Analysis of Conversational Game Pidgin Language

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Abstract-- **In this paper we analyze a new language called Game Pidgin Language (GPL) for speech interactive computer games. We use two formulas namely entropy and perfect information of Information Theory to perform the analysis. We establish that GPL is an efficient language for communication in real time speech interactive systems.**

***Index Terms*— GPL , Information Theory, Pidgin**

I. Introduction

The idea of Game Pidgin[1] Language (GPL) [2], [3] is an abstraction from the concept of Computer Pidgin Language (CPL), which has been conceived due the lack of progress in the development of natural language processors [4]. CPL is a spoken language with limited vocabulary and simple set of grammatical rules that can be an effective approach to tackle the problem of humans interacting with computers.

Although ignored by the academic community in the past, the field of Games Technology has now attained legitimacy in scholarly enquiries [5]. Computer games are the most popular means for edutainment today According to the Department of Trade and Industry, DTI [6], one of the most exciting and fast-growing sectors in digital content is the Games Industry. Buoyed by the availability of dedicated software personnel and robust software tools supported by high-speed computers and peripherals at affordable prices, the industry is all set to overtake the film industry in a couple of years. Today millions of dollars are spent on developing a computer game.

The paper is organised as follows – In the second section we argue the necessity for incorporating speech and emotion in games. In the third section we devote a section on natural language processing. In the fourth section we discuss the role of Information Theory in defining the efficiency of language. In the fifth section we analyse English, Papua New Guinea (PNG) Pidgin and a sample GPL. In the sixth section we tabulate the results. Finally we have the conclusion.

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II. Speech and emotion in GPL

The main aim of GPL is to capture verbal contents of game players along with its emotional content and generate an appropriate response. Today all major Game platforms have speech interfaces and ship with headsets. We believe that a game can be made more realistic if the game player is allowed to communicate with the characters in the game and vice versa. According to Rudra et al [3], there can be two types of speech communication –

1. *Active communication*: it takes place between the Game payer and the game characters and vice versa. Here the game players can change the flow or direction of the game by issuing vocal commands with the game characters.
2. *Passive communication*: it takes place between the Game characters. Here the communication takes place between the game characters only.

Emotion enters computer games both from the side of the human player and from the non-player characters (NPCs) in the game itself. The reasons for putting emotion in games are they get better player buzz, higher praise in the press and the development team put more passion into their work [7]. According to de Rosis and Graso, F [8], the field of human computer interaction would be immensely benefited if computers could express bad news with apparent empathy and sympathy. Internet chatting becomes more enjoyable with the display of appropriate emotion tags along with text [9]. Dealing with speaker's emotion is one of the latest challenges in speech technologies [10] and identification of speaker's emotional state is one of the natural goals of research on vocal expression of emotion [11]. Research of emotions in speech primarily deals with the search for acoustic features of speech that distinguish a number of emotional states [12]. Emotions are known to be carried in two ways, firstly via emotional expressions and secondly via expressivity, that is by using linguistic structures [13]. The GPL grammar [2] has a tag for incorporating the neutral emotional content of a word.

III. Natural Language Processing

Language is the manifestation of species-specific cognitive propensities and is regarded as the consequence of the biological peculiarities that make a human type of cognition possible [14]. Modern linguists concentrate on the details of sentence structure based on a grammatical theory in their study of Natural language (NL); here the grammar consists of syntactic or semantic rules, supports linear processing and is restricted to individual sentences. An essential part of Natural Language Processing (NLP)

analysis is the segmentation and classification of linguistic data into structures or phrases to determine the meaning of the sentence. The methodology of NLP consists of developing a theory, programming it and test the theory. For a natural language to be processed by the computer, we need efficient Natural Language Interfaces (NLI). The function of the NLI is to mediate primarily between the user and the application program [15].

A basic NLP have the following phases - lexical analysis, syntactic analysis, semantic analysis and pragmatic analysis. The major tasks of NLP are [16]:

1. Reading the input sentence and extracting the words.
2. Looking up words in the dictionary.
3. Identifying the sentence structure in the input sentence.
4. Identifying semantic items in the input sentence.
5. Generating a response.

The process of understanding a sentence begins with analyzing the syntactic qualities of a sentence. The complexity of a sentence decides the amount of processing to be done. Identifying phrases is a challenge in NLP. A phrase consists of one or more adjacent words that have names, which reflects the types of words they contain. As an example, the single word "sings" is a verb phrase so are the two words "is singing". A sentence may often contain more than one phrase, which needs to be recognized by dissecting it into their component phrases and further into their component words.

There are four principal types of phrases:

1. Noun Phrase
2. Verb Phrase
3. Adjective Phrase
4. Prepositional Phrase

A noun phrase is a combination of nouns, pronouns, adjectives or determiners. A verb phrase is a syntactic combination of verbs, adverbs or auxiliaries. An adjective phrase is a syntactic combination of adverbs or adjectives. A prepositional phrase is a syntactic combination of preposition and noun phrases.

