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TRANSLATING TERMS OF THE FUNCTIONAL BASIS INTO BIOLOGICALLY MEANINGFUL KEYWORDS

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ABSTRACT

Biology has long been recognized as an excellent source of analogies and stimuli for engineering design. Previous work focused on the systematic identification of relevant biological analogies by searching for instances of functional keywords in biological information in natural language format. This past work revealed that engineering keywords couldn't always be used to identify the most relevant biological analogies, as the vocabularies between biology and engineering are sufficiently distinct. Therefore, a method of identifying biologically meaningful keywords that correspond to engineering keywords was developed.

Here, we apply and refine this method by generating biologically meaningful keywords for the terms of the Functional Basis, which is widely accepted as a standardized representation of the functionality of engineering products.

We present insights gained on the selection of biologically meaningful keywords for the function sets based on semantic relations. We then observe the use of our keywords by providing 4th year undergraduate design students with the biologically meaningful keywords that are related to the desired functions of their design projects.

1. INTRODUCTION

Biomimetic design involves the use of biological phenomena as inspiration for solving engineering problems. Humans have borrowed many ideas from biology to innovate and solve problems: from studying birds to invent flying mechanisms to mimicking human body parts for various mechanical applications. Many of these ideas were based on chance observation or preexisting knowledge of biological phenomena. That is, while solving engineering problems, engineers perceived or recollected certain biological phenomena and connected two domains to generate solutions.

Despite the many successful examples of biologically inspired design that resulted as described above, we believe that engineers can take more full advantage of the vast amount of biological knowledge sources already in existence. Such sources are quickly expanding, especially at the molecular and cellular levels of biological organization (Rebholz-Schuhmann et al., 2005). Having access to such knowledge rather than being limited to one's own existing knowledge of biology is likely to result in more novel and useful concepts.

To take advantage of the large amount of biological information already in natural language format, e.g., texts, papers, etc., our approach is to directly search such information for occurrences of keywords that describe the intended function of engineering designs. However, past work revealed obstacles based on differences in lexicons between the domains of engineering and biology, i.e., words widely used in engineering might be used uncommonly or in different senses in biology (Chiu & Shu, 2005). Many match results thus may not be relevant and helpful for engineers. Therefore, a retrieval process was developed that finds biologically meaningful keywords corresponding to engineering keywords based on natural language analysis.

This method is adapted and refined here to generate biologically meaningful keywords that correspond to terms of the Functional Basis developed by Stone & Wood (2000). The Functional Basis has been widely accepted as a standardized set of engineering terms used for functional modeling.

The biologically meaningful keywords we generate serve as a thesaurus for the function set. Once engineers model a problem using terms of the Functional Basis, the corresponding

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