The IMAGACT4ALL Ontology of Animated Images: Implications for Theoretical and Machine Translation of Action Verbs from English-Indian Languages

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Abstract

Action verbs are one of the frequently occurring linguistic elements in any given natural language as the speakers use them during every linguistic intercourse. However, each language expresses action verbs in its own inherently unique manner by categorization. One verb can refer to several interpretations of actions and one action can be expressed by more than one verb. The inter-language and intra-language variations create ambiguity for the translation of languages from the source language to target language with respect to action verbs. IMAGACT is a corpus-based ontological platform of action verbs translated from prototypic animated images explained in English and Italian as meta-languages. In this paper, we are presenting the issues and challenges in translating action verbs of Indian languages as target and English as source language by observing the animated images. Among the ten Indian languages which have been annotated so far on the platform are Sanskrit, Hindi, Urdu, Odia (Oriya), Bengali, Manipuri, Tamil, Assamese, Magahi and Marathi. Out of them, Manipuri belongs to the Sino-Tibetan, Tamil comes off the Dravidian and the rest owe their genesis to the Indo-Aryan language family. One of the issues is that the one-word morphological English verbs are translated into most of the Indian languages as verbs having more than one-word form; for instance as in the case of conjunct, compound, serial verbs and so on. We are further presenting a cross-lingual comparison of action verbs among Indian languages. In addition, we are also dealing with the issues in disambiguating animated images by the L1 native speakers using competence-based judgements and the theoretical and machine translation implications they bear.

1   Introduction

IMAGACT (see fig. 1) is a multilingual infrastructure for representing the lexical encoding of around 1017 English and Italian action verbs in the first release (Moneglia et al., 2014b). It is a visual ontology of 3d prototypic animated action images of verbs broadly categorized into nine macro-level categories: facial expressions, actions referring to the body, movement, modification of the object, deterioration of an object, force on an object, change of location, setting relation among objects and actions in the inter-subjective space (Moneglia et al., 2014b; Panunzi et al., 2014; Moneglia et al., 2014a). Since action verbs deal with spontaneous speech of real pragmatic contexts, they occur frequently in any speech corpus (Moneglia et al., 2012; Moneglia and Panunzi, 2007). In the second release i.e. IMAGACT4ALL, the competence-based extensions have been extended to incorporate any natural language. Research has already been conducted as to how to make use of the IMAGACT data as an e-learning platform for various languages (Moneglia et al., 2013). Moneglia et al., (2014a) have also explained the annotation of Sanskrit, Hindi and Bengali, the very first Indian languages that have been annotated on the platform. The issues and challenges regarding annotating Urdu action verbs on the said platform have also been discussed in detail by Muzaffar et al, (2016). The theoretical implications have been provided by the research by Panunzi et al., (2014) in which they have discussed about the translation of action verbs from the dictionary of images. The Natural Language Processing (NLP) aspect has been provided by the research conducted by Moneglia (2011) wherein he has pointed out the fact that the variations in action verbs across languages have not been captured by any platform so far and are largely unknown,

but the IMAGACT platform brings out those variations for linguistic disambiguation purposes in Machine Translation (MT).

Figure 1. IMAGACT4ALL Log-in Platform

On this platform, the metalanguages considered for translation of animated actions are English and Italian and later extended to Spanish and Chinese. As reported by Muzaffar et al. (2016), the number (521) of verbs from Italian-English annotated is 515 and translated is 473. Out of the total 550, annotated and translated verbs from English-Italian are 546 and 497 respectively. So far as Italian is concerned, Italian-Chinese out of total 521 verbs, 430 have been annotated and 156 have been translated. In addition, the annotated and translated verbs are 30 and 22 respectively out of 550 verbs from English-Chinese. As far as the Indian languages are concerned, (see fig. 2) Odia, Manipuri and Tamil have 110 number of annotated verbs each and Magahi and Urdu have 100 each respectively. Hindi, Bengali, Sanskrit and Assamese have 149, 210, 256 and 662 annotated verbs respectively whereas Marathi is at the initial stage of incorporation.
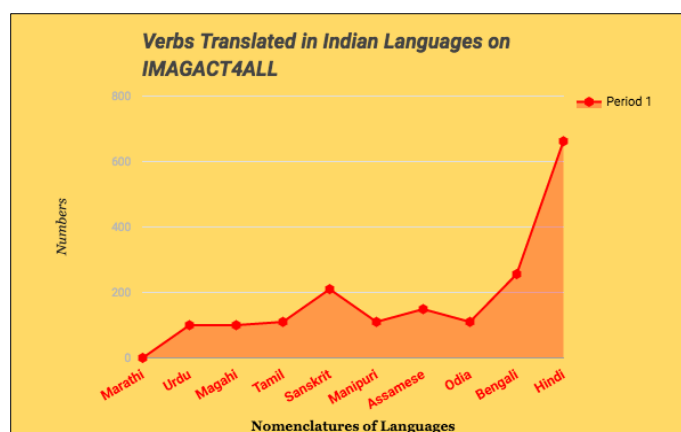

