Rangoli: A Visual Phonebook for Low-literate Users

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ABSTRACT
In developing countries, language and literacy are barriers that prevent many people from using simple applications like a phonebook on mobile phones. The traditional, alphabetical organization is not good enough for low-literate users who either do not know or have forgotten the alphabetical order of any script. We propose Rangoli, a phonebook that explores several ideas. It organizes contacts in nine colour ‘pages’. On each page nine icons are displayed in that colour. A contact is associated with a colour and an icon. Any contact can be accessed by pressing only two buttons on the number-pad. The spatial location of each contact does not change even as the phonebook fills up. The limitation of 81 contacts is not a major problem for these users for now. Rangoli was first conceived during a class project and was improved through iterations of user study, design and evaluation.

Categories and Subject Descriptors
H.5.2 [User Interfaces] Interaction styles, Screen Design, User Centred Design

General Terms
Design, Human Factors.

Keywords
Digital divide; literacy; appropriate design.

1. INTRODUCTION
India has seen a huge growth in telecommunications in recent times. From barely 5.5 million phone lines in 1991 [1], the country has moved to 40 million fixed line subscribers and 201 million mobile phone subscribers in July 2007 [2]. However, the current growth comes mainly from voice communication. The other advantages of information and communication technologies (ICTs) remain unavailable to a majority. Literacy and language form major barriers that prevent users from using these applications of a mobile phone.

Census data from year 2001 indicates that as many as 45% (468 million) people in India are illiterate and about 76% (771 million) people have not studied beyond the primary school [3]. Literacy may diminish further in life if one’s work requires little reading or writing. Even among the so-called literate population, literacy may not be high enough to allow people to navigate interfaces of interactive applications. For example, a literate person may have forgotten the alphabetical order and this may slow him down in browsing the phonebook.

Contrary to the popular perception about India (that English is a commonly spoken language), language is the other major barrier. While tele-density (number of phone lines per 100 people) has reached 21% [2], non-voice mobile phone usage (for example applications such as alarms, calculators, phonebooks, emails, cameras etc.) in India is almost entirely in English and is restricted to the English-speaking, upper and upper-middle class people. This stands in direct contrast with the demand for communication in non-English languages in other media. Non-English television channels claim all the top slots in television channel ratings [4]. English is not the most popular language even among the literate readership – the circulation of daily English periodicals was 19% in the year 2006 compared to 42% in Hindi periodicals [5]. Census data for the year 1991 shows that English is the first language for only 0.02% of Indians and second and third language for 8% and 3% respectively [6] (the English language data is not released for 2001 census yet).

The phonebook in the mobile phone is one of the most essential and basic applications. And yet current phonebook is designed for literate users only and in particular requires the user to remember the alphabetical order. In this project we were investigating the possibility of designing a phonebook for semi-literate users.

2. USER STUDY
The project started with contextual interviews with 11 users in the villages of Chinchavli and Ukarul, about 100 km from Mumbai, India. Most users were small-scale farmers and shop keepers. They were either low-literate or illiterate by education. This section summarizes our main findings.
We looked at how people stored phone numbers and contact information on paper. Many people owned a small notepad that they referred to as a ‘diary’ (fig 1). In this, people typically stored 40-80 contact numbers, names and often addresses. Small diaries that were carried around in pockets were often mutilated because of wear and sweat. At times, people owned several diaries. Diaries reflected the cultural identity of the owner, in particular religious or national identities (fig 2).

While the textual entries were always in Marathi, the numbers were either in English or in Marathi, or even mixed. Some diaries had the English alphabet tabs on their side, while none had the Marathi character tabs. Even in cases where the English alphabet tabs were present, very few people used the English alphabetical order, and nobody used the Marathi alphabetical order to organize the phone book. Where English alphabetical order was used, the Marathi entries were stored under the phonetically nearest English alphabet – e.g. names starting with Marathi ka and kha characters were stored on the English ‘K’ page.

Many users had alternative organizing principles. For example, some entries were ordered by location of the contacts – for example all Mumbai numbers were together. Some stored the numbers in the sequence in which it was written (older contacts first). Other entries were random.

