A Game Pidgin Language For Speech Recognition In Computer Games

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ABSTRACT

Today very little progress has been made in the field of Computer Science towards the development of robust Natural Language Processors. Developing a Computer Pidgin Language (CPL) with limited vocabulary and simple set of grammatical rules can be an effective approach to tackle the problem of humans interacting with computers. A CPL [7] is a new spoken language, which is taught to the user and is efficient for dialogues with the computer. In this paper an attempt has been made to develop a Game Pidgin Language (GPL) with limited vocabulary, grammar and syllables for use with speech interactive Computer Games. The GPL is illustrated with a set of vocabulary that is designed to optimise the efficiency of automatic speech recognizer (ASR).

Keywords

Pidgin languages, Information theory, Speech Recognition, Extensible Markup Language.

1. INTRODUCTION

The earliest record of the use of "pidgin" languages dates back to the Middle Ages when the European crusaders and traders of the eastern end of Mediterranean used it. Due to the dominance of French among the crusaders the language was known as *Lingua Franca*, which denotes any language that is used as a medium of communication among people having no other language in common. When a speech community endorses a pidgin language, it becomes a *Creole*. For a language to be pidgin, it must satisfy two conditions [5] –

1) It must have a sharply reduced grammatical structure and vocabulary.
2) The language must be native to none who use it.

The idea for the simplification of natural language has been envisaged for the communication of complex concepts with the help of simple expressions. Currently controlled language applications [e.g., 4, 13] have been developed for computational linguistic. Most controlled languages are for people whose profession is to write and who can be trained in the use of this new language. We attempt to design a language for speech interactive computer games. We use a simplified language because we want to minimize repeated words.

"CPL or Computer Pidgin Language is a radical departure from the normal approach to Speech Recognition Systems. CPL is inspired by a frustration at a perceived lack of progress in Spoken Language Research over the last 20-30 years" [7]. Hinde & Belrose believe that systems that only understand people 85% of the time are hardly usable, so speech recognition is very much a last resort technology or a curiosity. "One of the inspirations for thinking about CPL as an approach to spoken language recognition is observing the evolution of handwriting recognition." [7].

Computer games use 'barks', which is slang developed for the communications between game agents. The GPL we have developed will enhance the group bonding especially in multi-player games.

Speech recognition, or speech-to-text conversion involves capturing and digitising the sound waves, converting them into basic language units or phonemes, constructing words from phonemes, and finally contextually analysing the words to ensure correct spelling for words that sound alike (such as site and sight). The reverse process takes place in Speech synthesis or text-to-speech conversion.

Due to the absence of systematic cues marking word boundaries in continuous speech [2], we will incorporate short but maximum meaning bearing words with minimal syllables and grammatical constraints in the new language. Since Computer Games are primarily a source of fun and entertainment, our attempt is to create funny sounding but quickly memorisable words.

In this paper, we use Information Theory [15] to analyse four aboriginal languages and a sample pidgin language that we have developed.

Our hypothesis in this study is to show that the difference in entropy and perfect information content is minimum and this characteristic makes it rich in vocabulary and simple in grammar.

Information Theory, a branch of probability has two primary goals [3]–

1) Development of fundamental theoretical limits on the achievable performance when communicating a given information source over a given communication channel using coding schemes from within a prescribed class.
2) Development of coding schemes that is reasonably good in comparison with the optimal performance given by the theory.

Entropy provides the information of a random process about itself and measures the information content or uncertainty of 'x'.

Entropy (H(X)) is given by –

Formula - I: $\mathbf{H(X) = -\sum_{x \in Ax} P(x)*Log_2(P(x))}$ [3].

Here an ensemble 'X' is a random variable 'x' with a set of possible outcomes, *Ax* = {a_1, a_2, …… a_i}, having probabilities

$Px = \{P_1, P_2, \ldots\ldots P_i\}$, with $P(x = a_i) = P_i$, where $P_i > 0$ and $\_{x\_Ax}$ $(Px) = 1$.

In our study, *Ax* is a set of distinct words appearing in the paragraph, the set P*x* consists of probability of occurrence of distinct words in the paragraph.