Figure 2. Translated Verb Distribution from English-Indian Languages on the IMAGACT4ALL Platform[2]

1.1 Process of Translation

The process of translation can be comprehended from the very architecture (see fig. 3) of the IMAGACT Platform. The platform contains an ontology of action verbs that are quite frequent in any natural language. Some of the most universally frequent action verbs have been selected for incorporation into the web-based interface. All the actions have been initially annotated in English and Italian as meta-languages. Later, in the IMAGACT4ALL platform the verbs have been extended to Spanish and Chinese. Based on the actions, the verbs have been visually animated and linked by the BabelNet Project[3] for the avoidance of semantic under-determinacy. The gallery of images has been divided into nine macro-level

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[2] As adapted from Jha et al., 2016
[3] http://babelnet.org/

categories to incorporate all the action types. While interpreting the animations for translation purposes the decoder can refer to the annotations in the meta-languages. The decoder must be either a native speaker or an L1 speaker of target language (TL) as all the possible interpretations of the verb have to be captured in the respective TL. He must know any of the meta-languages to appreciate the animation. Finally, the output has to be annotated in any natural TL text considering especially the verbs and their valences. One thing an annotator has to keep in account is that he/she is to annotate the verbs in the present imperfective participle form. The arguments of the verbs especially the nomenclature for the human agent has to be specified as according to the commonly occurring named entities of the given output language.
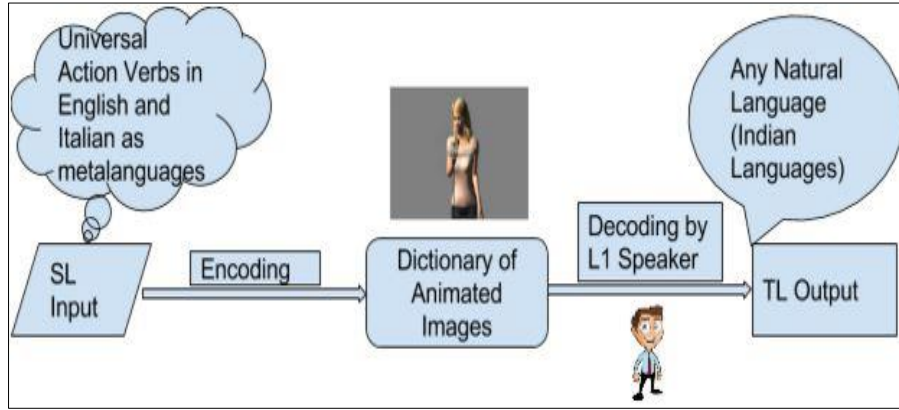