The one-time numbers and numbers written in a hurry were noted on the covers or outside the margins (fig 3), or on calendars or even walls. Annotations such as circling a few entries were used to denote a group of relatives or people belonging to same family or simply to make them easier to find. The physical location of an entry in the diary was important and people remembered locations of frequent contacts well. Many users left spaces between entries for updates, so that the location of the entry doesn’t change in future.

We also looked at how people stored numbers in their mobile phones. The names entered in the mobile phonebook were all in English, even in phones that had Indian language options. At times, entries in mobile phones were spelt wrongly, whereas the same entries in the diary were fine.

Typically, users had 10-15 contacts in the mobile phones (compared to 40-80 in their diaries). In some cases contacts were entered on the phone by friends or younger family members of the phone owners. In these cases, these tended to be the numbers common for the two people (common friends or relatives). ‘Location’ mattered even on mobile phones – at times digits were added before the name (e.g. “1 Home”, “2 Atul”) so that the entries don’t change the location and frequent contacts stay at the top of the alphabetical list.

Semi-literate users and literate users who could not read English memorized words as pictures and even identified patterns in the phone numbers rather than read the names. In particular, it was not too hard to memorize letters (e.g. H for Home and A for Atul).

On the other hand, alternative organizing functions available currently on phones were not used. For example, some phones had options of grouping the contacts as family, friends, etc. but the users didn’t even know of its existence, as these settings were hidden deep in the third layer of navigation.
When numbers are written in a hurry, they are often scribbled on covers of diaries. Annotations (e.g. outline box) made numbers easier to find. Numbers are in mixed scripts – Roman and Devnagari.

Some users, who had got adept at saving contacts in the mobile phonebook, had devised prefix abbreviations to categorize people based on profession (doc = doctor, post = postman), location (mum = Mumbai, pun = Pune), and business relation (sup = Supplier, truck driver). Users found the typing numbers easier than text – one user had saved a friend’s vehicle registration number instead of his name.

### 3. COLOURS AND ICONS

The feature of associating icons or colours with contacts is available in some commercially available phones such as the Nokia 1110 and others. However, the primary organization of the phonebook in these phones continues to be alphabetical, and the icons are primarily used for recognition once one has reached a contact.

The idea for using colours and icons as the primary organization for phonebooks for low-literate users emerged during a class project of a course on HCI. The group of students working on the project suggested that users identify a contact by choosing a colour and an icon (fig 4). Text need not be entered to name the contact and was secondary. They expected that many low-literate users may only enter a letter (rather than a whole word), and that, in combination with the icon and colour will be good enough a differentiator.

We were concerned if users will be able to use colours, icons and other schemes to classify phone numbers. We evaluated this idea by a card sort with seven users. These users were from in and around Mumbai, but from lower socio-economic strata and not highly educated. We started by asking the user some background questions about his / her mobile phone usage. We then gave a practice task for card sort. Once the user was comfortable with sorting cards, we copied phone numbers and names from his / her phonebook on post-it notes and asked the user to sort these into the following categories and subcategories:

- **Relationships** (close friends, friends, relatives, professional contacts etc.)
- **Age** (kids, teenagers, adults, elders etc.)
- **Colours** (red, yellow, blue, green etc.)
- **Tastes** (sweet, spicy/hot, bitter, salty etc.)
- **Icons** (circle, square, triangle, rectangle, star, heart etc.)

In each case we provided the examples of subcategories above but also encouraged users to add their own subcategories if they liked. While the users sorted the numbers into categories, we asked them to think aloud. After the users performed the task, we asked them to suggest their own categories. We finally asked users about their opinions about the different categorization schemes.

The icons category was most liked, as users thought that it was very ‘symbolic’ and that would relate to an individual easily. People found meanings in abstract shapes that we had not anticipated. For example, stars were for friends “who were far away and twinkle once in a while”, heart was for close relatives whom we like, circle denoted the friend’s / professional circles, square was co-related with the family structure etc.

Users also liked the colours category, as they thought that it would help them in differentiating their contacts. They could easily relate a colour with an individual’s personality e.g. red for relatives, as they were very close to them and not negative in connotations.

