Demography Based Automated Teller Machine

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ABSTRACT
Automated Teller Machine (ATM) is a widely deployed and used system to cater the banking needs of the user. The idea behind availing an ATM based service was to improve the efficiency of overall financial transaction process. However, in practice, many users with native languages other than English, struggle to efficiently utilize the ATM services on offer. The reason being, even after offering services for more than 40 years, the design of the ATM remained unchanged despite the commonly observed shortcomings. Most of the proposed attempts to redesign the ATM interactivity with the user do not befit a particular diverse demographic setting. The aim of this paper is to address the issue of ATM usability in India. We came up with a novel ATM design both in terms of hardware and software that offers the user a personalised space to interact with the intuitive interface. The proposed design when tested, measured a usability score of 79 on the System Usability Scale, and hence suits the Indian scenario well. The study also issues a set of guidelines that should be considered for designing a system specific to a demography.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentations]: User Interfaces-Input devices and strategies, Interaction styles, User-centered design

General Terms
Design, Reliability, Experimentation, Security, Human Factors,

Keywords
User Centered Design, Demography, Shoulder surfing attack, usability, authentication.

1. INTRODUCTION
Automated Teller Machine (ATM) is a widely used service by people across the globe to make cash withdrawals, check account balances and many other services that serve the banking needs of the user. This service that began in 1972 in UK [2], initially gained momentum in the developed nations. However, in the last decade, a tremendous growth in the number and usage of ATMs has been observed not only in developed, but also developing economies like India.

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Angeli et al. [1] commented "As ATMs cross new borders and pervade different cultures, we need to understand the role of cultural characteristics on people's perception of, attitudes towards, and action on, the machine. This understanding is instrumental in facilitating technology uptake and improving design localisation, or the process of infusing a specific cultural context into products designed for different cultures".

Thus today, it is widely accepted that a certain set of design choices that might be appropriate for one culture, might not necessarily suit another. This stresses the need of localisation of the user interface following the assumption that the requirements and the behavioral aspects of a user remain largely unchanged across a culture[13]. The demography of a place is the most important factor responsible for the decisions that drive the localisation of a design.

Demography can be defined as the general science of studying human population based on the statistics that is subjected to spatio-temporal change in accordance with aging, birth, death, migration etc [4]. Indian demography is similarly identified by a set of characteristics specific to the Indian population that add a unique flavor and contribute towards making the Indian demography distinct. The primary highlights, that are a part of Indian demography and affect the design of an ATM, are, low literacy rate of 74.04%, second highest population in the world, 1652 languages and their various dialects spoken[6]. In addition to these, knowledge, values, belief and attitude of an individual, when considered collectively, mould people's idea of interaction with the surroundings. These parameters therefore form important variables while designing user interaction for a system like ATM.

This paper describes a study that identifies the problems regarding user satisfaction, minimal input effort, inconsistent actions, security issues and more, specific to the Indian demography. To address these demographic concerns, we propose a new design concept for the ATMs in terms of both hardware and software. We conducted a user study to evaluate the usability and efficiency of our proposed design. The results indicate that our proposed design is able to mitigate the existing issues and satisfy the audience.

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2. RELATED WORK

The proposed research on the design of ATMs has been very sparse ever since its inception in the 70s. Some of the studies[5, 10, 11, 14] done on the diffusion of ATMs, clearly indicate the need to innovate and propose new designs for ATM. We below mention the existing design proposals and problems associated with them in terms of demographic suitability to India. BBVA Inc.[16] in collaboration with IDEO Inc. has introduced a concept of ATM that has a minimalistic design. It involves a touch-based screen that allows both display and interaction, as per the Fitt's law[8]. It uses a few key policies like 90 degree rotation of the screen with respect to the orientation of the queue to ensure privacy and prevent shoulder surfing attacks, all in one slot, full touch screen and personalisation to support flexibility. However, personalisation is favorable towards users with sufficient and long-term acquaintance with the system and its techniques.