Figure 3. The Architecture of the Translation on the IMAGACT4ALL Platform

For the time being, the process of translation is semi-automated which can be fully automated applying Finite State Automata, applying bilingual corpora of dictionary or any other Machine Learning technique. In this paper, the source language (SL) input considered as the meta-language is English and the TL outputs are in ten Indian languages: Sanskrit, Hindi, Urdu, Odia, Bengali, Manipuri, Tamil, Assamese, Magahi and Marathi. In the following instance (see fig. 4), SL input has been provided in English and Italian and the TL outputs are in ten Indian languages. The input animated image suggests that a lady is hanging her head. Therefore, the input sentence is "Mary hangs her head" which has been translated into Sanskrit as "latA mUrdhAm avanamati/ latayA avashIryate/latA avamUrdhayati", Hindi as "SitA sar jhukAti hai", Urdu as "AfarIna sara jhukAti hai", Odia as "banitA tA muNDaku nuA.Muchi/jhulAuachi", Bengali as "latA mAthA jho.MkAcche/nAmAcche/noyAcche", Manipuri as "Meri makok nonthai", Tamil as "mEri tan talaiyai kIzhE to~ga pOTTaa/~niRkiRaaL", Assamese as "meriYe mura dapiYAiche" and into Magahi as "sitavA muMDI gota ke baiThala halai". So far as the lexical verbal variation is concerned, English has captured two variations as 'hang' and 'drop'. On the other hand, Odia, Bangla and Sanskrit have captured three variations each. Tamil has captured two variations and the rest have annotated one verbal variation each.

2 Typological Features of Verbs in Indian Languages

In South-Asian languages such as Sanskrit, Hindi, Urdu, Odia, Bengali, Manipuri, Tamil, Assamese, Magahi and Marathi and many others, verbs referring to specific actions pose serious problems for NLP and other linguistic tasks. Action verbs that occur spontaneously in day-to-day communication are highly ambiguous in nature from the semantic perspective and consequently cause disambiguation complexities that are really relevant and applicable to Language Technologies (LT) like MT and NLP (Muzaffar et al., 2016).

The Indian languages considered so far for annotation on the IMAGACT4ALL include three language families from the Indian sub-continent region: The Sino-Tibetan, The Dravidian and the Indo-Aryan (IA). Hindi, Sanskrit, Marathi and Magahi use Devanagari script. Assamese and Bengali use Bengali while Manipuri uses both Bengali and Meithei. Odia, Tamil use their own independent scripts whereas Urdu uses Perso-Arabic.

With regard to the typological features, Indian languages have both subject-verb agreement and object-verb agreement. Intransitive dative subject is also one of the typological features used by almost all the Indian languages irrespective of their families. Complex predicates (V+V, N+V & JJ+V constructions) (Subbārāo, 2008 & 2012) are used for expressing a single verb translation in English. Similarly, a large number of verbs owes their genesis from Sanskrit which can be observed from lexicon, grammar and literature of the given language under consideration. Besides, Indian languages have also borrowed words from English, Portuguese and French (Jha et al., 2016).

Figure 4. A Translated Specimen on the IMAGACT4ALL Platform

2.1 Subject and Object Verb Agreement

In Indian languages verbs agree with both the subject and the object; provided some conditions are fulfilled. On one hand, in Hindi (Jha et al., 2014), Urdu (Muzaffar et al., 2015; Muzaffar & Behera, 2014) and Marathi, the oblique (both ergative and non-nominative) sentences generally have object-verb agreement while the ergative marker does not entail to the object-verb agreement in Assamese[4]. The rest of the languages (non-ergative) like Sanskrit, Odia (Jha et al., 2014; Behera, 2015; Ojha et al., 2015), Bengali, Magahi (Atreya et al., 2014), Manipuri and Tamil have non-nominative subjects where verbs agree with the object. Below are some of the sentences of subject-verb agreement in imperfective participle and progressive aspect.

For instance,

(1) (Hindi) rAMa   TopI ko khU.MTI pe laTakA-tA hai
    Ram-3.MSG.NOM. hat PP hook   PP hang-3MSG.IMPFV. is-PRS.
    "Ram hangs the hat on the hook."

(2) (Assamese) meriYe posTAra-khana matak-Aiche
    Marry-3.FSG.ERG poster-CL   roll-3.SG.PROG.PRS.
    "Marry is rolling up the poster."

(3) (Magahi) citThIa   nai likh-ala   jA hai
    Letter-3.FSG.NOM   not write-PASS go is-PRS.
     'Letter is not being written.' (Atreya et al., 2014)

(4) (Odia) dishArI Chabiku Abaddha karuaChi

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[4] Ergativity is non-functional in terms of agreement in Assamese.

Dishari-3.FSG.NOM picture surround do-3.SG.PROG.PRS.
"Dishari is surrounding/wrapping the picture."