The users also liked categorization according to the relationships and frequency. They thought that frequency would help them to manage their professional contacts very well. A few other users found this category complicated.

The taste category was not liked as users could not relate a taste to an individual’s personality. Further, a phonebook is not expected to be private at all times, so they were concerned that if someone saw the phonebook and found themselves “under bitter or spicy, will not like it”. Age was not useful as a category because “kids and elders wouldn’t have a mobile phone”.

Users suggested other categories such as fruits, symbols for professions (teacher, doctor, electrician etc.), locations (districts,
states etc.), but were on the whole comfortable with colours and icons.

4. NUMBER-PAD INTERFACES
Experience in the developing world suggests that while textual literacy is limited, numerical literacy is almost universal. People deal with numbers all the time. Apart from phone numbers, people deal with money, time, calendars, bus numbers, cricket scores etc. The advantages of using numerical interfaces for semi-literate users have been studied previously. Parikh et al [8] describe the advantages of using numbers for creating an accessible user interface for rural, semi-literate micro-finance groups in India on a desktop computer. They report that while users had difficulty reading text and words, numeric data provided significant cues for overall interface comprehension.

Vahanvati [9] describes a mobile-phone based application for small shopkeepers for making bills. He uses a ‘number-pad only’ interface to quickly list purchased items from among potentially hundreds of items in a general store. At a wider level, we believe that most functions of a mobile phone can be covered by this ‘number-pad only’ operation, making the soft buttons almost redundant.

5. DESIGN
In this paper, we present our explorations with colours and icons as a primary organization for phonebooks combined with a number-pad only interface. The interface uses the number pad only (numbers 0-9, plus the hash # and star * keys) to operate the phonebook.

When the phonebook application is launched, the user lands on a menu presented in a grid like the one shown in figure 5. Each menu item on the screen corresponds to a key on the keypad. To select a menu item, user presses the keypad key corresponding to the menu item.

To browse the phonebook, to call or look up a number, the user presses 1 (khojen = search) on the landing page of the phonebook (the other numbers have been deferred for later use). This leads him to a screen where he is presented with a choice of nine colours. Each colour represents a page in the phonebook. The user is prompted to choose a colour.

Once the user chooses a colour, that page zooms in and he is presented with nine icons in that colour. Each icon may have a contact stored in it. If a contact is associated with an icon, the icon appears to be filled like the square, heart, moon etc. in figure 5. Otherwise it appears in its outline, like the circle, flower and star in the figure 5. The user chooses the icon by pressing the corresponding number in front of the icon and the phone number corresponding to the icon zooms into the display.

This design has a limitation that it can’t store more than 81 contacts. But since the target users we talked to had 40-80 contacts, this does not seem to be a major problem for now.

We created a prototype of the proposed design of the visual phonebook using FlashLite 2.0 and deployed it on a mobile phone handset.

5.1 Formative Evaluation
The new design reduced the number of steps required to look up a contact, and we expected that it will be faster for users to look up contacts. On the other hand, the new design required the users to recall the colour and the icon associated with each contact. We expected that the extra memory load will cause more errors as compared to traditional phonebooks.

The main goal of the evaluation was to measure performance (time and errors) by semi-literate users to look up contacts on the visual phonebook and to compare it with the performance on a traditional phonebook with an alphabetically ordered list of names in the users’ mother tongue. We also wanted to find problems in both designs and user strategies to recall shapes and colours. At this time, we were not interested in evaluating other interface elements such as entering numbers or making calls.

It would have been ideal to use the same phone in both cases. Unfortunately, none of the phones available in the market currently support Flash and Marathi. Hence, we used the visual phonebook Flash prototype running on a Nokia 6300 phone and compared it with the traditional alphabetical phonebook running on a Nokia 1110 phone with Marathi support.

