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### **Nayanagari**

#### *A Simple Script for Devanagari*

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**Abstract.** The conjuncts (or ligatures) are a fundamental issue for the Devanagari script (or lipi), as it is for any other Brahmi scripts (e.g., Bengali or Bangla, Gujarati, Tamil, Kannada, Malayalam, etc). The conjuncts make the script unnecessarily complex and difficult to learn and to use. The conjuncts not only engender an exponentially large number of total characters for the script, but also render the character set of the script to stay undefined and open ended. For example, one is unable to conclusively answer the question, exactly how many conjunct characters exists (or will exist in future) there in the Devanagari script? If we can do away with the conjuncts we can make the script not only very simple, but also truly complete (or close ended).

In this paper a complete script of a conjunct-free writing system of Devanagari, named as Nayanagari, is presented. The alphabet set of the Nayanagari script and the rules to convert any Devanagari word into Nayanagari format is described. Nayanagari is simple, direct, and easy to use in computing and in any other use. An efficient and easy-to-memorize mapping of the QWERTY keyboard for the Nayanagari characters is illustrated as well.

The concepts and the ideas of Nayanagari are equally applicable to any other Brahmi script. In designing, developing, grouping and ordering the alphabets of the Nayanagari script, we put significant effort so that each character (in both the vowel and the consonant tables, as illustrated below) has (or potentially has) a phonetically identical character in any Brahmi script (with 1:1 mapping), only the artistic rendering of the characters being different. In other words, in our new simple and enhanced scripting proposal below, the Nayanagari character set represent the alphabet set of any Brahmi script in a generic fashion.

**Keywords.** Devanagari script, Indic scripts, Devanagari computing

### **Introduction**

Devanagari alphabets, as that of other Indic languages, are derived from the Brahmi script. Brahmi is the ancestor of hundreds of languages predominantly used in the Indian sub-continent as well as in south-east and east Asia [1][2]. The majority of the scholars believe that the Brahmi script originated from the West-Semitic languages

(like that of any other Indo-European languages) and has been in use in our sub-continent starting at least from 500 BC. Among the descendants of the Brahmi script are the Devanagari script (used in Hindi, Sanskrit, Nepali, Marathi, etc) and the Bangla script (used in Bangla, Assamese, Garo, Mundari, etc). The alphabet set of any of the languages originating from the Brahmi script are very similar in phonetic sounds, positional order, and in various other features.

The writing systems that originated from the Brahmi script constitute of syllabic alphabets, also known as abugida. The consonants of these alphabet sets have an inherent vowel (e.g., a /ə/ in Hindi, and o /a/ in Bangla) with them. The inherent vowel of the consonant can either be muted by means of a special diacritic (named as halanth or hash), or be superseded by attaching a separate vowel diacritic. The vowels can be used either as a diacritic to a consonant or as a separate letter, either at the beginning of a word or elsewhere. The diacritics representing a vowel may reside above, below, before, after, or on both sides of a consonant, and thus often being placed in a non-progressive sequence.

Like other Brahmi scripts, conjuncts (or ligatures) are used in Devanagari whenever two or more consonants occur together and have no pronounced vowel in-between the adjacent consonants. Conjuncts are one of the major disadvantages of the Devanagari script (and for other Brahmi scripts as well), making its written representation very complex. The conjunct characters generate a huge number of character symbols, making it difficult for a user to learn and use them efficiently in various usage, e.g., in computing applications. There are hundreds of conjuncts in Devanagari, and theoretically it could be even more. In addition to the huge number, the lack of a fully defined set of conjuncts, mandates the script to remain open-ended and incomplete.