(5) (Manipuri) imA-na   haujika cAk thong-li.
my mother-3.FSG.NOM. now meals cook-3.SG.PROG.PRS
"My mother is cooking meals now." (Manjulakshi and Devi, 2013)

2.2 Present Imperfective Participle

In Indian languages the imperfective participles are formed with the addition of inflected phonemes and morphemes (IA languages and Sino-Tibetan) and agglutinated morphemes (Dravidian). In most of the Eastern IA languages, the verbal string for the imperfective participle is one inflected string. For languages like Hindi, Urdu, Magahi and Marathi the string consists of two verbs (main + auxiliary). For Tamil, it is of one string which includes the agglutinated morphemes for PN and TAM features. In the instance below, for Tamil the agglutinated morpheme /ya/ is suggestive of the number, tense and aspect. Similarly, in Odia the /e/ phoneme is referent to the number, tense and aspect. In Hindi and Urdu, the root verb /pa.Dh/ takes /tA/ verbal suffix to express person, number, gender and aspect.

(6) (Tamil) nAna velai cey-ya
I-1.SG.NOM. the work do-SG.PRS.IMPFV.
"I do the work."

(7) (Odia) sItA tAraku mo.De
Sita-3.FSG.NOM wire-ACC bend-SG.PRS.IMPFV
"Sita bends the wire."

(8) (Hindi-Urdu) rAhula kitAba pa.Dha-tA hai
Rahul-3.MSG.NOM. book read-3.MSG.IMPFV is-PRS
"Rahul is reading the book."

(9) (Magahi) gItA apanAra laikabAna para dhiyAna deba haI
Geeta   her children   attention on give-IMPFV be-PRS.
"Geeta pays attention to her children." (Rakesh and Kumar, 2013)

2.3 Complex Predicates

Complex predicates (Subbārāo, 2008, 2012) are one of the interesting phenomena in Indian languages. They encapsulate both the compound and conjunct verbs. The compound verbs are those which comprise of a main verb (compound) or a nominal/adjectival component (conjunct) followed by an auxiliary having the function of an 'intensifier, explicator, operator or vector' (Masica, 1993). According to him and Abbi (1991), the auxiliaries are so called because they explicate the meaning of the complete action bearing the TAM and concord markers.

(10) (Hindi-Urdu) (Muzaffar et al., 2015 & Muzaffar et al., 2016)
Compound (V+ V) /KhA liyA/, /mAra DAlanA/, /de denA/, /to.Da diyA/ etc.
Conjunct (N/JJ + N) /BharosA karanA/, /pariwartana karanA/, /Khusha honA/, /mazabUr honA/ etc.

(11) (Magahi) (Rakesh and Kumar, 2013)
Compound
rAma Chata se gira gelaI (fell down)
"Ram fell down from the roof."
Conjunct
okAr GharwA hama kala sAfa karale (cleaned) haliAI
I cleaned his/her room yesterday."

(12) (Odia) (Jha et al., 2014)
Compound /mAri debA/, /hasi uThibA/, rAgI jibA/, /uThi pa.DibA/ etc.
Conjunct /BharasA karibA/, /duKhI hebA/, /nAca karibA/, /Bhadra hebA/, /saPhA hebA/ etc.

2.4 Dative Subjects

The dative subject (Subbārāo, 2008 & 2012) or the non-nominative subject or the Indirect Construction[5] is the experiencer rather than the nominative or ergative agent in Indian languages. One of the NPs

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[5] Masica uses 'indirect construction' as a term derived from the traditional description.

which is the main candidate for the syntactic role subject gets the dative case. In Bengali, Assamese and Oriya it is also marked by the genitive case in most of the circumstances (Masica, 1993). But from the instance exemplified in the following example (14), it is quite evident that Odia does not apply genitives for expressing dative subject experiencer. Therefore, they should not be confused with each other. According to Masica (1993), 'experience' includes (a) the physical conditions and sensations like feeling cold, feeling sleepy, feeling hungry or thirsty etc., (b) psychological or mental states like liking and perceiving, (c) wanting or needing (d) obligation or compulsion (e) having kinship relations and (f) external circumstances or events that are not controlled by dative subjects.

(13) (Hindi-Urdu) muJha-ko miThAIAM pasanda haiM
I-DAT sweets-3.FSG. like-3.PL.IMPFV.PRS
"I like sweets."