In order to ensure privacy of operation, BBVA Inc.has followed an approach wherein the user keeps the queue of people in the corner of his eye instead his back, as a way to attain privacy. Such a disciplined approach might not suit the Indian demography and way of life.

Apple Inc. has got itself a patent[7] for an ATM that is a transaction block allowing all the possible transaction right through his iPhone interface. They plan to have a digital signature with the iPhone on the transaction block to authenticate a user. The Bank of America ATM[3] uses a touch based screen with a talking feature to help the visually impaired. It also accepts cheques and money and also allows their validation. Most of these studies have been conducted at a regional level and achieved significant results within the particular domain of audience. We took this as our motivation, and therefore, explored this opportunity for design intervention specific to the Indian demography.

3. RESEARCH METHODOLOGY

We evaluated the design and usability of the proposed ATM interface in two phases. The initial phase was dedicated to identify the problems associated with the ATM within the given demographic region. The process involved survey and personal interviews with the participants from the given region. The second phase of the user study involved the actual evaluation of the proposed interface in the light of the problems mentioned in the first phase. We utilized SUS metrics for the measurement. We recruited 20 participants from in and around the University campus for the study. We screened and recruited participants specifically so that the final set is true and a better representative of the concerned demography. In effect, the participants were from diverse educational and economical backgrounds. For example, one participant was a security guard with primary education while another was a professor at a University with a doctorate degree. Eleven of the participants were male while 9 participants were female and their age ranged from 11 years to 52 years. In the collected sample population, we asked the participants about their ATM experiences. Majority of the users were familiar with the ATM service having a minimum experience of 2 years and used it at least once a week.

4. USER STUDY (Phase 1)

The first phase of user study aimed at identifying the problems with the existing ATMs and their services. We divided our sample population into two groups, each group having 10 participants, based on their experience with ATM usage. First group (Group A) had participants that had 5 or more years of experience in using ATMs while the second group (Group B) has participants with minimum of 2 years of experience. The rationale behind the approach was to counter-balance the effect of habituation with the system for the people with long-term (5 years or more) experience.

We asked the individual group to report the shortcomings on ATM interface on a paper. The study also involved one on one brainstorming discussion sessions with the participants. A compilation of their feedback about the system is tabulated in Table 1.

Prob. Id.	Articulated Problems	Problem Classification
1.	No warning is issued if the amount requested to be withdrawn is more than user's account balance.	Interaction (Software)
2.	The keypad being prone to shoulder surfing attacks, poses a security problem. The vertical screen of ATM can also be easily tracked by the next person in queue, thus adding to the security issue.	Security (Hardware)
3.	No indication regarding the direction of insertion of ATM card confuses the user, making him commit more errors.	Interaction (Hardware)
4.	The fast cash and cash withdrawal options convey same meanings to the user, leading to redundancy of information on the screen.	Interaction (Software)
5.	The time duration of interaction of the ATM machine with the ATM card varies from a few seconds to more. A few machines lead to automation surprise by absorbing in the ATM card.	Interaction (Hardware)
6.	At times, the system does not offer expected degree and quality of interaction, as messages displayed are not meaningful or helpful.	Interaction (Software)
7.	Verification of availability of sufficient amount in the ATM is done towards the end of transaction, leading to transaction failure.	Maintenance (Software)

Table 1: User identified issues with ATM

Along with these identified shortcomings, a few more issues that persist in the existing design of the system, are presented in Table 2 that are gathered through a brainstorming session and self-realization.