Due to the difficulties related to the use of conjuncts along with the non-progressive nature of the Devanagari vowels, a number of fundamental computing aspects (e.g., indexing, sorting, database usage, optical character reading, speech to text and text to speech conversion, etc) are still open issues, waiting to be resolved effectively. Even after decades, since Devanagari was first used in computer, there are no significant use of Devanagari in one's daily computing (e.g., programming languages, OSes, e-mail, database, office applications, web applications, banking applications, etc). Neither the business offices, nor the educational institutions are able to use Devanagari effectively for their all computing purposes. Devanagari computing are restrictively being used primarily in the areas of printing, publishing and documenting, though not in a very efficient manner. To use Devanagari effectively in all spheres of computing, it is essential that its interface with the computer be very simple. Without the simplicity, the effective and mass application of Devanagari in computing will continue to stay as a dream.

We discovered that there are two fundamental issues with the writing systems that originated from the Brahmi script: a) the inherent vowel with each consonant not allowing two or more adjacently (side by side) placed consonants to make a compound consonant sound together, and, b) the same diacritic not being able to be applied to two or more adjacent (side by side) consonants due to the non-progressive nature of the vowel diacritics (as the vowel diacritics are used above, below, before, after, or on both sides of a consonant). We identified that these two aspects (i.e., the syllabic use of consonants and the non-progressive use of vowels), which are inherent in all the Brahmi scripts, are the fundamental flaws that mandate conjuncts. By resolving these two fundamental issues, the Devanagari script (as well as any other Brahmi script) can be made very simple and systematic, without requiring any conjuncts.

In the Nayanagari proposal, the above mentioned issues of the Devanagari script are addressed firstly by taking off the inherent vowel from the consonants, and secondly by making the vowels strictly progressive. Each of the Nayanagari vowels is represented by a single symbol, always being placed in a progressive manner after a consonant (or a group of consonants) that is (or are) affected by it. In Nayanagari the Devanagari vowels are simplified by: a) reducing the number of vowels to 8, as the basic vowel sounds of Devanagari, and, b) adopting only the diacritic representations of the vowels as alphabets (which can be placed independently at the beginning of a word or elsewhere). Thus the Nayanagari script becomes fully alphabet based and progressive, requiring no conjuncts, as described in the sections below.

The Nayanagari script has only 45 alphabet symbols (or characters) as compared to (currently) many hundreds in Devanagari, making Nayanagari much easier to learn and to use. Also note that, Nayanagari has a phonemic alphabet set (as there are no inherent vowel with the consonants), as compared to a syllabic alphabet set of Devanagari.

### The Basic Vowels

As per the position of the tongue while pronouncing a vowel, the Nayanagari vowels are categorized in three different groups, a) front, b) back, and c) central. Table-1 shows the 8 basic vowels of the Nayanagari script, in their new groups and positional order. The 1st and the 2nd column of Table-1 shows the position of the tongue when a particular vowel is pronounced. The 3rd column shows the new positional order, which is important for sorting and indexing. The 4th column illustrates the written representation (or artistic rendering) of any vowel character. The 5th and the 6th columns show the names of the vowels in Nayanagari and in IPA (International Phonetic Alphabet [3][4]) respectively. (Note that the name and the phonetic sound of a Nayanagari vowel is the same, as shown in Table-1. By coining an additional beautiful name for each of the Nayanagari vowels may be more convenient to learn and use them.) The 7th column of Table-1 shows the corresponding letter or diacritic form in Devanagari for any particular vowel.

Instead of over 35 letter and diacritic vowel symbols (अ, आ, इ, ई, उ, ऊ, ऋ, ॠ, ए, ए, ऐ, ओ, औ, ऑ, अं, अः, ओ, ऐ, ा, ि, ी, ु, ू, ृ, ॄ, ॆ, ै, ो, ौ, ाँ, ं, ृ, ॄ ) used in Devanagari, there are only 8 vowel alphabets in Nayanagari. In Devanagari, some of the diphthong sounds are represented directly by a single vowel alphabet (e.g., ऐ/æɪ/, औ /əʊ/), while the other diphthongs are represented by using more than one vowel alphabets (e.g., /aɪ/, /eɪ/, /ao/, /ʊɪ/, /aʊ/, etc). In Nayanagari none of the vowel alphabets possess any diphthong sounds, one must place more than one vowel characters side by side to represent any diphthong sound.

