

# Machine Translation of Telugu Singular Noun Inflections to Sanskrit

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**Abstract** - Inflections are the key elements in finding the subject and object in a given sentence. The details of verb can also be obtained with the help of inflections. A Morphological Analysis System (MAS) is implemented for Machine Translation (MT) to analyze and to identify the inflections. MAS can perform forward and reverse morphology. In Source Language (SL), identification and separation of inflection and generating the root noun of the word is known as forward morphology. Thereafter, equivalent term for the obtained noun in the Target Language (TL) will be identified from the database. In addition to the root noun, separated inflections will also be converted according to the grammatical rules of the TL. Translated inflections will be attached to the noun of TL. This phenomenon is known as reverse morphology. In this paper, SL is Telugu and TL is Sanskrit. This paper details translation only for singular and proper inflections of noun. There are numerous special cases in Sanskrit, but they are not considered in this paper.

**Keywords** - Singular Noun Inflections, Declensions, Machine Translation, Morphological Analysis.

## 1. Introduction

An inflection ('*vibhakti*') can be defined as the modification of a word to evince various voices, moods, genders, numbers, persons, etc. [1]. Inflections that are attached to a root word that can be noun, pronoun or adjective are known as declensions, whereas the inflection of verbs is known as conjugation [2] [12]. Majority of vocabulary of Sanskrit is either an inflection or manifestation of any of the root verbs ('*dhAtus*') [3] that are 2128 in number in Sanskrit according to the great, ancient and renowned Sanskrit grammarian Panini, 300 BCE [6] [7]. That is the reason why conjugations are possible in Sanskrit but not in Telugu [4]. Telugu grammar classified nouns into five types (Table 1.1), pronouns into eight types and adjectives into six types [8]. Inflections and morphological analysis of pronouns are not discussed

in this paper. Inflections of adjectives are not considered for the convenience of MT since third classification of nouns ('*guNa nAmavAcakamu*') and second classification of pronouns ('*viSEshaNa sarvanAmamu*') denotes the characteristics of adjectives briefly.

Table 1.1: Classifications of nouns

Type	Description	Example
<i>jATi</i> (Race)	Similar type of entities i.e. race name	<i>manishi</i> (human), <i>kukka</i> (dog), etc
<i>saMjnA</i> (Symbolic)	<i>saMjnas</i> (symbols), in general they are names.	<i>gODAvari</i> , <i>HyderAbAd</i> , etc
<i>guNa</i> (Nature)	Name of <i>guNa</i> (nature).	<i>maMchi</i> (good), <i>cheDu</i> (bad),
<i>sAmuDAYaka</i> (Group)	Name of the group of people, animal or objects	<i>samUhaM</i> (society), <i>taMDaa</i> (tribe) etc
<i>kriyA</i> (Verbal)	Name of the <i>kriya</i> (work)	<i>naDuchu</i> (walk), <i>vaMDu</i> (cook), etc

Very large number of inflections is used in human conversations, but Telugu grammar considers only eight as proper inflections. (Table 1.2) Being nominatives are the nouns or pronouns; they will be inflected in seven ways viz. accusative, instrumental, dative, ablative, possessive, locative or vocative. It is a custom in Telugu that a noun or pronoun can be inflected twice, e.g. the term '*EnuguniguriMci*' is inflected twice accusatively i.e. with '*ni*' and '*guriMci*'. There will be no change in meaning even if the first inflection is removed i.e. '*EnuguniguriMci*' means the same as '*EnuguriMci*'.

Table 1.2: Declensions of Telugu nouns

<i>vibhakti</i>	Inflections	Types of Declensions
<i>prathamA</i>	Nominative	<i>Du, mu, vu, lu</i>
<i>dviTyA</i>	Accusative	<i>ni(n), nu(n), lanu, kUrci, guriMci</i>
<i>tRiTyA</i>	Instrumental	<i>cEta(n), cE(n), tODa(n), tO(n)</i>
<i>caturthI</i>	Dative	<i>koraku(n), kY</i>
<i>paMcaml</i>	Ablative	<i>valana(n), kaMTTe(n), paTTi</i>

<i>vibhakti</i>	Inflections	Types of Declensions
<i>shashTI</i>	Possessive	<i>ki(n), ku(n), yokka, IO(n), IOpala(n)</i>
<i>saptamI</i>	Locative	<i>aMdu, na(n)</i>
<i>saMbOdhana prathamA</i>	Vocative	<i>OrI OsI OyI hE</i>