Prob. Id.	Other Problems	Problem Classification
8.	As per the Fitt's Law[8], gulf of evaluation[9] is broadened, as the user is unable to get the feedback of his actions simultaneously in the same operational space where he interacts with the system.	Interaction (Hardware)
9.	Many attacks have been registered till date, where the attacker has added a trap to obtain a user's card.	Security (Hardware)
10.	A considerable amount of paper wastage in the existing system due to issue of receipts when not required to the user.	Ecology (software)
11.	No customized service is provided as the ATM always delivers default denomination towards the user for the entered amount without considering the user requirements, e.g. No option to select lower denominations like 10, 20 or 50 rupees that would enable better distribution of the denominations to cater transactional exchanges.	User freedom (software)
12.	No option is provided to deposit money, submit DD or cheque into the ATM.	User freedom (Hardware and Software both)

Table 2: Other issues in ATM

5. PROPOSED DESIGN

A single design innovation can serve one or more identified issues. We have, therefore, clustered different user concerns from Table 1 and 2 and mapped them to the key features of our system enlisted in Table 3. Our design should contain these improvements to make it a unique system suitable for a demography like India. We propose a new ATM design, which provides both hardware and software innovations, efficiently catering the needs of the users.

We put forth an inclined touch based screen, making an angle of 30 degrees with the horizontal surface. It checks shoulder surfing attacks by reducing the visibility of the screen to the user standing next, thus making it more secure and easy to access. The touch-based screen with inbuilt keypad, enables the user to interact and get the feedback on the same surface. Thus the single point interface improves the usability on the lines of Fitt's Law.

We provide a fixed RFID card reader that limits the interrogation zone but still grants freedom to the user to place the ATM card without any specific orientation. It brings a standardisation by getting rid of the variable time of interaction of the card and the machine, and hence avoids the automation surprises due to the absorption of card. In addition to this, it avoids incidences of card being trapped inside the ATM, as the user never loses interface with his ATM card.

The system offers customisation to the user for choosing the required denominations to better suit the audience with a demography like India, that promotes easy exchange of lower denominations. Such customisation in terms of denominations supports user expectations.

Uncertainty avoidance and navigation combined together, suggest that, high uncertainty- avoidance countries like India prefer limited options and simple controls[1]. Based on the above principle, a sufficient but restrictive set of menu options is provided to the users.

Our proposed system ensures better system interaction by incorporating the following improvements: (1) Display of account balance while entering the amount for withdrawal supports the user task of cash withdrawal. (2) Inclusion of options that convey redundant meanings to the user like 'fast cash/cash withdrawal', 'savings/current account' is strictly avoided. (3) Based on the denominations available in the ATM, the bank authorities will be kept informed in advance with a mail alert to facilitate better management of the ATMs. (4) The feature to select denominations enables a user to exercise his freedom while withdrawal of the requested cash amount. (5) By taking user consent before printing any transaction receipt, wastage of paper is avoided.

Issues (refer to Prob. Id. in Table 1 & 2)	Key features of our design
8	Single point interface to interact with the machine to avoid user confusion
3, 5, 9	Making the card reader more accessible to the user
10	Options to suit the demography of the country to ensure customer satisfaction
All software related issues (1,4,6,7,10,11,12)	Design better interactive system
2	More personalised experience to ensure security and avoid shoulder surfing attacks
12	All-in-one slot

Table 3: Key features of our design

To make the operations more secured even in an open public place, we have come up with a new hardware design, which provides a personal space to the user. The form is inspired from a dolphin and withholds the screen, card reader plate, and the all-in-one slot within, thus ensuring isolation and concealing the user actions away from the surroundings. The new dolphin case, refer Figure 1, facilitates the user a secured interaction with the ATM.