The Nayanagari vowel alphabets, in shape in general, resemble the corresponding diacritic forms in Devanagari in many respects (5 of them being exactly the same), in an intention to keep the look and feel of the Nayanagari script as close as possible to that of Devanagari. Each of the Nayanagari vowels is represented by a single symbol and is placed in a word as an individual character in a *progressive* manner. A Nayanagari vowel alphabet may reside in a word in three ways: a) at the beginning of a word (making an independent sound), b) after one or more consonants (being pronounced with one or more consonant sounds), and, c) after or before one or more vowels (generating diphthongs and long vowel sounds). When there are more than one consonant before a vowel in a Nayanagari word, the vowel affects all of those

consonants. The example words in Table-1 show the usage of the Nayanagari vowels as compared to that of Devanagari vowels and diacritics.

To represent the Nayanagari vowels, in general we chose the diacritic-style art (ऎ, ए, ऑ, ऒ, ओ, औ, क, ख, ङ), instead of the letter-style art (e.g., अ, आ, इ, उ, ए, ओ, ऐ, औ), primarily for two reasons. Firstly, using the diacritic-style art makes a word shorter in length and quicker to write (note that the a vowels happen to occur more frequently in words than the consonants), and secondly, using the diacritic-style art seems to generate more clarity and less confusion in reading a word as compared to that of the letter-style art.

Table 1. Nayanagari vowels and their usage

Tongue Position (High=jaw close, Low=jaw open)	#	Nayanagari Vowel	Name of the Vowel		In Devanagari (letter, diacritic)	Example word in Nayanagari	Same word in Devanagari	
			In Nayanagari	In IPA				
Front	High	1.	ɪ	ɪ	/ɪ/	इ, ि	सि, दान	इस, दिन
	Mid	2.	ɛ	ɛ	/e/	ए, े	के, दना	एक, देना
	Low	3.	æ	æ	/æ/	ऐ, ै	बनक	बैंक
	Low	4.	ɑ	ɑ	/ɑ/	आ, ा	आंख, साल	आंख, साल
Back	Low	5.	ɔ	ɔ	/ɑ/	ऑ, ाँ	ऑफिस, कॉल	ऑफिस, कॉल
	Mid (lip rounded)	6.	o	o	/o/	ओ, ो	ओठ, मोम	ओठ, मोम
	High (lip rounded)	7.	u	u	/u/	उ, ु	उदास, दउर	उदास, दुर
Central	Mid (neutral)	8.	ə	ə	/ə/	अ	हनउमार्ता, कहल	अनुमाति, कल

### The Compound Vowels

Table-2 shows the use of the compound vowels in Nayanagari. Compound vowels (as defined here) are formed when two or more Nayanagari vowels are used adjacently in a word. Compound vowels may generate diphthongs or long sounds as well. Table-2 though does not have an exhaustive list of the Devanagari vowel sounds, but it shows in general how compound vowels are represented in Nayanagari using the 8 vowel alphabets.

The long vowel letters and diacritics (ई, ऊ, ी, ू) of Devanagari are represented by placing the corresponding Nayanagari monophthong vowel twice, side by side. It is done so to maintain the legacy, otherwise placing even a single vowel would have sufficed. A long vowel has no real implications on making the sound long, even

though the name of the vowel itself may suggest so in Devanagari. The long-ness of a sound (long monophthong) really depends on how the word is pronounced, rather than on how the word is written.