Perfect Information content ($H_0(X)$) is a lower bound for the number of binary questions that are guaranteed to identify the outcome. It is given by –

Formula - II: $\mathbf{H_0(X) = Log_2|\,Ax|}$ [12].

In this paper we have focused on developing a framework of a Computer Pidgin Language (CPL) illustrated with a set of vocabulary for speech interactive computer games. The emphasis of the vocabulary is on having minimum difference between ***Entropy*** and ***Perfect Information*** content of the language. Our endeavor is also to have much lower value of Entropy of GPL than English. We have developed an Extensible Markup Language (XML) called GPLXML to structure our grammar and demonstrated its use with an instance. An XML defines a set of rules, which identifies how we can define tags that separate a document into individual parts and subparts [17].

2. INFORMATION CONTENT IN THE USE OF ABORIGINAL LANGUAGES

There were approximately 200 aboriginal languages in Australia, out of which nearly 100 are in use [1]. The characteristics of Aboriginal languages are [8] -

1) They are rich in vocabulary.
2) Complex words can be formed by compounding, reduplication or by using suffixes.
3) They normally do not have sounds of f, v, s, z and sh.
4) They have terms for every species of animal and plant in their environment.
5) They have elaborate vocabulary in the area of kinship.
6) They have complex syntax and word building processes.
7) They tend to have similar sets of speech sound and share numerous grammatical features but differ greatly in vocabulary.
8) All of them usually have the sounds of p, b, t, d, k and g.

In this paper, our purpose is to focus on information content related to semiotics rather than phonemes. The first four characteristics of Aboriginal languages prompt us to incorporate some of their vocabulary in our GPL along with others inherited from different languages of the world.

Reducing the number of phonemes has considerable advantages for speech recognition. Recent work suggests that languages such as Italian, which are largely phonetic and have fewer phonemes than English, have a much lower rate of dyslexia [6]. For our purposes we can make recognition faster and more robust. However, the focus of this paper is not on the phonetic representation as such, but the semiotic qualities of the pidgin language. There are many ways of calculating the entropy of a block of text. Words have strong serial correlations, which affect the joint entropy. In this first study we have elected to look at word frequencies only.

An example showing the calculation procedure for extracting $H(X)$, $H_0(X)$ parameters are given below, the data is listed in Table 3 –

a) Language 1: English

b) Test paragraph: The Guugu Yimithirr people lived in Northern Queensland, in an area northwest of Cooktown, where Captain Cook first landed in Australia and first met an aboriginal language. So, the first aboriginal language they heard was Guugu Yimithirr. The remaining Guugu Yimithirr live now in Hopevale, and there around 100 speakers of the language left. Names correspond to traditional areas where the features named by colonialists appear in maps.

c) Total number of words: 68

d) Number of unique words: 47

e) Occurrence of distinct words and their probabilities in b) are listed in table-1 -

Table-1

Word	Occurrence	P_i
The	5	0.0735
Guugu	3	0.0441
Yimithirr	3	0.0441
people	1	0.0147
lived	1	0.0147
in	5	0.0735
Northern	1	0.0147
Queensland	1	0.0147
an	2	0.0294
area	1	0.0147
Northwest	1	0.0147
Of	2	0.0294
Cooktown	1	0.0147
where	2	0.0294
Captain	1	0.0147
Cook	1	0.0147
first	3	0.0441
landed	1	0.0147
Australia	1	0.0147
and	2	0.0294
met	1	0.0147
Aboriginal	2	0.0294
language	3	0.0441
So	1	0.0147
they	1	0.0147
heard	1	0.0147
was	1	0.0147
Remaining	1	0.0147
live	1	0.0147
now	1	0.0147
Hopevale	1	0.0147
there	1	0.0147

Around	1	0.0147
100	1	0.0147
speakers	1	0.0147
Left	1	0.0147
Names	1	0.0147
Correspond	1	0.0147
To	1	0.0147
Traditiona	1	0.0147
areas	1	0.0147
features	1	0.0147
named	1	0.0147
By	1	0.0147
colonialists	1	0.0147
appear	1	0.0147
maps	1	0.0147

f) Entropy: 5.32, by applying formula I.

g) Perfect Information: 5.55, by applying formula II.