## 2. Structure of Declensions in Telugu and Sanskrit

Telugu, also called ‘AMdhramu’, whose vocabulary is mainly classified into five types viz. ‘*tatsama, tadbhava, dESya, anya-dESya*’ and ‘*grAmya*’. Usage of only ‘*tadbhava*’ and ‘*dESya*’ leads to ‘*acca telugu* (the purest Telugu)’ [9]. Telugu is heavily influenced by Sanskrit, though both are considered to be mother and child kinds [6], there are considerable variations and customs in formation of declensions. In Sanskrit, inflections vary from gender to gender and the ending character of the word. There are three types of genders in both Sanskrit and Telugu viz. masculine, feminine, and neuter. Unlike Sanskrit, Telugu equates feminine and neuter genders in word formation [8]. Sanskrit considers gender and sex to be separate entities [11].

Unlike Telugu, the gender of the Sanskrit words does not depend on the person or the object the word represents. It depends on how the word ends, e.g., ‘*viSvakarma*’ (all creating god) is feminine in Sanskrit but masculine in Telugu. Another example is ‘*siMhaH* (lion)’ is of masculine gender in Sanskrit but feminine in Telugu since all the non human living beings are considered as feminine genders in Telugu. Still further, the word ‘*ghaTaH* (pot)’ is masculine in Sanskrit [10] and neuter in Telugu since all non living beings are considered as neuter genders in Telugu. Though there are conflicts in declaring the gender of the words in Sanskrit, naturally the words end in vowels like ‘*aH, iH, uH*’ are considered as masculine, in ‘*A, I, U*’ are considered as feminine and in ‘*aM*’ are considered as neuter. The genders of the words end in consonant are word dependant.

A comparative analysis on inflections of Telugu and Sanskrit is described as follows:

### 2.1 Nominative

- In Telugu, it is a custom that the nouns end in ‘*Du, mu, vu*’. The nominative ‘*lu*’ generally denotes plural form of a word [1]. But being an ‘*ajanta*’ (means ‘ends in vowels’) language, Telugu vocabulary can end in vowels.
- In Sanskrit, nouns end in many ways (Table 2.1, 2.2 and 2.3) based on the genders.

Table 2.1: Masculine gender nouns with examples

Ends in	Examples
<i>a</i>	<i>rAma, dEva, Siva, hara, siMha</i>
<i>i</i>	<i>hari, ravi, kavi, muni</i>
<i>u</i>	<i>guru, vishNu, SaMbhu</i>
<i>R</i>	<i>dAtR, karIR, dhAtR, pitR</i>
<i>c</i>	<i>jalamuc, prayOmuc, suvAc</i>
<i>j</i>	<i>vaNIj, bhishaj, hutabhuj, rAj</i>
<i>t</i>	<i>marut, indrajit, bhUBhRt</i>
<i>d</i>	<i>suhRd, divishad, tamOnud</i>
<i>n</i>	<i>yuvan, maghavan, pathin</i>
<i>S</i>	<i>viS, tAdRS, bhavAdRS</i>
<i>sh</i>	<i>dvish, ratnamush, sitatvish</i>
<i>s</i>	<i>vEdhas, SrEyas, sumanas</i>
<i>h</i>	<i>lih, bhUruh, mahIruh</i>

Table 2.2: Feminine gender nouns with examples

Ends in	Examples
<i>A</i>	<i>ramA, sItA, lajJA, kshamA</i>
<i>i</i>	<i>mati, kRti, Suci, sRshTI</i>
<i>I</i>	<i>nadI, gWrI, vANI, sakhI</i>
<i>u</i>	<i>dhEnu, tanu, ishu, rajju</i>
<i>U</i>	<i>vadhU, camU, SvaSrU, bhU</i>
<i>R</i>	<i>svasR, mAtR, yAtR, duhitR</i>
<i>c</i>	<i>vAc</i>
<i>j</i>	<i>straj</i>
<i>t</i>	<i>sarit</i>
<i>d</i>	<i>saMpad, Apad, mRd</i>
<i>dh</i>	<i>kshudh, yudh, samidh</i>
<i>n</i>	<i>sIman, dAman</i>
<i>p</i>	<i>ap (it is always plural)</i>
<i>r</i>	<i>gir, dhur, pur</i>
<i>v</i>	<i>div</i>
<i>S</i>	<i>niS, vipAS, diS</i>
<i>sh</i>	<i>prAvRsh, tvish</i>
<i>s</i>	<i>bhAs, ASis,</i>
<i>h</i>	<i>upAnah</i>