The evaluation was done in the villages of Chinchavli and Ukarul, about 100 km from Mumbai by 6 users (5 men, 1 woman) who were over the age of 30, had studied up to eighth standard and did not use a mobile phone.
To begin with, we demonstrated the two phonebooks to the user and explained how they worked. We then selected 25 frequently used phone numbers from the user’s phone diary and wrote those out on post-it notes. Users were asked to categorise each number in colours and icons and assign the contact a name in Marathi. Users were encouraged to do categorization and name assignment in such a way as to help them in the task of finding the contact in the respective phonebook later. This exercise was done by the users on paper (fig 6). After the user was done, the numbers were entered in phones by the moderator.

Users were then asked to look up seven contacts on each phone, one at a time. The data from the first attempt was considered as a practice task and was ignored. We measured performance in terms of time to look up a number and counted the errors. Our definition of what constituted an error was very conservative for our design. We classified each wrong choice of a colour or an icon on the first attempt as an error.

5.2 Findings
We found that users were about twice as fast with the visual phonebook. We also found that people preferred to pick meaningful shapes (moon, flower, star, heart) though in our earlier user studies, users were successful in assigning meaning to abstract shapes (square, circle, triangle, hexagon and octagon). There was a particular confusion between the shapes of hexagon and octagon as the users were not familiar with these figures and did not have a name for them. One user expressed particular dislike towards triangles.

Many users made errors while identifying a colour or an icon associated with a contact in first attempt. No user made an error on second attempt for a given contact. On the whole the errors, though substantial, were not as many as we had expected. The user who made most errors on the visual phonebook also made most errors on the alphabetical phonebook. This user had memorized over 40 phone numbers and did not own a written phone diary.

5.3 Redesigned Interface
Based on the feedback from the pilot evaluations, the design was changed and a second prototype was created (fig 7). The main change was that contact names were displayed in a small typeface just above the icons. We also changed three icons – we substituted the hexagon, the octagon and the triangle with a mango, a house and a tree.

5.4 Evaluation
Another usability evaluation was done in the same location with nine new users (5 men, 4 women) over the age of 30, who had studied up to eighth standard and did not use a mobile phone. The one change from the earlier evaluation was that we decided to not
recruit people who had memorized phone numbers, but only those who stored numbers in a paper-based phone diaries and with 25+ numbers. At the end of the tasks, the users were also asked to give marks out of 10 to rate their preference between the alphabetical phonebook, the visual phonebook and the traditional paper phone diary.

5.5 Results
To assign colours, users typically categorized phone numbers into four categories: ‘family’, ‘relatives’, ‘friends’ and ‘work’. Few users used location and distance (same village, nearby villages, far off places). One user in particular, assigned green colour for the people staying in her village as her village is ‘green’.

Problems arose when users needed to assign more than 9 numbers to one colour, particularly in categories of family and relatives. In such cases many people assigned two colours for family, but this led to errors in later tasks.

Users had consistent names for colours, but some users complained that the colours did not match their expectation. For example, cyan was called ‘sky blue’ [akaashi] to differentiate it from the other darker blue, but they thought that the colour was not exactly sky blue. Similarly, dark green was not green enough or saffron was not saffron enough.

People showed particular fondness towards some shapes. People typically assigned the star and heart for people close to them. Flowers were for daughters, while hearts and moons were for sons. The son-in-law got a star. House was used for landline numbers (neighbour, hospital, school etc.)

Keeping icons and colours in a ‘fixed’ position helped in locating them. Many users seemed to have memorized position in addition to the colour and icon and referred to them by position e.g. ‘the one on the lower right’.

Users did not use the shortcut keys to jump down the list in the alphabetical phonebook, though some of the characters were printed on the phone. (All characters are never printed on keys in Devnagari phones as there are too many to fit.)

Problems arose when users wanted to assign the same shape to two people. For example, one user wanted to assign the heart to both his sons. In another case, one user referred to circle as moon, and confusion arose as another user was assigned crescent moon.

The nine users were asked to select six contacts each on each phonebook. The average time taken to choose a contact was 8.8 seconds (SD= 7.91) on the visual phonebook and 20.5 seconds (SD = 18.41) on the traditional alphabetical phonebook. The statistical difference is significant (t = 3.26, p = 0.005). All users consistently performed better with the visual phonebook as compared to the alphabetical phonebook (fig 8). There was a lot of variation in the performance on the alphabetical phonebook (lowest = 1 s, highest = 120 s) compared to the visual phonebook (lowest = 2 s, highest = 36 s). This is because the number of button clicks it takes to look up a contact in the alphabetical phonebook depends on where the name appears in the alphabetical order. The visual phonebook takes two clicks consistently.