a) Language 2: Guugu Yimithirr

b) Test paragraph: Guugu Yimithirr herria bizi zen Queensland iparraldean, Australian, Cook Kapitainak lur hartan oina lehenbizikoz jarri zuen tokian. Beraz, hizkuntza hau izan zen Australian zuriek entzun zuten legena. Oraingo Guugu Yimithirr jendea Hopevale deritzon tokian bizi dira, eta hiztunak 100 inguru izan litezke. Gure zerrendako izenak dira eremu tradizionalen izenak, non kolonialistek izendatutako tokiak ageri diren mapetan.

c) Total number of words: 56

d) Number of unique words (UW): 47

e) Occurrence of distinct words and their probabilities in b) are listed in table-2 -

Table-2

Word	Occurrence	P_i
Guugu	2	0.0357
Yimithirr	2	0.0357
herria	1	0.0179
bizi	2	0.0357
zen	2	0.0357
Queensland	1	0.0179
Iparraldean	1	0.0179
Australian	2	0.0357
Cook	1	0.0179
Kapitainak	1	0.0179
lur	1	0.0179
hartan	1	0.0179
oina	1	0.0179
Lehenbizikoz	1	0.0179
jarri	1	0.0179
zuen	1	0.0179
tokian	2	0.0357
Beraz	1	0.0179
Hizkuntza	1	0.0179
hau	1	0.0179
izan	2	0.0357
zuriek	1	0.0179
entzun	1	0.0179
zuten	1	0.0179
legena	1	0.0179
Oraingo	1	0.0179
jendea	1	0.0179
Hopevale	1	0.0179
deritzon	1	0.0179
dira	2	0.0357
eta	1	0.0179
hiztunak	1	0.0179
100	1	0.0179
Inguru	1	0.0179
litezke	1	0.0179
Gure	1	0.0179
Zerrendako	1	0.0179
izenak	2	0.0357
eremu	1	0.0179
Tradizionalen	1	0.0179
non	1	0.0179
Kolonialistek	1	0.0179
Izendatutako	1	0.0179
tokiak	1	0.0179
ageri	1	0.0179
diren	1	0.0179
mapetan	1	0.0179

f) Entropy: 5.49, by applying formula I.

g) Perfect Information: 5.55, by applying formula II.

Analyzing the data of Table 3 to 6, we find that our GPL (table 8) is most suitable as a new pidgin language for games and Guugu Yimithirr is least suitable.

The following tables provide the statistical measures of information in Aboriginal languages [1] based on the principles of Information theory.

In the following tables, UW = unique words; H = entropy; H_0 = perfect information.

Table-3

English				Guugu Yimithirr			
Words	UW	H	H_0	Words	UW	H	H_0
68	47	5.32	5.55	56	47	5.49	5.55

Table-4

English				Arabana-Wangkangurru			
Words	UW	H	H_0	Words	UW	H	H_0
57	47	5.40	5.55	36	33	5.00	5.04

Table-5

English				Dyirbal			
Words	UW	H	H_0	Words	UW	H	H_0
93	68	5.84	6.09	64	57	5.76	5.83

Table-6

English				Yagara / Yugambeh			
Words	UW	H	H_0	Words	UW	H	H_0
59	52	5.63	5.70	49	41	5.26	5.36

3. MODEL OF A PIDGIN LANGUAGE

3.1 GPL Vocabulary

Advantages of GPL in computer games are –

1) The more limited vocabulary and simple grammar makes speech processing across many ethnic backgrounds much easier.
2) Games move fast, and short simple utterances are more appropriate.
3) Peer groups and sub-cultures love to have their own "cool" vocabulary. An extension to the work we discuss will look at adaptive mechanisms for modifying the language by the game players themselves.
4) It has great significance in building the cognitive models for the animats in the game. The mini-language defines the cognitive framework within which they operate and determines also the sophistication (and feasibility) of their world view.

The words in the sample GPL dictionary has been compiled from words in English, Australian Aboriginal languages and some International languages, they are –
Arabic, English, Bengali, Gunyah [14], Hindi, Kamilaroi [11], Portuguese, Russian, Slang English, Wiradjuri [9].

