost	0.75

These estimates are based on conservative assumptions including
a. The price of the iris camera remains at Rs. 1 lakh, and will not decrease over time or with increasing demand and larger order quantity.
b. The iris camera will last an average of three years.
c. Iris capture takes one minute
d. Iris software price will not decrease over time or with larger volumes