The all-in-one slot helps user avoid confusion of where to collect the cash or insert the DD/cheque. This feature has not yet been

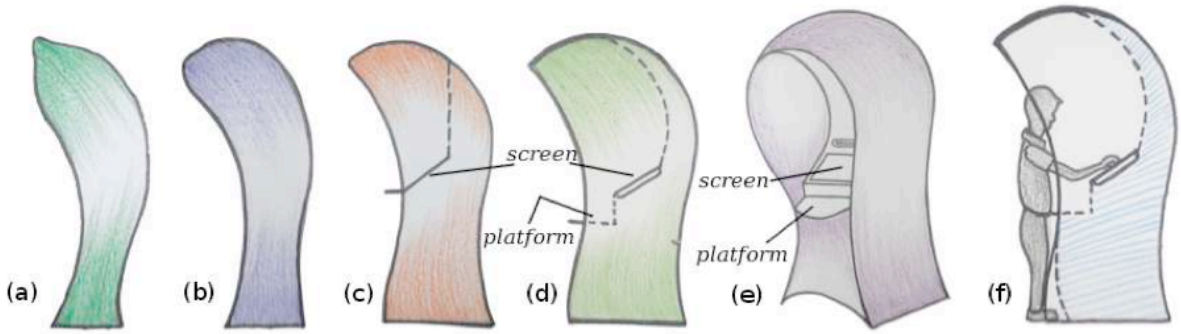

Figure 1: Evolution of Dolphin form from a nascent stage to final ATM case

(a) Inspiration from the Dolphin form; (b) and (c) side view of the ATM case; (d) final form including a screen and a platform to keep any essentials; (e) 3 D view of the ATM case personalising the transaction space of a user including the touch based screen oriented at about 30 degrees with the horizontal, all-in-one slot and card reader plate; (f) User interacting with the proposed ATM. It shows how it isolates his actions from the surroundings and promotes secured transactions.

incorporated in the proposed design and is considered as the future work.

A distinct feature of personalisation is present in the discussed competitive products. Such personalisation in terms of promoting a distinct flow of actions specific to a user is, however, avoided to keep the conceptual model homogeneous to all the users to suit Indian demography.

5.1 Scenario of Usage

Figure 2 shows a series of snapshots demonstrating the flow of actions to perform the withdrawal operation with the proposed design, which includes the following steps:

a. The user selects a suitable language to start his transaction.

b. He holds his ATM card near to the RFID plate to authenticate his account. Red light of the RFID plate changes to green while processing the card details.

c. He takes the card back when green light changes to yellow signaling the authentication granted.

d. He enters his ATM PIN to get access to his account.

e. Here, he selects cash withdrawal so as to continue his transaction.

f. The amount to be withdrawn is then entered.

g. For the entered amount, user selects the denominations he wishes to get from the machine.

h. Lastly, he collects the cash and can check the remaining balance on the same screen. Moreover, he could also continue his transaction for some other option, unless he selects to terminate his transaction.

6. USER STUDY (Phase 2)

We evaluated the usability of the proposed design using our sample population from the earlier study performed in phase 1. We believed these participants would judge the usability better since they had faced the problems with ATM and reported the same in the survey. Our usability test consisted of two sessions that lasted for about half an hour. The first session was dedicated to registration and training. We explained the working of the system to the participants with a sample hands on demo. Written instruction on how to use the system were also made available to the user (both in text and digital form). The second (last) session involved actual user interaction with the interface. No guidance or help were given in this session. Each user was given a dummy Personal Identification Number (PIN) and was then asked to interact with the system to model a dummy transaction. For example, we asked the users to make the following transaction: "withdraw 200 Indian Rupee using the given ATM interface." Finally, we asked the participants to fill a System Usability scale based questionnaire for qualitative analysis.

6.1 Results

We parameterized our study for the software interaction using System Usability Scale (SUS), which is an effective, reliable tool for measuring the usability of a wide variety of tools, products and services. Results of the collected response from the participants show high usability on SUS scale (SUS score =79). The benefits of the proposed hardware, RFID plate and the Dolphin case unit, have not yet been quantified because of the unavailability of the physical assets.

6.2 User satisfaction

We measured the user satisfaction in terms of the ease, with which the user could use the developed interface, and the system ability to assist the user to enable him achieve his objectives successfully. Information about both these parameters, namely user satisfaction and system ability, were gathered from the users through subjective assessment during personal interrogation post their acquaintance with the developed system. We also tried to analyze the ability of our system to tackle with the existing problems such as Shoulder surfing attack and inappropriate system feedback.