The sample GPL dictionary has the following words –

Here N = noun; Pron = pronoun; V = verb; Adj = adjective.

Table-7

Word	Meaning	Type	Phrase	Source
Ma	I, my, me, myself	N		
Gaba	Man	N		Wiradjuri
Tum	You, your	pron		Hindi
Bingo	Expression of joy	V	Y	English
Fat	Expression of despair	V	Y	
Aka	Master	N		Arabic
Kid	an inferior	N		slang
Goofy	stupid	Adj		slang
Yea	Yes	N		English
Nay	No	N		English
Wa	What, when, where, which, how	V		
Wana	do you want?	V	Y	
Wata	What is it?	V	Y	
Wamba	Who is it/he?	V	Y	Kamilaroi
Wara	Where is/are it/you	V	Y	
Waay	look out	V	Y	Wiradjuri
Birra	move/went away	V		Wiradjuri
Gaja	get away	V	Y	Wiradjuri
Gaa	to take	V	Y	Kamilaroi
Eta	it/he/she is a	Pron		Russian
Bom(b)	Bomb	N		
Buma	to hit, kill	V	Y	Kamilaroi
Samba	dance	N		Portuguese
Jet	Aircraft	N		
Noka	Ship	N		Bengali
Villi	Enemy	N		
Buddy	Friend	N		English
Limbo	trouble	N		slang
Gali	Water	N		Kamilaroi
Kola	drink	N		
Rivi	River	N		
Croc	Crocodile	N		English
Duma	House	N		Russian
Humpy	shelter	N		Gunyah
Dud	dumb, slack	Adj		English
Gubi	swim	V	Y	Kamilaroi
Guju	jump	V	Y	
Gumo	Climb	V	Y	
Zoom	to fly, drive, run, fast movement	V	Y	English
Yami	Food	N		
Yaki	dirty: adj	Adj		
Wee	sit	V	Y	Wiradjuri
Kam	Work	N		
Jumbo	huge	Adj		English
Dagi	to pierce with sharp object	V	Y	
i (é)	Is	V		

The dictionary we have developed is an example that illustrates the idea of developing a Pidgin language for Game play.

3.2 GPL Grammar

The GPL has a very limited set of grammatical rules. It primarily has eight rules –

1) The Sentence may begin with a noun or noun phrase followed by Verb.
2) A Sentence may begin with a Verb Phrase followed by a Noun.
3) An Adjective is a valid sentence.
4) A Noun is a valid sentence.
5) A Verb Phrase is a Valid Sentence.
6) The auxiliary 'i' (é) is added as suffix to a noun that does not end with 'i', 'a' or 'y' sounding alphabet.
7) There is no tense in this language as Computer games are played in real time.
8) The language has no gender.

A valid sentence is any word or phrase that satisfies conditions 1 to 5 and is composed of word or words within the GPL dictionary. A valid sentence may generate a response from the system.

Examples of some GPL sentences:

1) I went home. – Ma birra doma.
2) I had food and water. – Ma yami gali gaa.
3) Shoot the Aircraft. – Jet buma.
4) Jump in the river. – Rivi guju.
5) He is a dumb guy. – Eta dud.
6) A crocodile is swimming in the dirty river. – Kroki gubi yaki rivi.
7) Look out for the enemy. – Waay villi.
8) Gosh! You killed a friend. – Fat! tu buddy buma.
9) Do you want a coke? – Wana kola?
10) Where are the enemy aircrafts? - Wara villi Jet?
11) Run for shelter! – Zoomi humpy!

3.3 Document Type Definition (DTD) of the GPL Grammar

A DTD defines rules for validating an XML document using Backus-Naur-Form grammar to identify, which elements are valid for a particular XML document and which attributes are then valid to be used with each of those elements [17]. The popularity of DTD is due to its ease of development coupled by the availability of more Software's for validating and testing the conformance of XML documents.