Table 2.3: Neuter gender nouns with examples

Ends in	Examples
<i>a</i>	<i>Pala, Gana, vana dhana</i>
<i>i</i>	<i>vAri, dadhi, akshi, suci</i>
<i>u</i>	<i>madhu, aMbhu, vastu, dARu</i>
<i>R</i>	<i>dAtR, karIR, gantR, vaktR</i>
<i>c</i>	<i>suvAc</i>
<i>j</i>	<i>asRj</i>
<i>t</i>	<i>jagat, bhAsvat, tanvat, dadat</i>
<i>d</i>	<i>hRd</i>
<i>n</i>	<i>nAman, Sarman, vyOman</i>
<i>r</i>	<i>gir, vAr</i>

Ends in	Examples
<i>S</i>	<i>tAdRS, IdRS, kIdRS</i>
<i>sh</i>	<i>sutvish, ratnamush</i>
<i>s</i>	<i>manas, tapas, yaSas</i>
<i>h</i>	<i>aMbhOruh,</i>

## 2.2 Accusative

- a. In Telugu, ‘*ni(n)*, ‘*nu(n)*, ‘*la(n)*, ‘*kUrci*, ‘*guriMci*’ are the terms used to inflect accusatively. ‘*la(n)*’ is the term used to for plural inflections. ‘*kUrci*’ becomes ‘*gUrci*’ in word formation. A noun cannot be accusatively inflected with ‘*nu*’ when it is ended with ‘*i*’ or ‘*T*’ in Telugu (Table 2.3).

Table 2.3: Formations of Telugu accusatives

Nominative + Accusative	Example
<i>karra + ni / nu / gUrci / guriMci</i> (stick)	<i>karrani / karranu / karragUrci / karraguriMci</i>
<i>pilli + ni / gUrci / guriMci</i> (cat)	<i>pillini / pilligUrci / pilliguriMci</i>
<i>paTTI + ni / gUrci / guriMci</i> (strip)	<i>paTTIni / paTTIgUrci / paTTIguriMci</i>
<i>illu + ni / nu / gUrci / guriMci</i> (house)	<i>illuni / illugUrci / illuguriMci</i>
<i>kaTTe + ni / nu / gUrci / guriMci</i> (stick)	<i>kaTTeni / kaTTenu / kaTTegUrci / kaTTeguriMci</i>
<i>rAmuDu + ni</i>	<i>rAmuDini / rAmuDni / rAmuNNi</i>

- b. In Sanskrit, reverse morphology is applied (Tables 2.4, 2.5 and 2.6) for various types of nouns to form accusative inflection, based on the gender of the nouns and their ending letters.

Table 2.4: Formations of Sanskrit accusatives for masculine genders using reverse morphology

Ends in	Accusative	Example
<i>a, c, j, t, d, n, S, sh, s, h</i>	<i>aM</i>	<i>rAmAH + aM = rAmAM, jalamuCaM, vaNijaM, marutaM, suhRdaM, yuvAnaM, viSaM, dvishaM, vEdhasaM, lihaM,</i>
<i>i</i>	<i>iM</i>	<i>hariH + iM = hariM</i>
<i>u</i>	<i>uM</i>	<i>guruH + uM = guruM</i>
<i>R</i>	<i>AraM</i>	<i>dAtR + AraM = dAtAraM</i>

Table 2.5: Formations of Sanskrit accusatives for feminine genders using reverse morphology

Ends in	Accusative	Example
<i>A</i>	<i>AM</i>	<i>ramA + AM = ramAM</i>
<i>i</i>	<i>iM</i>	<i>matiH + iM = matiM</i>
<i>I</i>	<i>IM</i>	<i>nadI + IM = nadIM</i>
<i>u</i>	<i>uM</i>	<i>dhEnuH + uM = dhEnuM</i>
<i>U</i>	<i>UM</i>	<i>vadhUH + UM = vadhUM</i>
<i>R</i>	<i>araM</i>	<i>mAtR + araM = mAtaraM</i>
<i>c, j, t, d, dh, bh, r, v, S, sh, s, h</i>	<i>aM</i>	<i>vAc + aM = vAcAM, strajaM, saritaM, saMpadaM, kshudhaM, kakubhaM, giraM, divaM, viSaM, prAvRshaM, bhAsaM, upAnahaM</i>

Ends in	Accusative	Example
<i>n</i>	<i>AnaM</i>	<i>sIman + AnaM = sImAnaM</i>

Table 2.6: Formations of Sanskrit accusatives for neuter genders using reverse morphology