Sixty percent of the users (12 out of 20) appreciated the proposal of RFID plate, which provide them enough confidence to use their ATM cards. Seventy-five percent of the users (15 out of 20) appreciated the flow of the transaction in a very natural manner. Ninety percent of the users (18 out of 20) were happy about the system look and feel and the provision of feedback in terms of signals' variations (red, green, and yellow).

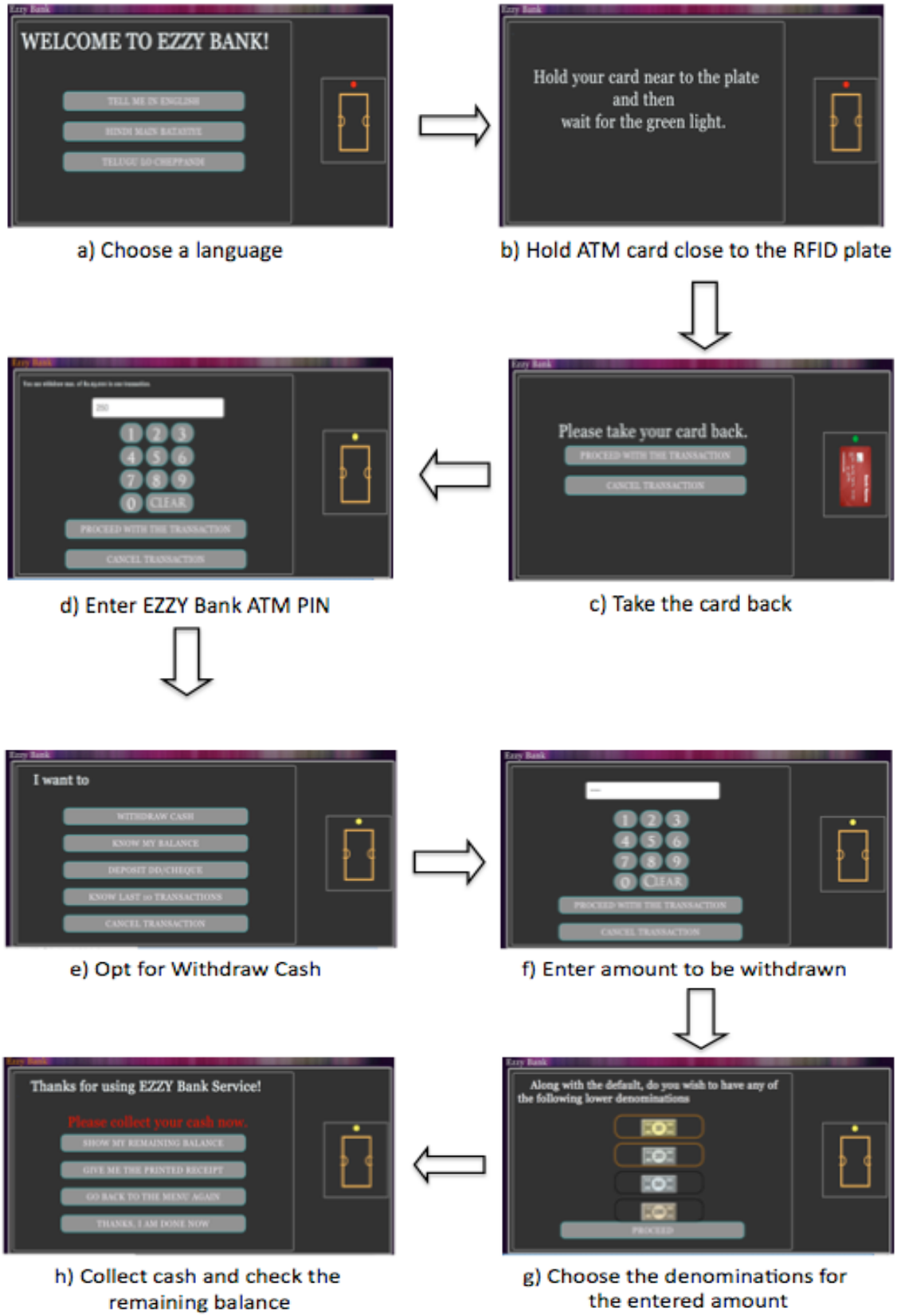

Figure 2: The flow of actions to perform a cash withdrawal operation with the proposed design

Through conversations with the frequent ATM users, we realized that language is not a major driving factor while using ATMs. The reason behind this is that the users, over a period of time, through frequent trials with the system, get habitual to the sequence of events within, and then ignore the system instructions. This motivates us to design a language independent system interface in future using only images and icons. This would also help us better serve a multi-lingual Indian demography.

To summarize, users appreciated our proposed design and found the system very interactive and intuitive. They found the instructions very clear and easy to interpret. These instructions enable the users to recognize, diagnose, and recover from the errors easily.

7. CONCLUSION

The observation of user traits and user feedback during multiple iterations that drove the formulation of our design concludes that demography based systems serve better user satisfaction. We propose our learning based on these observations, as a set of guidelines that should be followed for designing any demography based system:

- The novelty of an idea may or may not be appreciated in two separate demographies. (Refer section 6.4.1)
- Personalisation based on implicit user behavior introduces dynamic navigation. However the extent of its suitability differs with a demography. E.g. Variable process flows are not conducive to demography like India.
- Customisation favors the use of a system by a group of people with diverse demeanor and variable requirements. E.g. Customisation of a currency specific to a demography.
- User satisfaction varies with demography. E.g. easy completion of task matters more than the speed and efficiency in Indian demography.
- Adaptability to changes is demography dependent. E.g. For a demography with low adaptability, stepwise minimal changes should be introduced thoughtfully.