The GPLXML we have developed will be used for word recognition. The simple tags will make it easier to synthesize utterances from cognitive models. It has the following DTD -

```
<?xml version="1.0" standalone="yes"?>

<!ELEMENT GPLXML (grammar)>

<!ELEMENT grammar (nouns, verbs, adjectives, pronouns)>

<!ELEMENT nouns (noun)+>

<!ELEMENT noun (word, meaning, feature+)>

<!ELEMENT verbs (verb)+>

<!ELEMENT verb (word, meaning, feature+)>

<!ELEMENT adjectives (adjective)+>

<!ELEMENT adjective (word, meaning, feature+)>

<!ELEMENT pronouns (pronoun)+>

<!ELEMENT pronoun (word, meaning, feature+)>

<!ELEMENT word (#PCDATA)>

<!ELEMENT meaning (#PCDATA)>

<!ELEMENT feature (phoneme, emotion?)>

<!ELEMENT phoneme (#PCDATA)>

<!ELEMENT emotion (#PCDATA)>

<!ATTLIST noun type CDATA #REQUIRED>

<!ATTLIST verb phrase (yes|no) "yes">

<!--"prosody" features as attributes in "emotion", the
       prob attribute provides accuracy in judgement -->

<!ATTLIST emotion pitch CDATA #IMPLIED range CDATA #IMPLIED
prob CDATA #IMPLIED>
```

The GPL DTD has `grammar` as its root node. The `grammar` has `words` along with their `meanings` and `features` classified in `nouns`, `verbs`, `adjectives` and `pronouns`. The `feature` has `phoneme` and `emotion` tags that store `phonetic` representation and `emotion` features of every `word`. The `emotion` tag has the prosody features of `pitch` and `range` inherited from Java™ Speech API Markup Language [16] as attribute along with `prob` that stores the probability of accuracy of judgement of emotion. The `Prob` attribute will provide flexibility of programming to the Game developer.

XML schema definition language (XSD) is a powerful but flexible document definition language that provides control not only over elements and attribute existence, content and order but also specifies when and how elements and attributes can be used along with the content of attribute based on the position of attribute elements within the document hierarchy [17]. The work on XML Schema began in 1999 and got recommendation status in May 2001 [10].