Ends in	Accusative	Example
<i>a</i>	<i>aM</i>	<i>phal + aM = phalaM</i>
<i>i, u, R, t</i>	Use as it is	<i>vAri, dadhi, madhu, guru (heavy), dAtR, jagat,</i>
<i>c, j, S</i>	<i>k</i>	<i>suvAc = suvAk, asRj = asRk, tAdRS = tAdRk,</i>
<i>n</i>	Remove ‘ <i>n</i> ’	<i>nAman = nAma, karman = karma</i>
<i>d</i>	Change ‘ <i>d</i> ’ to ‘ <i>t</i> ’	<i>hRd = hRt</i>
<i>sh, h</i>	Change ‘ <i>sh</i> ’ to ‘ <i>T</i> ’	<i>sutvish = suviT, aMbhOruH = aMbhOruT</i>
<i>s</i>	Change ‘ <i>s</i> ’ to ‘ <i>H</i> ’	<i>manas = manaH, havis = haviH, vapus = vapuH</i>

## 2.3 Instrumental

- a. In Telugu, ‘*cEta(n)*, ‘*cE(n)*, ‘*tODa(n)*, ‘*tO(n)*’ are the terms used for instrumental inflection. ‘*cEta(n)*’ and ‘*cE(n)*’ are considered as same and also ‘*tODa(n)*’ and ‘*tO(n)*’. (Table 2.7)

Table 2.7: Formations of Telugu instrumentals

Nominative + Instrumental	Example
<i>karra + cEta / tO</i> (stick)	<i>KarracEta / karratO</i>
<i>pilli + cEta / tO</i> (cat)	<i>pillicEta / pillitO</i>
<i>paTTI + cEta / tO</i> (strip)	<i>paTTicEta / paTTItO</i>
<i>illu + cEta / tO</i> (house)	<i>illucEta / illutO</i>
<i>kaTTe + cEta / tO</i> (stick)	<i>kaTtecEta / kaTTetO</i>

- b. In Sanskrit, reverse morphology is applied (Tables 2.8, 2.9 and 2.10) for various types of nouns to form instrumental inflection, based on the gender of the nouns and their ending letters.

Table 2.8: Formations of Sanskrit instrumentals for masculine genders using reverse morphology

Ends in	Instrumental	Example
<i>a</i>	<i>Ena / ENa*</i>	<i>dEvaH + Ena = dEvEna, rAmAH + Ena = rAmENa*</i>
<i>i, u</i>	<i>nA / NA*</i>	<i>hariH + nA = hariNA*, guruH = guruNA*, ravi + nA = ravinA, SaMbhuH = SaMbhunA</i>
<i>R, c, j, t, d, n, S, sh, s, h</i>	<i>A</i>	<i>dAtR + A = dAtRA, pitR = pitRA, jalamuc = jalamuCA, vaNij = vaNija, rAj = rAjA, marut = maruta, suhRd = suhRdA, pathin = pathA, karin = kariNA*, viS = viSA, tAdRS = tAdRSA, dvish = dvisha, vEdhas = vEdhasA, SrEyas = SrEyasA, lih = lihA</i>

\*if ‘*na*’ follows one of ‘*ra/sha/R*’ it will be converted to ‘*Na*’ as per Panini’s grammar rule

Table 2.9: Formations of Sanskrit instrumentals for feminine genders using reverse morphology

Ends in	Instrumental	Example
A	Change 'A' to 'ayA'	ramA = ramayA
i, I	Change 'i/I' to 'yA'	matih = matyA, nadI = nadyA
u, U	Change 'u/U' to 'vA'	dhEnuH = dhEnvA, vadhU = vadhvA
R	Change 'R' to 'rA'	svasR = svasrA, mAtr = matrA
c, j, t, d, dh, n, bh, r, v, sh, s, h	A	vAc = vAcA, straj = strajA, sarit = saritA, Sarad = SaradA, kshudh = kshudhA, sIman = sImA, kakubh = kakubhA, gir = girA, div = divA, niS = niSA, prAvRsh = prAvRshA, bhAs = bhAsA, upAnah = upAnahA

Table 2.10: Formations of Sanskrit instrumentals for neuter genders using reverse morphology

Ends in	Instrumental	Example
a	Ena / ENa*	phalaM = phalEna
i, u, R	nA / NA*	vAri = vAriNA*, dadhi = dadhinA, madhu = madhunA, guru = guruNA, datR = dAtRNA*
c, j, t, d, n, r, S, sh, s, h	A	suvAc = suvAcA, asRj = asRjA, jagat = jagatA, hRd = hRdA, nAman = nAmA, gir = girA, tAdRS = tAdRSA, sutvish = sutvishA, vEdhas = vEdhasA, aMbhoruh = aMbhoruhA

\*if 'na' follows one of 'ra/sha/R' it will be converted to 'Na' as per Panini's grammar rule

## 2.4 Dative

- a. In Telugu, 'koraku(n), kY' are the terms used for dative inflection (Table 2.1). Both the inflections can also be combined as 'korakY' gives no change in meaning.