(14) (Odia) mote bhoka lAg-u-Chi
I-DAT hunger-3.SG.NOM feel-3.SG.PROG.PRS
"I am feeling hungry."

(15) (Bengali) amAr triSnA peyeChile (Masica, 1993)
I-GEN thirst-3.SG.NOM drink- 3.SG.PRFV.PST
"I was thirsty."

(16) (Assamese) mora bhoka lAgisil (Masica, 1993)
I-GEN hunger-3.SG.NOM feel-3.SG.PRFV.PST
"I was hungry." Or "I felt hungry."

3 Challenges in Translation of Verbs

When an annotator annotates the verbs observing the dictionary of animated images, they are confronted with some barriers. The barriers are owing to the fact that issues such as ambiguously annotated illustrations, verbal polysemy, affordances, valence and thereby semantic discrepancy persist. Although much care has been taken into account to avoid the semantic discrepancy on the platform, there is still a place for ambiguity. Some of the nomenclatures have been taken from the paper by Muzaffar et al., (2016).

3.1 Ambiguity in Visual Illustrations

When the images themselves are equivocal, ambiguous and misleading they are included in this category. In other words, owing to the fact that the action verbs are wrongly encoded as 3d animations, the L1 annotators are confronted with ambiguity issues which thereby paves the way for disambiguation challenges. If one observes the figure no. 4 above and the below images, the English verbal lemma of which is 'to hang' or 'to drop' has been interpreted with deviant annotations in the SL English. Because hanging, waving and dropping of head bear several semantic, pragmatic and discourse consequences. Therefore, the annotations in Indian languages vary and sometimes they get deviant. Analogously, the instances exemplified in the following section point to the fact that verbs like rotate, spin and turn (refer to section 3.2) have invariably been annotated for all the actions. One can observe that both the images are annotated as 'to hang' and 'to incline' in English that have further been annotated as the Hindi cognates of 'jhukAnA' in other Indian languages. Therefore, in most of the Indian languages the distinction between 'to tilt' and 'to hang' the head is clearly marked.

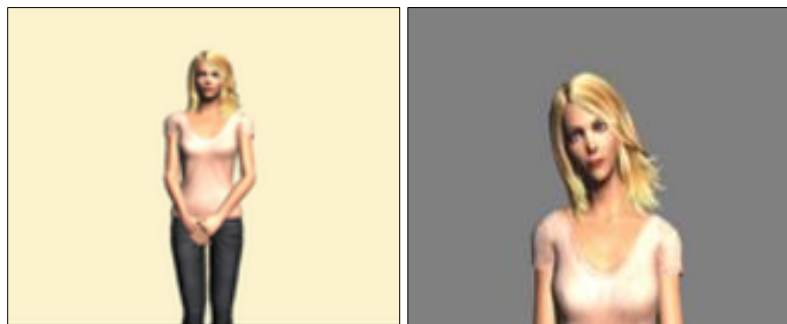Figure 5. Illustrations for 'to hang'

3.2 Verbal Polysemy and Semantic Discrepancy

When one visual illustration of action refers to more than one verb and several animated actions refer to one verbal string they are categorized under this category. This issue behaves as a bottleneck so far as the annotation of actions is concerned for annotators. The verb 'to turn' with the id number 51ad2030 has been interpreted by Indian L1 speakers differently. In Sanskrit, the number of variations (for e.g. arda, shuka, narda, cala, gacha etc.) has amounted to thirty which is due to the over-interpretation and over-generalization by the annotators. The other languages that have captured variations are Hindi (mu.DanA, ghumanA), Urdu (mu.DanA and ghUmanA), Odia (ghuribA, bulibA) and Bengali (ghorA, pherA) with two variations each. The ambiguity arises as all the illustrations suggest a single verbal lemma 'to spin' or 'to rotate' or 'to turn' which is also quite evident from the languages of the Indian counterpart. It is further quite evident in the Italian language itself where 'girare' has been translated from the infinitive 'to turn'.
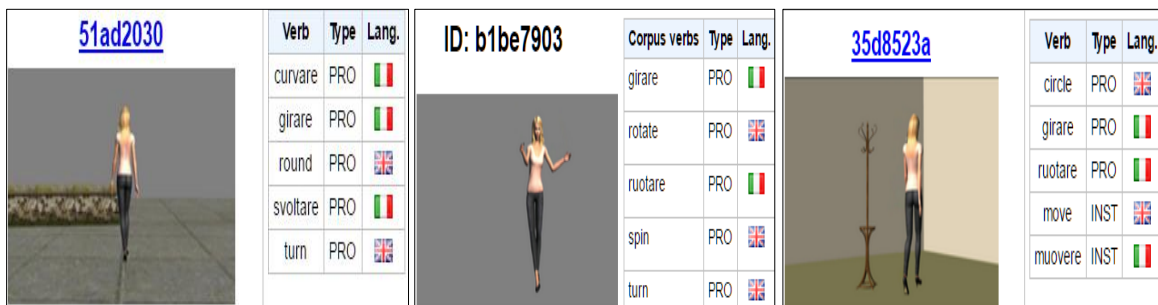