The GPL Schema for the GPL grammar is as follows:

```
<? xml version="1.0" encoding="utf-8"?>
<xsd:schema
xmlns:xsd=http://www.w3.org/2001/XMLSchema>
<xsd:element name="GPLXML">
  <xsd:attributeGroup name="prosody">
    <xsd:attribute name="pitch" type="xsd:string"
```

```
            use=”optional”/>
        <xsd:attribute name=”range” type=”xsd:string”
            use=”optional”/>
        <xsd:attribute name=”prob” use=”optional”>
          <xsd:simpleType >
            <xsd:restriction base=”xsd: nonNegativeInteger”>
              <xsd:minInclusive value=”0”/>
              <xsd:maxInclusive value=”100”/>
            </xsd:restriction>
          </xsd:simpleType >
        </xsd:attribute >
      </xsd:attributeGroup>
      <xsd:complexType>
        <xsd:sequence>
          <xsd:element name=”noun” minOccurs=”1”
              maxOccurs=”unbounded”>
            <xsd:complexType>
              <xsd:sequence>
                <xsd:element name=”word” type=”xsd:string”/>
                <xsd:element name=”meaning”
                    type=”xsd:string”/>
                <xsd:element name=”features” minOccurs=”1”
                    maxOccurs=”unbounded” >
                  <xsd:complexType>
                    <xsd:sequence>
                      <xsd:element name=”phoneme”
                            type=”xsd:string”/>
                      <xsd:element name=”emotion”
                      type=”xsd:string” minOccurs=”1”
                            maxOccurs=”1” >
                        <xsd:complexType>
                          <xsd:attributeGroup
ref=”prosody”/>
                        </xsd:complexType>
                      </xsd:element>
                    </xsd:sequence>
                  </xsd:complexType>
                </xsd:element>
              </xsd:sequence>
                <xsd:attribute name=”type” type=”xsd:string”
                use=”required”/>
            </xsd:complexType>
          </xsd:element>
          <xsd:element name=”verb” minOccurs=”1”
              maxOccurs=”unbounded”>
            <xsd:complexType>
              <xsd:sequence>
                <xsd:element name=”word” type=”xsd:string”/>
                <xsd:element name=”meaning”
                    type=”xsd:string”/>
                <xsd:element name=”features” minOccurs=”1”
                    maxOccurs=”unbounded” >
                  <xsd:complexType>
                    <xsd:sequence>
                      <xsd:element name=”phoneme”
                        type=”xsd:string”/>
                      <xsd:element name=”emotion”
                      type=”xsd:string” minOccurs=”1”
                            maxOccurs=”1” >
                        <xsd:complexType>
                          <xsd:attributeGroup
ref=”prosody”/>
                        </xsd:complexType>
                      </xsd:element>
                    </xsd:sequence>
                  </xsd:complexType>
                </xsd:element>
              </xsd:sequence>
                <xsd:attribute name=”phrase” use=”required“
                  default=”yes”>
                <xsd:simpleType >
                  <xsd:restriction base=”xsd:string”>
                    <xsd:enumeration value=”yes”/>
                    <xsd:enumeration value=”no”/>
                  </xsd:restriction>
                </xsd:simpleType >
              </xsd:attribute>
            </xsd:complexType>
          </xsd:element>
          <xsd:element name=”adjective” minOccurs=”1”
            maxOccurs=”unbounded”>
            <xsd:complexType>
              <xsd:sequence>
                <xsd:element name=”word” type=”xsd:string”/>
                <xsd:element name=”meaning”
                    type=”xsd:string”/>
                <xsd:element name=”features” minOccurs=”1”
                    maxOccurs=”unbounded” >
                  <xsd:complexType>
                    <xsd:sequence>
                      <xsd:element name=”phoneme”
                            type=”xsd:string”/>
                      <xsd:element name=”emotion”
                      type=”xsd:string” minOccurs=”1”
                            maxOccurs=”1” >
```

```
                    <xsd:complexType>
                      <xsd:attributeGroup
ref=”prosody”/>
                    </xsd:complexType>
                  </xsd:element>
                </xsd:sequence>
              </xsd:complexType>
            </xsd:element>
          </xsd:sequence>

        </xsd:complexType>
      </xsd:element>
      <xsd:element name=”pronoun” minOccurs=”1”
           maxOccurs=”unbounded”>
        <xsd:complexType>
          <xsd:sequence>
            <xsd:element name=”word” type=”xsd:string”/>
            <xsd:element name=”meaning”
                 type=”xsd:string”/>
            <xsd:element name=”features” minOccurs=”1”
                 maxOccurs=”unbounded” >
              <xsd:complexType>
                <xsd:sequence>
                  <xsd:element name=”phoneme”
                         type=”xsd:string”/>
                  <xsd:element name=”emotion”
                         type=”xsd:string” minOccurs=”1”
                         maxOccurs=”1” >
                    <xsd:complexType>
                      <xsd:attributeGroup
ref=”prosody”/>
                    </xsd:complexType>
                  </xsd:element>
                </xsd:sequence>
              </xsd:complexType>
            </xsd:element>
          </xsd:sequence>

        </xsd:complexType>
      </xsd:element>
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
</xsd:schema>
```