Table 2.11: Formations of Telugu datives

Nominative + Dative	Example
karra + koraku / kY (stick)	karrakoraku / karraku
pilli + koraku / kY (cat)	pillikoraku, / pillikY
paTTI + koraku / kY (strip)	paTTIkoraku / paTTIkY
illu + koraku / kY (house)	illukoraku / illukY
kaTTe + koraku / kY (stick)	kaTTEkoraku / kaTTEkY
rAmuDu + koraku / kY (Rama)	rAmuDikoraku / rAmuDikY*

\*if a word is ended with 'Du', then it is changed to 'Di' if it is dative.

- b. In Sanskrit, reverse morphology is applied (Tables 2.12, 2.13 and 2.14) for various types of nouns to

form dative inflection, based on the gender of the nouns and their ending letters.

Table 2.12: Formations of Sanskrit datives for masculine genders using reverse morphology

Ends in	Dative	Example
a	Change 'a' to 'Aya'	rAmah + Aya = rAmAya
i	Change 'i' to 'ayE'	hari + ayE = harayE
u	Change 'u' to 'avE'	guruH + avE = guravE
R	Change 'R' to 'rE'	dAtR + rE = dAtRE, pitR = pitRE
c, j, t, d, S, sh, s, h	Append 'E'	Jalamuc + E = jalamucE, vaNij = vaNijE, rAj = rAjE, marut = marutE, suhRd = suhRdE, viS = viSE, dvish = dvishE, vEdhas = vEdhasE, lih = lihE
n	-	Have many special cases

Table 2.13: Formations of Sanskrit datives for feminine genders using reverse morphology

Ends in	Dative	Example
A	Append 'yY'	ramA + yY = ramAyY
i, I	Change 'i/I' to 'yY'	matI + yY = matyY, nadI = nadyY
u, U	Change 'u/U' to 'vY'	dhEnu + vY = dhEnvY, vadhU = vadhvY
R	Change 'R' to 'rE'	svasR + rE = svasrE,
c, j, t, d, dh, n, bh, r, v, S, sh, s, h	Append 'E'	vAc + E = vAcE, straj = strajE, sarit = saritE, Sarad = SaradE, kshudh = kshudhE, sIman = sImE, kakubh = kakubhE, gir = girE, div = dive, niS = niSE, prAvRsh = prAvRshE, bhAs = bhAsE, upAnah = upAnahE

Table 2.14: Formations of Sanskrit datives for neuter genders using reverse morphology

Ends in	Dative	Example
a	Change 'a' to 'Aya'	phalaM + Aya = phalAya
i, u	Append 'nE/NE'*	Suci + nE = SucinE, vAri + NE = vAriNE*, madhu = madhunE, guru = guruNE,
R	Append 'nE/NE'	dAtR + NE = dAtRNE
c, j, t, d, n, r, S, sh, s, h	Append 'E'	suvAc + E = suvAcE, asRj = asRjE, jagat = jagatE, hRd = jRdE, nAman = nAmE, vAr = vArE, tAdRS = tAdRSE, sutvish = sutvishE, manas = manasE, aMbhoruh = aMbhoruhE

\*if 'nE' follows one of 'ra/sha/R' it will be converted to 'NE' as per Panini's grammar rule

## 2.5 Ablative

- a. In Telugu, 'valana(n), kaMTe(n), paTTi' are the terms used for ablative inflection (Table 2.15). Generally, 'paTTi' becomes 'baTTi' in word formation. This inflection can be entwined with the accusative 'ni/nu', e.g., 'karranibaTTi, karranubaTTi'.

Table 2.15: Formations of Telugu ablatives

Nominative + Dative	Example
karra + valana / kaMTe / baTTi (stick)	karravalana / karrakaMTe / karrabaTTi
pilli + valana / kaMTe / baTTi (cat)	pillivalana / pillikaMTe / pillibaTTi
paTTi + valana / kaMTe / baTTi (strip)	paTTivalana / paTTikaMTe / paTTibaTTi
illu + valana / kaMTe / baTTi (house)	illuvalana / illukaMTe / illubaTTi
kaTTe + valana / kaMTe / baTTi (stick)	kaTTevalana / kaTTeKaMTe / kaTTebaTTi
rAmuDu + valana / kaMTe / baTTi (Rama)	rAmuDivalana / rAmuDukaMTe / rAmuDubaTTi

\*if a word is ended with 'Du', then it is changed to 'Di' if it is ablative.