Table 2. The Compound vowels of Nayanagari

No.	Compound Vowels	Example word in Nayanagari	Example word in Devanagari
1.	र्ऱ	नदर्रर्ऱ	नदी
2.	र्ऱ	लर्ऱ	लिए
3.	र्ऱ	मर्ऱल	मेइल
4.	र्ऱ	कर्रसिर्ऱ	कैसे
5.	र्ऱ	टार्ऱप	टाइप
6.	र्ऱर्ऱ	दर्रर्रसलर्रर्ऱ	दियर्रसलर्रई
7.	र्ऱ	उठर्र	उठर्र
8.	र्ऱउ	डर्रउनलुड	डर्रउनलुड
9.	र्ऱर्ऱ	कर्रर्ऱ	कुई
10.	उर्र	हुउर्र	हुआ
11.	उउ	कानउउन	कानून
12.	उद	सउदर्रर्ऱ	सुअरी
13.	दर्र	नदर्र	नइ
14.	दर्रर्ऱ	मउमबदर्रर्ऱ	मुंबई, मुम्बई
15.	दर्र	गदर्र	गए
16.	दउ	ददउर्र	दौर

### The Consonants

Table-3 shows the consonants of the Nayanagari alphabet set being appropriately placed in groups and positional order. There are 37 consonants in Nayanagari, in 8 different groups. As shown, the characters in the Nayanagari consonant alphabet set follow a nice and easy-to-memorize logical as well as systematic progression, while being part of a close-knit and tight overall package. The consonants in the set are pretty much the same as it is in Devanagari, with a few exceptions. Note that the consonants are no longer syllabic. The Nayanagari consonants no longer possess the inherent vowel sound /ə/ (अ) with them, rather it represents only the phonemic consonant part of the sound.

It seems that the pundit(s) who developed the original Brahmi script were profusely gifted to design the consonants as compared to that of the vowels. The first 25 consonant characters (in 5 logical groups of velar, palatal, retroflex, dental, and labial), in all the Brahmi scripts, indicate the mental caliber of the pundit(s) of such ancient times. The order and the groupings of these 25 characters are kept unchanged in Nayanagari. The rest of the consonant alphabets in Nayanagari are reordered and bundled in 3 groups (each group containing four characters), while following a more theoretical and systematic approach.

The names of the Nayanagari consonants are as shown in Table-3 (both in Nayanagari and in IPA). The names are the same as they are in Devanagari, for the maximum of the consonants. The name, in general, is the phonemic sound of the

consonant added with the neutral vowel schwa, अ(/ə/). The name and the sound of ङ is different than that of Devanagari. ङ is an alveolar approximant in Nayanagari, exactly like the sound of an English r, in an effort to enrich Nayanagari to gain authority over the English sounds. The letter *chandra bindu* is used in Nayanagari as an independent letter instead of as a diacritic to a consonant. One may notice that the nasalization influenced by *chandra bindu* happens with its adjacent vowel, rather than with its adjacent consonant, and such the placement of *chandra bindu* as a diacritic of a consonant in Devanagari are not even linguistically justified.

Table 3. Nayanagari consonants

Origin	#	Nayanagari Consonants	Name of the Consonant		Example words	
			In Nayanagari	In IPA	In Nayanagari	In Devanagari
Velar	1.	क	कट्ट	/kə/	करपट्टया	कृपया
	2.	ख	खट्ट	/xə/	खट्टतरा	खतरा
	3.	ग	गट्ट	/gə/	गट्टरर्मा	गर्मी
	4.	घ	घट्ट	/ɣə/	घउमाना	घुमाना
	5.	ङ	ङट्ट	/ŋə/	रट्टङग	रंग
Palatal	6.	च	चट्ट	/tʃə/	चउमबट्टक	चुम्बक
	7.	छ	छट्ट	/tʃʰə/	छाता	छाता
	8.	ज	जट्ट	/dʒə/	जानवट्टर	जानवर
	9.	झ	झट्ट	/dʒʰə/	झापट्टड	झापड
	10.	ञ	ञट्ट	/jə/	पट्टञजाब	पंजाब
Retroflex	11.	ट	टट्ट	/tə/	टउट	टुट
	12.	ठ	ठट्ट	/ʈə/	ठाक	ठिक
	13.	ड	डट्ट	/də/	डाकघट्टर	डाकघर
	14.	ढ	ढट्ट	/dʱə/	ढट्टककट्टन	ढक्कन
	15.	ण	णट्ट	/ɳə/	मट्टणड ल	मण्डल
Dental	16.	त	तट्ट	/t̪ə/	तनेदउा	तेंदुआ
	17.	थ	थट्ट	/θə/	थालर्मा	थाली
	18.	द	दट्ट	/d̪ə/	दट्टरपट्टण	दर्पण
	19.	ध	धट्ट	/d̪ʰə/	धट्टनयट्टवाद	धन्यवाद
	20.	न	नट्ट	/nə/	नट्टकशा	नक्शा
Labial	21.	प	पट्ट	/pə/	परट्टसतान	प्रस्तान
	22.	फ	फट्ट	/pʰə/	फउसफउसाना	फुसफुसाना
	23.	ब	बट्ट	/bə/	बानसउरर्मा	बांसुरी
	24.	भ	भट्ट	/βə/	भारट्टत	भारत
	25.	म	मट्ट	/ma/	मट्टचछ र	मच्छर
Approximant	26.	य	यट्ट	/jə/	यार	यार
	27.	ऱ	ऱट्ट	/ɹə/	काऱड	काऱ
	28.	ल	लट्ट	/lə/	लाठर्मा	लाठी
	29.	व	वट्ट	/wə/	वट्टकत	वक्त

