

Two-Dimensional Visual Language Grammar*

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Abstract. Visual language refers to the idea that communication occurs through visual symbols, as opposed to verbal symbols or words. Contrast to a sentence construction in spoken language with a linear ordering of words, a visual language has a simultaneous structure with a parallel temporal and spatial configuration. Inspired by Deikto [5], we propose a two-dimensional string or sentence construction of visual expressions, i.e. spatial arrangements of symbols, which represent concepts. A proof of concept communication interface has been developed, which enables users to create visual messages to represent concepts or ideas in their mind. By the employment of ontology, the interface constructs both the syntax and semantics of a 2D visual string using a Lexicalized Tree Adjoining Grammar (LTAG) into (natural language) text. This approach captures elegantly the interaction between pragmatic and syntactic descriptions in a 2D sentence, and the inferential interactions between multiple possible meanings generated by the sentence. From our user test results, we conclude that our developed visual language interface could serve as a communication mediator.

1 Introduction

Skills at interpreting visual symbols play an important part in humans' learning about the world and understanding of language. Words are also composed by symbols, of course. There are nonverbal symbols that can provide essential meanings with their succinct and eloquent illustrations. Humans respond to these symbols as messages, though often without realizing exactly what it is that has caused us to reach a certain conclusion. Such symbols are often visual, though they can be auditory or even tactile. The research described in this paper concentrates on visual nonverbal symbols. In particular, it focuses on exploring such symbols to represent concepts, i.e. objects, actions, or relations.

According to [15], human communication involves the use of concepts to represent internal models of humans themselves, the outside world and of things with which the humans are interacting. In earlier work, we have investigated a language independent communication using visual symbols, i.e. icons [8], based on signs and symbols, which are understood universally [15]. As a proof of concept, an iconic interface has been developed in a specific domain. It is applied on a communication interface on PDAs in crisis situations. In such situations, wired communication could be disabled by the breakdown of the infrastructure or information overload and speech communication is difficult due to noisy

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environments. Visual language has been used successfully in human-computer interaction, visual programming, and human-human communication. Words are easily forgotten, but images stay in our minds persistently [6]. Therefore, icons can evoke a readiness to respond for a fast exchange of information and a fast action as a result [14]. Furthermore, a direct manipulation on the icons allows us to have a faster interaction [11].

A visual (communication) language uses a set of spatial arrangements of visual symbols with a semantic interpretation that is used in carrying out communication [3]. This language is based upon a vocabulary of visual symbols where each symbol represents one or more meaning, which are created according to the metaphors appropriate for the context of this type of languages. The sentence structure of a visual language is different from a sentence in spoken language [12]. The spoken language is composed by a linear ordering of words, while a visual language has a simultaneous structure with a parallel temporal and spatial configuration, e.g. the sign language syntax for deaf people [1], comic illustrations [4], diagrams. Based on this, we propose a two-dimensional syntax structure that enables a visual language sentence constructed in a 2D way.

2 Related Work

The approach described in this paper basically is inspired by Deikto, a game's interaction language [5]. The creator aimed at producing the smallest language capable of expressing the concepts used in the story world. A sentence in Deikto is represented by a connected acyclic graph, where a predecessor element explains its successor. A graph element can be a lexicon or another clause. To help the players, the game provides hints of what lexicon(s) can be selected based on its word class. Deikto follows a rigid grammar by assigning each verb the parts of the sentence in its dictionary definition. This revolving verb approach is supported by Fillmore's case grammar [7] and Schank's conceptual dependency theory [17]. In case grammar, a sentence in its basic structure consists of a verb and one or more noun phrases. Each phrase is associated with the verb in a particular case relationship. The conceptual dependency defines the interrelationship of a set of primitive acts to represent a verb. The approach employs rules and a set of primitive acts, e.g. ATRANS: transfer possession of an object. Instead of using the word class (e.g. subject, verb, object), both approaches use thematic roles, e.g. agent, patient, instrument, etc, to define a sentence structure.

VIL, a one-dimensional visual language application [13], is designed to allow people to communicate with each other by constructing sentences solely relying on icons. The system is based on the notion of simplified speech by reducing a significant complexity. It is also inspired by the case concept of Fillmore and the verb classification of Schank.

In the following sections we will give an overview of the 2D visual language we propose. Further, we will concentrate on the visual sentence construction and conversion to text or speech as well as a proof of concept visual language interface we have developed. Finally, we also present our test results.

3 Two-Dimensional Visual Language

According to [1], the syntax analysis of the visual language does not reduce to classical spoken sentence syntax. There exists a set of "topic" and "comment" relations, in which a