- b. In Sanskrit, reverse morphology is applied (Tables 2.16, 2.17 and 2.18) for various types of nouns to form ablative inflection, based on the gender of the nouns and their ending letters.

Table 2.16: Formations of Sanskrit ablatives for masculine genders using reverse morphology

Ends in	Ablative	Example
a	Change 'a' to 'At'	rAmaH + At = rAmAt
i	Change 'i' to 'EH'	hariH + EH = harEH
u	Change 'u' to 'OH'	guruH + OH = gurOH
R	Change 'R' to 'uH'	dAtR + uH = dAtuH
c, j, t, d, n, S, sh, s, h	Append 'aH'	jalamuc + aH = jalamucaH, vaNij = vaNijaH, marut = marutaH, suhRd = suhRdaH, karin = kariNaH*, viSa = viSaH, dvish = dvishaH, vEdhas = vEdhasaH, lih = lihaH

\*if 'naH' follows one of 'ra/sha/R' it will be converted to 'NaH' as per Panini's grammar rule

Table 2.17: Formations of Sanskrit ablatives for feminine genders using reverse morphology

Ends in	Ablative	Example
A	Append 'yAH'	ramA + yAH
i, I	Change 'i/I' to 'yAH'	mati + yAH = matyAH, nadI = nadyAH,
u, U	Change 'u/U' to 'vAH'	dhEnu + vAH = dhEnvAH
R	Change 'R' to 'uH'	svasR + uH = svasuH
c, j, t,	Append 'aH'	vAc + aH = vAcaH, straj =

Ends in	Ablative	Example
d, dh, n, bh, r, v, S, sh, s, h		strajaH, marut = marutaH, Sarad = SaradaH, kshudh = kshudhaH, sIman = sImanaH, kakubh = kakubhaH, gir = giraH, div = divaH, niS = niSaH, prAvRsh = prAvRshaH, bhAs = bhAsaH, upAnah = upAnahaH

Table 2.18: Formations of Sanskrit ablatives for neuter genders using reverse morphology

Ends in	Ablative	Example
a	Change 'a' to 'At'	phalaM + At = phalAt
i, u, R	Append 'naH / NaH*'	Suci + naH = SucinaH, vAri + NaH = vAriNaH*, madhu = madhunaH, guru = guruNaH, dAtR = dAtRNaH
c, j, t, d, n, r, S, sh, s, h	Append 'aH'	suvAc + aH = suvAcaH, asRj = asRjaH, jagat = jagataH, hRd = hRdaH, nAman = nAmaH, vAr = vAraH, tAdRS = tAdRSaH, sutvish = sutvishaH, manas = manasaH, lih = lihaH

\*if 'naH' follows one of 'ra/sha/R' it will be converted to 'NaH' as per Panini's grammar rule

## 2.6 Possessive

- a. In Telugu, 'ki(n), ku(n), yokka, lO(n), lOpala(n)' are the terms used for possessive inflection (Table 2.19). Generally, 'ki(n)' and 'ku(n)' are used interchangeably like 'lO(n)' and 'lOpala(n)'.

Table 2.19: Formations of Telugu possessives

Nominative + Possessive	Example
karra + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (stick)	Karraki / karraku / karrayokka / karralO / karralOpala
pilli + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (cat)	pilliki / pilliyokka / pillilOpala
paTTi + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (strip)	paTTiki / paTTiyokka / paTTilOpala
illu + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (house)	Illuki / illuyokka / illulOpala
kaTTe + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (stick)	kaTTeKi / kaTTeYokka / kaTTeLOpala
rAmuDu + ki(n) / ku(n) / yokka / lO(n) / lOpala(n) (Rama)	rAmuDiki / rAmuDuyokka / rAmuDulOpala

\*if a word is ended with 'Du', then it is changed to 'Di' if it is possessive.

- b. In Sanskrit, reverse morphology is applied (Tables 2.20, 2.21 and 2.22) for various types of nouns to form possessive inflection, based on the gender of the nouns and their ending letters.

