

國立清華大學工業工程與工程管理學系研究所

Utilizing text mining technique to support design automation

利用文字探勘進行自動化設計

學生：林孔昭、陳易妘、林昕翰、林芷亘
指導教授：邱銘傳 教授

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國立清華大學工工系 工程一館R705室

Outline

- **Introduction**
- **Literature Review**
- **Methodology**
- **Case Study**
- **Conclusion**

Introduction

- With the rapid expansion of Web2.0, more and more people express their views and comments about products online.



Research Question

- To understand customer requirement and keep up with trends, enterprises need to find out helpful information from online reviews.
- However, popular products can get hundreds of reviews, therefore designers often spend a lot of time on identifying customer needs.

Research Question

**A design automation system
to speed up product
development process**

Literature Review

- **Text Mining**
- **Design Automation**
- **Design Informatics**



Literature Review

Text Mining

- Text mining is a technique for knowledge discovery from unstructured texts, firstly introduced by Feldman and Dagan (1995).

Literature Review

Design Automation

Design automation allows the computer to compute the recalculations and the remodeling that engineer-to-order manufacturers can complete in days of custom engineering in just minutes, saving cost and lead time.

Literature Review

Design Informatics

Design informatics is a designing method using structure, behavior, and interactions. It focus on designing with the collected data. We can see design informatics as a method that can make a difference through computational design, and improve things.

Methodology

Customer Review Gathering

1. Download online reviews from forums
2. Remove noise and stop words

Information Analysis

1. Tag part-of-speech (POS) for each words
2. Identify the semantic orientation for each words and review sentences
3. Generate component-review table and mapping table

Conceptual Design Generation

1. Visualize the design

Methodology

Customer Review Gathering

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2. Remove noise and stop words

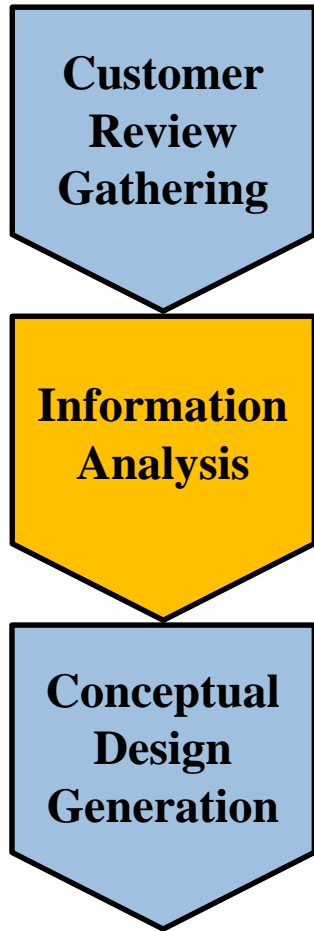
Information Analysis

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Conceptual Design Generation

1. Visualize the design

Methodology



- The part-of-speech (POS) tags are generated manually for each review sentence.
- In practice, product and component features are usually nouns or noun phrases in review sentences.
- The opinions and feelings are usually presented as adjectives.

Methodology

Customer Review Gathering

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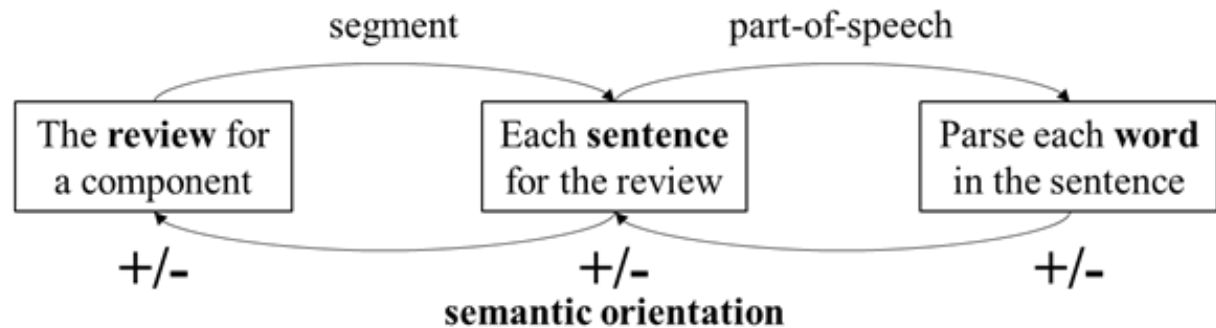
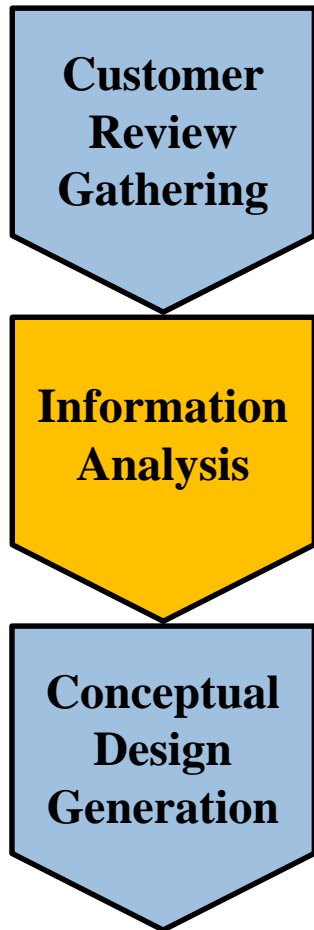
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Methodology