Figure 6. Images for 'to turn'

In all the images illustrated in the following, the sense of 'wiping' has been captured. Thus a single verb 'to wipe' has been used to refer to a series of actions that more or less are equivalent from the perspective of their meaning.
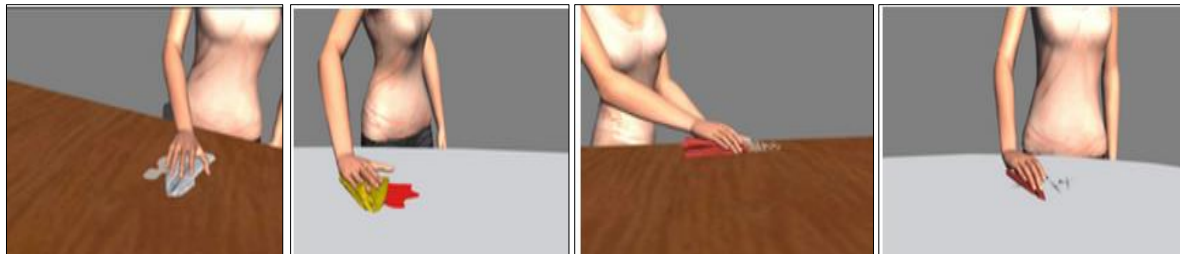

Figure 7. Illustrations for 'to clean'

Similarly, all these below images suggest the English verb 'to roll' or 'roll up' that have been translated differently by Indian languages (as in Hindi-Urdu lu.DhakAnA for the first two images (left-right), mo.DanA for the next two images and ghumAnA for the final two images.

70

Figure 8. Illustrations for 'to roll'

3.3 Affordances

Results demonstrate the fact that pragmatic information (affordances) is more relevant than semantic information in assigning the appropriate interpretation to sentences. The theory of affordances establishes a co-relation between the action and the perception by the annotator (De Felice, 2014). Taking into consideration the affordances like the shape and size of the objects, facial expressions, actions referring to the body, movement, modification of the object, deterioration of an object, force on an object, change of location, setting relation among objects and actions in the intersubjective space (Moneglia et al., 2014b; Panunzi et al., 2014; Moneglia et al., 2014a), verbs can be annotated exactly and all the action images have been categorized on this basis.

On the basis of grasping the shape and size of the objects, grasping has been divided into four major categories (De Felice, 2014): one hand grasp, both hand grasp, grasp with part and grasp with instrument. The first category includes grasping the objects whose size and shape must not exceed two-three fingers as two fingers will be needed to hold them by bending (for example, holding a lighter, a pen etc.). The following category represents grasping the objects not necessarily on the basis of size and shape as it may expand in the case of holding a baby with both the hands. The third category includes the grasping of the objects the size of which exceeding the hand size; as for instance holding a suitcase or any human being. The final division discusses the grasping of the objects that are handled with another recipient. For instance, when we talk of a fluid (water, oil) or solid (ice cubes) substance it is obvious and suggestive of the fact that we are taking assistance of some other instrument. Thus, we are taking the help of a glass (of beers or cubes) or bowl (of milk) as instruments for carrying them. Therefore, an annotator needs to take into account both the semantic and pragmatic knowledge while translating.