Sibilant	30.	ष	षट्	/ʃə/	भाषा	भाषा
	31.	श	शट्	/ʃə/	शहरक्षणार्थी	शरणार्थी
	32.	स	सट्	/sə/	सकउल	स्कूल
	33.	ज़	ज़ट्	/zə/	ज़रउरहत	ज़ररत
Glottal, Rhotic, and Nasal accent	34.	ह	हट्	/hə/	हमिमहत	हिम्मत
	35.	ड़	ड़ट्	/ɽə/	दहउड़	दौड़
	36.	र	रट्	/rə/	राषटराियहता	राष्ट्रीयता
	37.	ढ	चौनदरौ बनिदउ	/'tʃəndrə 'bindʊ/	हणउउ	ॐ

### Conversion From Devanagari To Nayanagari

The generic rules of conversion from Devanagari script to Nayanagari is simple and straight forward. One just writes the corresponding vowels and consonants of any word in an explicit and progressive manner in Nayanagari. The inherent vowel, with the Devanagari consonants, are explicitly shown in Nayanagari. As Nayanagari does not support any complex vowel or diphthong as a single alphabet, one must break the Devanagari alphabets, representing complex vowels, into the corresponding complex vowels of Nayanagari (e.g., Devanagari, ऐ = Nayanagari, ɛ).

Presented below are couple of small paragraphs about an Idlee cooking recipe, to give the reader some idea about the look and feel of the Nayanagari script. Note that the art-work of the Nayanagari font, as shown here, is at the very initial stage of development. As there are only 45 symbols (and all individual alphabets) in Nayanagari, various fonts could be developed, with some research, having clarity as compared to that of English, even at the smallest font sizes. Note that in Nayanagari, each individual character font is easily represented by a single glyph, unlike that of Devanagari.

#### कउरकउरार्नी इडलार्नी चाट : (कतिनट लोगोन कट लटि - ४)

सामहगरार्नी : ४० मर्नार्नी इडलार्नी, २० पापडार्नी, ५० गराम उबला हउा काबउलार्नी चअना, ७५ गराम कहटा हउा पहनार्नी, ५० गराम कहतहरा हउा लउ, ४ टबहल सपउन मर्नट या पउदार्नीट कर्नी चहटनार्नी, ४ टबहल सपउन सौठ पाउडहर, २० टबहल सपउन मर्नीठा दहहार्नी, सहजानट कट लटि कहतहर्नी हउार्नी मर्च हउर हहर्नी धहन यी, सवादानउसार नहमहक, १ टार्नी सपउन लाल मर्च पाउडहर, जहरउरहत कट ँनउसार तले ।

बार्धी:

१. इडलार्नी, पहनार्नी हउर लउ को हलहग-हलहग तहल लने ।
  २. हब काबउलार्नी चहनट, हहर्नी मर्च, धहनया, नहमहक हउर लाल मर्च पाउडहर के बाउल मने डालने । इसमहन पापडार्नी को तोडहकहर डालने । फरि हहलहक सट सहर्नी सामहगरार्नी केसाथ मर्लाट ।
  ३. हब पउदार्नीट कर्नी चहटनार्नी हउर सौठ डालकहर हहर्नी तहरहह मर्लाट ।
  ४. हब के हनयह बाउल मने इस मर्शरहण को वयहवहसर्थात कहरने । फरि बाउल कट कर्नारट पहर दहहार्नी डालट हउर हहर्नी धहनया सट सहजाकहर सहरवह कहरने ।
- नोट: इडलार्नी को केदहम हनत मने तहलट ।

## Nayanagari Keyboard And The Computer Interface

Table-4 shows the keyboard mapping for the Nayanagari characters for an standard QWERTY keyboard. The mapping is intuitive and is as simple as it is in English. Nayanagari interface with the computer is direct. It uses only the standard English keyboard, and does not require any specific hardware or software keyboard mechanism. Nayanagari alphabets is currently designed fully based on the ASCII encoding, though in future it will be implemented using the Unicode encoding of its own. From the computing and usage point of view, Nayanagari has no less advantages in any way to that of English. Out of the 52 keys of the English alphabets (26 uppercase and 26 lowercase), 47 (8 vowels + 37 consonants + 2 special characters) are being currently used in Nayanagari, leaving 5 keys (H, I, Q, X, and Z) for potential use in future. In Table-4 each cell represents one keypad, and the letter pair in each cell indicate which Nayanagari key corresponds to which QWERTY key.

Table 4. Nayanagari keyboard map

ई/i	ऎ/e	ऀ/A	ँ/a	
ऌ/o	ए/O	ब/u	ः/E	
क/k	ख/K	ग/g	घ/G	ङ/Y
च/c	छ/C	ज/j	झ/J	ञ/q
ट/t	ठ/T	ड/d	ढ/D	ण/N
त/v	थ/V	द/f	ध/F	न/n
प/p	फ/P	ब/b	भ/B	म/m
य/y	ऒ/W	ल/l	व/w	
ष/x	श/S	स/s	ज़/z	
ह/h	ङ/R	र/r	उ/U	
।/L	(rupee symbol)/M			

## Conclusion

The existing character set and the script of Devanagari ( and of any Brahmi script) are not as systematic as one would expect. The vowel characters are used in the script in a non-progressive manner while the consonant characteres are used as syllables (having an inherent vowel sound associated with each consonant). The non-systematic use of the vowels and the consonants of the script mandate conjuncts, which create major issues in sorting, indexing, learning, etc. The conjuncts also render the script to stay open-ended, as there exists no closed set of conjuncts agreed by all.

We presented in this paper a systematic and completely conjunct-free writing system (or script) of Devanagari, named as Nayanagari. Nayanagari has an alphabet set of 45 characters (8 vowels and 37 consonants), which are grouped and ordered in a systematic manner. As there are no conjuncts in Nayanagari, the script is simple and fully close-ended. We showed in this paper how any Devanagari word can be converted into Nayanagari format.

For the computer interface of Nayanagari, we presented a keyboard map, which is simple and very easy to memorize. As Nayanagari is directly and fully mappable to ASCII, one can easily be enabled to write programs like C, C++, or any other computing language or script in Nayanagari. Any Operating System (OS) can easily be ported to Nayanagari as well, enabling its ubiquitous use in computing. As it is systematic, Nayanagari is very easy to learn and to use by everyone including the children.



The Nayanagari solution, as presented in this paper, apply in general for any other Brahmi language as well. We believe, it is inevitable for any of the Brahmi scripts to be more systematic and to be free of conjuncts, for simplicity and for computing ease.

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