- There exists a trade-off between localisation and centralisation of a design.

It must be noted that even though a few competitive products, mentioned in the related work, solve some of the user identified issues, they are not suitable to the Indian demography as they involve high rate of learning and tend to put more cognitive load upon the user. This hypothesis can be supported from the user dialogue during the multiple iterative rounds that they oppose any drastic change in the system but at the same time appreciate better systems with minimalistic design change. It therefore suggests the need of an intuitive system, which should be designed to suit the demography based needs of the user, providing an easy interface and a rich experience.

8. LOGISTICS

Replacing existing systems with the proposed one will incur heavy cost and also pose a challenge before the users to get accustomed to the new design changes. Considering the slow adaption of Indians to technological changes owing to their low literacy, our suggested design can be well implemented in the existing scenario with some compromises. To start with, the existing ATMs can be upgraded by involving the suggested interactivity in a touch-based screen (since a significant number of the existing systems already have touch-based screens along with a physical keypad). In order to avoid the shift of cards from magnetic Stripe cards to RFID based, a unidirectional horizontal swipe-in slot can replace the push-in pull-out / absorb-in slot, that lets the user have more control and all time access to his ATM card. Implementing RFID based ATM cards, would require investment to make a technology shift, but it can be considered as a long-term investment. New ATMs can be built completely as per the proposed design later.

9. FUTURE WORK

The usability of ATMs so far depends on various factors, language being one of them. For the future work, we will experiment our design to cater the needs of illiterate, semi-literate or literate users simultaneously, by providing a pictorial based approach for any ATM transaction. This is based on the understanding that pictures might serve specially-abled users, and also the users of a nation with more than 1600 languages and dialects are spoken, better.

We would also try to incorporate our design with the Unique Identification Number (UID) card [15], which is a unique as it is based on the fingerprints, iris scan, and user image of a person, making ATMs more secure.

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