The context-free-grammar (CFG) for the GPL can be given as follows –

S → NP-V | VP-N | VP

S → A | NP | PP

PP → P-N

Here S signifies a valid sentence, NP signifies noun phrase, VP signifies verb phrase, PP signifies preposition phrase, N signifies noun, V signifies verb, A signifies adjective and P signifies preposition.

Syntactic analysis is restricted to the identification of phrases and word types of a sentence. It is then the job of semantic analyser to decipher the meaning of the words so that the sentence can be understood and an appropriate response be generated. Semantic analysis performs two specific functions:

1. Identification of the meaning in the sentence.
2. Mapping the meaning into knowledge base, which contains the meaning in the sentence.

According to Suereth [17], there are basically ten semantic items to be considered by conversation processor, they are - Manner, reason, description, definition, direct object, indirect object, time, place, action, subject.

Pragmatic Analysis is the way a conversational processor handles questions. There are seven types of questions – who, what, where, when, why, how and which.

IV. Information Theory and Languages

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 [17] is a branch of probability, it has two primary goals [18] –

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: $\mathbf{H(X) = - \Sigma_{x \epsilon Ax} P(x)*Log_2(P(x))}$ [18]. – (1)

Here an ensemble 'X' is a random variable 'x' with a set of possible outcomes, $Ax = \{a_1, a_2, \ldots\ldots a_i\}$, having probabilities $Px = \{P_1, P_2, \ldots\ldots P_i\}$, with $P(x= a_i) = P_i$, where $P_i > 0$ and $\Sigma_{x \epsilon Ax} (Px) = 1$.

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: $\mathbf{H_0(X) = Log_2| \mathit{Ax}|}$ [19]. – (2)

Favorable values of the measures of information theory for GPL are as follows (Rudra et al, 2003) –

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.

V. Analysis of Languages

In this paper, we use Information Theory to analyse the efficiency of English, PNG Pidgin and a sample GPL that we have developed. PNG is renowned for having over 700 languages spoken by its four million people. The two colonising powers in PNG spoke German and English, and those two languages gave rise to a Pidgin language [20]. We analyse the Entropy and Perfect Information content of

three languages based on an email reply. The languages are English, PNG pidgin and GPL.

English
Thank you for the email. I was happy to receive it.
I am sorry for not replying earlier.
How are you? Hope you are fine.
Where do you belong?
I belong to Manus Province, Papua New Guinea.
I work for the University of Papua New Guinea.
Prof. Kevin Wilkins is my very good friend.
I want to go to the market.
I want to sleep now.

PNG Pidgin
Tenkyu yu salim email long mi. Mi hamamas tru.
Sori mi no bekim ariap.
Olsem wanem, yu orait tasol.
Yu belong we?
Mi belong Manus Province, Papua New Guinea.
Mi wok long University bilong Papua New Guinea.
Prof. Kevin Wilkins i gutpela friend na brother bilong be tru.
Me laik go long market.
Mi laik silip nau.

GPL
Tenkyu email í. Happy get í.
sorry late.
Hawa? Hope Fine.
Wara belong?
Belong Manus Provinice, Papua New Guinea.
Wok University Papua New Guinea.
Buddy Prof. Kevin Wilkins.
Go market í.
Wana moi.

The word belong is spelled bilong in PNG pidgin.

VI. RESULTS

The following tables provide the statistical measures of information in the above languages based on the principles of Information theory and the formulas (1) and (2) of section IV. The joint entropy provides the co-relation between two languages.

In the following tables, UW = unique words; H = entropy; H_0 = perfect information. The values are rounded to three digits after decimal.

Table 1

English				PNG Pidgin			
Words	UW	H	H_0	Words	UW	H	H_0
65	46	5.292	5.524	56	41	5.180	5.358

Joint Entropy = 5.917

Table 2

English				GPL			
Words	UW	H	H_0	Words	UW	H	H_0
65	46	5.292	5.524	32*	27	4.664	4.755

Joint Entropy = 5.628

Table 3

PNG Pidgin				GPL			
Words	UW	H	H_0	Words	UW	H	H_0
56	41	5.180	5.358	32*	27	4.664	4.755

Joint Entropy = 5.575

*Including í of GPL

The lower difference in H and H_0 of GPL signifies extremely low grammatical constraints as compared to both English and PNG pidgin. GPL uses very few words as compared to both English and PNG pidgin. The joint entropy for English and GPL as well as PNG pidgin and GPL are less than perfect information of the combined languages. H_0 of combined language can be calculated by $Log_2 (UW_{L1}+UW_{L2})$, where L1 and L2 are languages 1 and 2 respectively. This shows that GPL is related to both English and PNG pidgin. There can be a closer co-relation between GPL and English if we replace the English words with synonyms.

VII. CONCLUSION

Our Aim in this paper is to have a closer co-relation between English and GPL in both pronunciation and vocabulary. Since the vocabulary will be game specific, it will be upto the game developers to populate the XML [2] with actual data. Through the experiment we were able to show that GPL has low H_0 and H than both PNG pidgin and English, which is a desirable criteria for real time speech interactive systems.

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