Table 2.20: Formations of Sanskrit possessives for masculine genders using reverse morphology

Ends in	Possessive	Example
a	Change 'a' to 'asya'	rAmāH + asya = rAmasya
i	Change 'i' to 'EH'	hariH + EH = harEH
u	Change 'u' to 'OH'	guruH + OH = gurOH
R	Change 'R' to 'uH'	dAtR + uH = dAtuH
c, j, t, d, n, S, sh, s, h	Append 'aH'	jalāmuc + aH = jalāmucāH, vaNij = vaNijāH, marut = marutāH, suhRd = suhRdāH, karin = kariNāH*, viS = viSāH, dvish = dvishāH, vEdhas = vEdhasāH, lih = lihāH

\*if 'naH' follows one of 'ra/sha/R' it will be converted to 'NaH' as per Panini's grammar rule

Table 2.21: Formations of Sanskrit possessives for feminine genders using reverse morphology

Ends in	Possessive	Example
A	Append 'yAH'	ramA + yAH = ramAyAH
i, I	Change 'i/I' to 'yAH'	matīH + yAH = matyAH, nadī = nadyAH,
u, U	Change 'u' to 'vAH'	dhEnuH + vAH = dhEnvAH, vadhUH = vadhvAH,
R	Change 'R' to 'uH'	svasR + uH = svasuH,
c, j, t, d, dh, n, bh, r, v, S, sh, s, h	Append 'aH'	vAc + aH = vAcāH, straj = strajāH, sarit = saritāH, Sarad = SaradāH, kshudh = kshudhāH, sIman = sImanāH, kakubh = kakubhāH, gir = girāH, div = divāH, niS = niSāH, prAvRsh = prAvRshāH, bhAs = bhAsāH, upAnah = upAnahāH

Table 2.22: Formations of Sanskrit possessives for neuter genders using reverse morphology

Ends in	Possessive	Example
a	Append 'asya'	phalām + asya = phalasya
i, u, R	Append 'naH / NaH'	Suchi + naH = SucināH, vAri + NaH = vAriNāH*, madhu = madhunāH, guru = gurunāH, dAtR = dAtRNāH
c, j, t, d, n, r, S, sh, s, h	Append 'aH'	suvAc + aH = suvAcāH, asRj = asRjāH, jagat = jagatāH, hRd = hRdāH, karman = karmaNāH*, vAr = vArāH, tAdRS = tAdRSāH, sutvish = sutvishāH, havish = havishāH, ambhOruh = ambhOruhāH

\*if 'naH' follows one of 'ra/sha/R' it will be converted to 'NaH' as per Panini's grammar rule

## 2.7 Locative

- a. In Telugu, 'aMdu, na(n)' are the terms used for locative inflection (Table 2.23). Generally, 'aMdu' or 'aMduna' is used as inflection and alone 'na(n)' is

given less significance. 'aMdu' becomes 'yaMdu' in word formation.

Table 2.23: Formations of Telugu locatives with examples

Nominative + Locative	Example
karra + aMdu (stick)	KarrayaMdu
pilli + aMdu (cat)	pilliyaMdu
paTTI + aMdu (strip)	paTTIyaMdu
illu + aMdu (house)	IlluyaMdu
kaTTe + aMdu (stick)	kaTTeYaMdu
rAmuDu + aMdu (Rama)	rAmuDiyaMdu

\*if a word is ended with 'Du', then it is changed to 'Di' if it is locative.

- b. In Sanskrit, reverse morphology is applied (Tables 2.24, 2.25 and 2.26) for various types of nouns to form locative inflection, based on the gender of the nouns and their ending letters.

Table 2.24: Formations of Sanskrit locative for masculine genders using reverse morphology

Ends in	Locative	Example
a	Change 'a' to 'E'	rAmāH + E = rAmE
i, u	Change 'i/u' to 'W'	hariH + W = harW, guruH = gurW,
R	Change 'R' to 'ari'	dAtR + ari = dAtari
c, j, t, d, dh, n, bh, r, v, S, sh, s, h	Append 'i'	jalāmuc + i = jalāmuci, vaNij = vaNiji, marut = maruti, suhRd = suhRdi, karin = kariNi*, viS = viSi, dvish = dvishi, vEdhas = vEdhasi, lih = lihi

\*if 'ni' follows one of 'ra/sha/R' it will be converted to 'Ni' as per Panini's grammar rule

Table 2.25: Formations of Sanskrit locative for feminine genders using reverse morphology

Ends in	Locative	Example
A	Append 'yAm'	ramA + yAm = ramAyAm
i, I	Change 'i/I' to 'yAm'	matīH + yAm = matyAm, nadī = nadyAm,
u, U	Change 'u/U' to 'vAm'	dhEnuH + vAm = dhEnvAm, vadhUH = vadhvAm
R	Change 'R' to 'ari'	svasR + ari = svasari
c, j, t, d, dh, n, bh, r, v, s, sh, s, h	Append 'i'	vAc + i = vAci, straj = straji, sarit = sariti, Sarad = Saradi, kshudh = kshudhi, sIman = sImani, kakubh = kakubhi, gir = giri, div = divi, niS = niSi, prAvRsh = prAvRshi, bhAs = bhAsi, upAnah = upAnahi