3.4 An Instance of GPLXML

The instance of GPLXML begins with the *grammar* tag, which has *nouns*, *verbs*, *adjectives* and *pronouns* as sub-nodes. The *nouns* tag has multiple *noun*(s) within it and each *noun* has *type* as attribute along with *word*, *meaning* and *feature* as sub-nodes. There can be more than one *feature* tag per *noun* that stores phonetic representation of the *word* along with its *emotional* content as its sub-nodes. The *emotion* tag has optional attributes of *pitch*, *range* and *prob* to store the *pitch*, *frequency range* and *probability* (of judgement in the estimation of emotional content) respectively. The *verbs* tag has multiple *verb*(s) within it and each *verb* has *phrase* as attribute along with *word*, *meaning* and *feature* as sub-nodes. The rest is similar to that of *nouns* tag. The *adjectives* tag has multiple *adjective*(s) within it and each *adjective* has *word*, *meaning* and *feature* as sub-nodes. The rest is similar to that of *nouns* tag. The *pronouns* tag has multiple *pronoun*(s) within it and each *pronoun* has *word*, *meaning* and *feature* as sub-nodes. The rest is similar to that of *nouns* tag.
An instance that conforms to the GPLXML DTD is given below –

```
<!DOCTYPE GPLXML SYSTEM "GPLXML.dtd">
<GPLXML>
  <grammar>
    <nouns>
      <noun type="proper">
        <word>duma</word>
        <meaning>home</meaning>
        <feature>
          <phoneme> D UW M AH </phoneme>
          <emotion>
                  joy
          </emotion>
        </feature>
      </noun>
      <noun type="common">
        <word> buddy </word>
        <meaning> friend </meaning>
        <feature>
          <phoneme> B AH D IY </phoneme>
          <emotion>
                joy
          </emotion>
        </feature>
      </noun>
    </nouns>
    <verbs>
      <verb phrase="yes">
        <word>wata</word>
        <meaning>what is it</meaning>
        <feature>
          <phoneme>HH W AH T . IH Z . IH T
          </phoneme>
          <emotion prob="90">
                Anger
```

```
        </emotion>
      </feature>
    </verb>
    <verb phrase="no">
      <word>i</word>
      <meaning>is, was</meaning>
      <feature>
        <phoneme>IY</phoneme>
      </feature >
    </verb>
  </verbs>
  <adjectives>
    <adjective>
      <word>jumbo</word>
      <meaning>huge</meaning>
      <feature>
        <phoneme>JH AH M B OW</phoneme>
        <emotion prob="80">
              astonishment
        </emotion>
      </feature>
    </adjective>
  </adjectives>
  <pronouns>
    <pronoun>
      <word>tu</word>
      <meaning>you</meaning>
      <feature>
        <phoneme>T UW</phoneme>
        <emotion>
              anger
        </emotion>
      </feature >
    </pronoun>
  </pronouns>
 </grammar>
</ GPLXML>
```

3.5 INFORMATION CONTENT OF GPL

Since the use of GPL is in short bursts, we have analyzed the examples of section 3.2 to extract the value of Entropy and perfect information of English and GPL.

Favorable values of the measures of information theory for GPL are as follows –

1. Lower value of perfect information and hence unique words in GPL over its English equivalent.
2. Lower value of entropy in GPL over its English equivalent.
3. Lower difference between the values of perfect information and entropy of GPL.

The values are listed in Table 8. From the table we can see that only 30 words of GPL can be used to convey the same information expressed by 52 words in English, resulting in lower value of Entropy of GPL over English. This signifies substantial reduction in grammar in GPL over English. We also find that the ratio of perfect information of GPL to English is less than 1 and the unique words (UW) to Words ratio is much higher in GPL than English, implying that the core of GPL lies in its vocabulary, which is one of the desired criteria.

Table-8

English				GPL			
Words	**UW**	**H**	**H_0**	**Words**	**UW**	**H**	**H_0**
52	38	5.05	5.25	30	27	4.71	4.75

The requirements of the game are for rather short utterances, where we would like to have a significant semiotic weight carried by every word. Thus the entropy should approach the maximum value where every word contributes to an utterance with equal probability. We show some examples of typical utterances and calculate the corresponding entropy. Note that we do not use all of the words of our vocabulary, but use this to demonstrate the procedure by which we measure word independence.

4. CONCLUSION

1) Both AL's and have low values of $H_0(X)$ and $H(X)$ and hence number of unique words as compared to English for expressing the same information, thus we can express more information with minimum number of words by both AL and GPL.
2) Low differences in the values of $H_0(X)$ and $H(X)$ in AL's and GPL shows that both AL's and GPL are rich in vocabulary.
3) The extremely low values and difference between $H_0(X)$ and $H(X)$ of GPL over English signifies minimal grammar and richness in vocabulary of GPL.

We have shown in this paper how a CPL with small vocabulary with cues from aboriginal and other languages can be used to develop a GPL. Although much work is needed to be done in generating a cross continental, socio-culturally acceptable vocabulary, we believe that GPLXML will be sufficient for representing the grammar of GPL. The limitation of analysis of a language with Information theory is that it is silent about the characteristics and complexity of vocabulary in that language, hence we have focused on developing a limited set of vocabulary with least number of syllables that is bound by simple and non-rigid grammatical rules for use with speech interactive Computer Games.

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