3.4 Factors of Verb Selection Preferences

All the actions on the IMAGACT4ALL platform can broadly be categorized into two action types: transitive and intransitive considering the semantic aspect of the language and the valence the verb takes as arguments. Furthermore, the transitive verbs can be classified as mono-transitive and di-transitive verbs. There are several action illustrations that are intransitive and hence one needs to consider the argument of the verb as its forms are dependent on the transitivity of the sentence; especially in Indian languages here.

The verb 'to roll' in the exemplary animations has to be annotated taking into consideration the arguments of the verb. Although there is no change of the verbal string (rolling) of the English annotation, the very information of causation is encoded in the verbal string in Indian languages. So, the annotations for the same string in Hindi-Urdu become 'lu.DhakanA' (intransitive) and 'lu.DhakAnA' (transitive). In Odia 'roll' becomes (ga.Duachi and ga.DAuachi), Sanskrit (ghurNati & ghurNayati), and Assamese (ghurigaiche & ghurAidiche)[6].

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[6] The rest of the examples in Odia, Sanskrit and Assamese follow the same chronological order (intransitive & transitive) as in Hindi-Urdu.
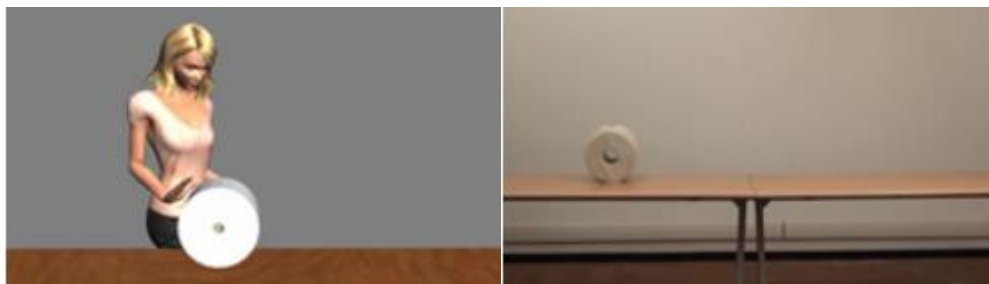
Figure 9. Illustrations for 'to roll' on a Surface

4   Scope and Implications for Theoretical and Machine Translation

The IMAGACT platform generates a huge amount of new horizons of knowledge for Lexicography, Language Typology and Translation Theory (Moneglia, 2011) in linguistics. So far as the theoretical translation is concerned, it bears an enormous amount of consequences as the L1 translator or decoder directly involves in the process of translation. Since the input is provided in both the orthographic annotation and 3d prototypic animated images, there should not be any divergence or discrepancy with respect to translating SL text into the TL. In spite of the encoded text in both the forms there still has some room for ambiguity. All the ambiguities pertaining to both processing of the translation and their interpretations have been provided from different perspectives in the present paper.

With regard to Machine Translation, there are a few points that are noteworthy to be made here. The IMAGACT platform has been a repository of verbs and their animated images. The repository of verbs can be made automated from translating SL text to TL text. This will facilitate the process of automatic translation of verbs without the assistance from the native speaker. Consequently, we are certain that this will provide efficient results as the annotation concerns only present imperfective participle finite verbs. Furthermore, the platform can also be made Text-speech and Speech-text translation among languages belonging to various families. In doing so, the bilingual dictionary of verbs (Panunzi et al., 2014) can play a significant role when we reach at level with fair number of verbal annotation. Although prototypic scenes are not computable objects the verbal database can be exploited to disambiguate which will pave the way for new generation computational tools for MT (Moneglia, 2011). Therefore, this will definitely be quite beneficial for disambiguating action verbs as no any other platform exists which is solely dedicated to action verbs and their translations.

5   Conclusion

In the very introductory section, we have discussed about the IMAGACT platform, the languages that have been annotated so far and the architecture of the process of translation. In the following section, the typological features pertaining to verbs in Indian languages have been discussed in detail. The features such as subject-verb agreement, the present imperfective participle, complex predicates and dative subjects have been provided due emphasis on inter-familial and intra-familial contrast with English and other Indian languages. The third section throws much light on the challenges such as ambiguity in visual illustrations, verbal polysemy and semantic discrepancy, affordances and factors of verb selection preferences. The final section lays emphasis on making the platform an automatic translator of verbs using the annotated bilingual dictionary of verbs.

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