Users still made errors in selecting correct colour or icon on the visual phonebook, though there was improvement from the earlier version. Of the (9x6 =) 54 attempts to look up contacts, users made an error in selecting the right colour on first attempt 7 times and an error in selecting the right icon on first attempt 4 times. The display of contact name above the icon seemed to have helped in reducing the number of errors in selecting icons. Still, 8 out of 9 users made at least one error.

In terms of preference, users gave more marks to the alphabetical phonebook (8.9/10) as compared to the visual phonebook (7.7/10) and the traditional paper phone diary (6.7/10). However, the two users who gave a higher preference to the visual phonebook had very low levels of literacy and were the poor performers in terms of task completion times.

6. DISCUSSION AN FUTURE WORK
Colours-and-icons based phonebook reduces number of keystrokes and the amount of time required to look up a contact. It takes away the need to scroll a long list alphabetically. This is useful to users with lower literacy levels, and particularly to those who have difficulties in recalling the alphabetical order and jumping to a desired letter. It is also useful in contexts of scripts that have too many letters to be displayed on the number pad. We believe that this design could potentially benefit many users, not just the low-literate ones.

Our study pointed to ideas in design of icons and colours. It is useful to use meaningful shapes as these would be preferred over abstract shapes, e.g. star is preferred over a triangle. It is important to avoid potential confusions, e.g. a circle may also be thought of as the moon. It is better to select icons and colours to which users can assign names, e.g. avoid cyan, use sky-blue for Marathi speaking users. This is important even if the name of the colour or icon itself is not displayed or used in the interface.

Displaying contact names above icons reduced the errors in selecting icons. Colours and icons could very well work as navigation, but text helps in reducing errors, particularly for users with some literacy. Our studies showed that even people with low literacy memorize text as visual patterns and start recognizing them. So we are not suggesting doing away with text in phonebooks, but merely changing its priority. As an added benefit, displaying text along with icons can potentially improve literacy.

We need to find ways of reducing the number of errors in selecting colours. One way of doing this would be to pre-define
category names to colours and displaying these on the colour cell. At this time our suggestions for category names would be family, relatives, friends, neighbours, market, business and others.

One important conclusion emerged from this study is that we can’t have ‘one interface for all illiterates’. Localization in terms of choice of colours, icons, terms and text are important, as are choice of applications, metaphors and organizing principles.

Though the visual phonebook prototype fared poorly on errors in first attempt, we expect that errors will reduce with practice, particularly for frequently used contacts.

Shortcuts on mobile phones have been used for a long time, but they have not been a part of the primary navigation. Few interfaces have helped users in memorizing the shortcuts and migrating to it over time. The main advantage of using the visually supported number-pad-only interface is that the interface starts out being visual, but with practice gets converted into a set of number shortcuts. We expect that with practice users will memorize frequent contacts as a two digit number rather than as a navigation exercise.

We were somewhat surprised to find that though users achieved much higher speeds with the visual phonebook, they gave it a lower preference rating than the alphabetical phonebook. This could be because they made fewer errors with the alphabetical phonebook and found it less confusing as the interface could be navigated by two buttons only. It may also be because the visual phonebook required the user to rely on their short term memory. A third reason could be that our users were ‘too literate’ for the alphabetical phonebook. Indeed, two of our users had a very low level of literacy and they preferred the visual phonebook.

6.1 Future Work
In future, we plan to add voice support to the interface which will be useful to both illiterate as well as colour-blind users. We would like to add a method to overcome the current limitation of 81 numbers in the visual phonebook. We would like to investigate what impact a visual phonebook will have on long term usage. In particular, we are interested in finding out what organizational principles will people use in real life and how the organization changes over time. Finally, we would like to extend this interface style to more applications on the mobile phone.

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