Table 2.26: Formations of Sanskrit locatives for neuter genders using reverse morphology

Ends in	Locative	Example
a	Append 'E'	phalām + E = phalE
i, u, R	Append 'ni/Ni*'	Suci + ni = Sucini, vAri + Ni = vAriNi*, madhu = madhuni, guru = guruNi*, dAtR = dAtRni*,

Ends in	Locative	Example
c, j, t, n, r, S, sh, s, h	Append 'i'	<i>suvAc + i = suvAci, asRj = asRji,</i> <i>jagat = jagati, ahan = ahani, vAr =</i> <i>vAri, tAdRS = tAdRSi, sutvish =</i> <i>sutvishi, vapus = vapushi, ambhOruh</i> <i>= ambhOruhi</i>

\*if 'ni' follows one of 'ra/sha/R' it will be converted to 'Ni' as per Panini's grammar rule

### 3. Results and Discussions

Since many of the grammar rules are adapted from Sanskrit to Telugu [5], the declensions also have the same structure in Sanskrit. Like Sanskrit, all the inflections form at the end of nouns in Telugu but, the 'vocative' is the only inflection prefixed to the nominative as a separate phrase in Telugu and Sanskrit. Keeping this reason in view, much importance is not given to vocative as an inflection in MT since it can be translated directly. Though majority of regular word formations are discussed, there are some special cases that are not discussed in this paper since they are not in much usage. Along with the above mentioned examples in tables, some more examples viz. 'rAmuDu (lord Rama - rAmaH), kavi (poet - kaviH), gAli (air - vAyuH), cEnu (field - kshEtraM), illu (house - gRhaM), rAtri (night - niSA), bhUmi (earth - bhUmiH), nArI (lady - strI), nIru (water - jalaM), pannu, paMDu (fruit - phalaM), ceTTu (tree - vRkshaH), pAmu (snake - sarpaH), siMhamu (lion - siMhaH), tAbElu (tortoise - kUrmaH), cApa (carpet - kaTaH), cEyi (hand - bAhuH), cEyyi (hand - bAhuH)' etc. are taken as dataset to translate Telugu inflections and translated successfully with more than 98% accuracy.

### 4. Conclusions

A number of cases related to singular noun inflections in Sanskrit and Telugu morphological analysis has been discussed in the paper. Gender is differently handled in both the languages. Inflections in Sanskrit are based on the gender and the ending character of each word. In future it is proposed to take up for singular pronoun inflections as well as dual and plural inflections for both nouns and pronouns in Sanskrit and Telugu morphological analyses.

### References

[1] T. Kameswara Rao, T. Ashok Kumar, Dr. T. V. Prasad, "Handling Plural Forms of Telugu Words in Machine Translation", Proceedings of 3rd ISERD International Conference, Singapore, 31st May 2015, ISBN: 978-93-85465-22-2.

[2] Jasti Suryanarayana, "Sanskrit for Telugu Students", Sri Balaji Printers, 1993.

[3] Madhav M. Deshpande, "A Sanskrit Primer", University of Michigan, 2007.

[4] K. L. V. Sastry and Pt. L. Ananta Rama Sastri, "Sabda Manjari", R. S. Vadhya publishers, 2002.

[5] Kambhampati Ramagopala Krishnamurti, "Telugu Vyaakaranamu", Sri Sailaja Publications, 1991.

[6] T. Kameswara Rao, Dr. T. V. Prasad, "Key Issues in Vowel Based Splitting of Telugu Bigrams", Int. Journal of Advanced Computer Sci. and Applns. (IJACSA), Special Issue on Natural Language Processing 2014.

[7] Srimaddayananda Saraswati, "Panini's - Dhātu pathah", published by Anne Kesavarya Sastri, 1968

[8] Malladi Krishna Prasad, Telugu Vyakaranamu, Victory Publishers, 2002.

[9] Divakarla Venkata Avadhani, "Telugu in Thirty Days", Andhra Pradesh Sahithya Academy, 1976.

[10] K. Srinivasacharyulu, "Sanskrit in 30 days", Andhra Pradesh Sahithya Academy, 1972.

[11] D. G. Koparkar, "Linganusasana of Durgasimha", Deccan College, Puna, 1952.

[12] T. Kameswara Rao, Dr. T. V. Prasad, "Telugu Bigram Splitting using Consonant-based and Phrase-based Splitting", International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 5, No. 5, 2014

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