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Conceptual Design Generation

1. Visualize the design

Methodology

Customer
Review
Gathering

Information
Analysis

Conceptual
Design
Generation

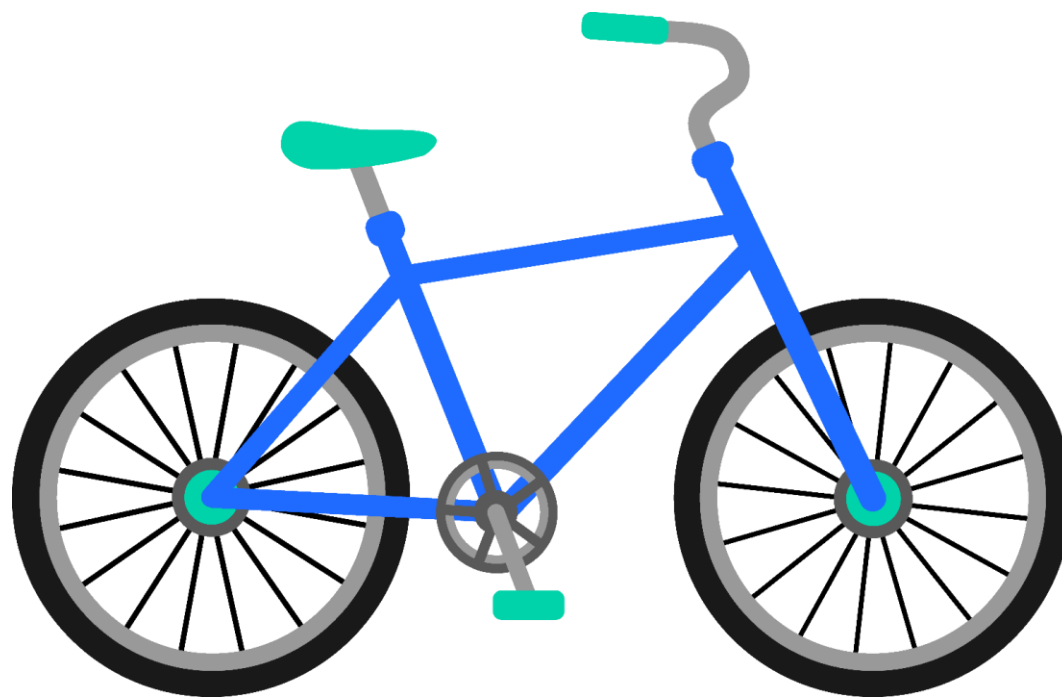
		Number of Sentences	Positive	Negative	Score
Component _A	Brand _a	100	30 <individual review sentences>	5 <individual review sentences>	25
	Brand _b	70	20 <individual review sentences>	30 <individual review sentences>	-10

Methodology



At the present stage, we only hand-painted the final concept design layout. We leave the combination with the result of text mining and CAD software, such as Solidworks, to our future work.

Case Study



Case Study

Phase 1. Customer Review Gathering

Download online reviews from forums

- Four products of Giant road bikes are selected: FastRoad Comax 1, FastRoad Comax 2, Escape 3 and AnyRoad Comax.
- The reviews are collected from Mobile01.

Case Study

Phase 1. Customer Review Gathering

Remove noise and stop words

- Moreover, a review consists of many sentences, to divide a review into several sentences, we set period and comma as a stop point.
- Thus, after using stop point to divide reviews, here are 91 sentences for subsequent analysis. The subsequent analysis is implemented sentence by sentence.

Case Study

Phase 2. Information Analysis

Tag part-of-speech (POS) for each words

- Each key component on a bike is classified into 14 categories: frame, fork, color, handlebar, stem, transmission system, brake, chain wheel, freewheel, chain, rims, tires, saddle and seat post.
- If a noun or a noun phrase is likely to denote one of components, it is tagged as “key component”.

Case Study

Phase 2. Information Analysis

Identify the semantic orientation for each words and review sentences

In practice, an adjective is easy to identify. However, a key component is possible presented in different words. For instance,

“GIANT D-Fuse Composite is awesome.”

In this sentence, “D-Fuse Composite” is a noun phrase and “Awesome” is adjective.

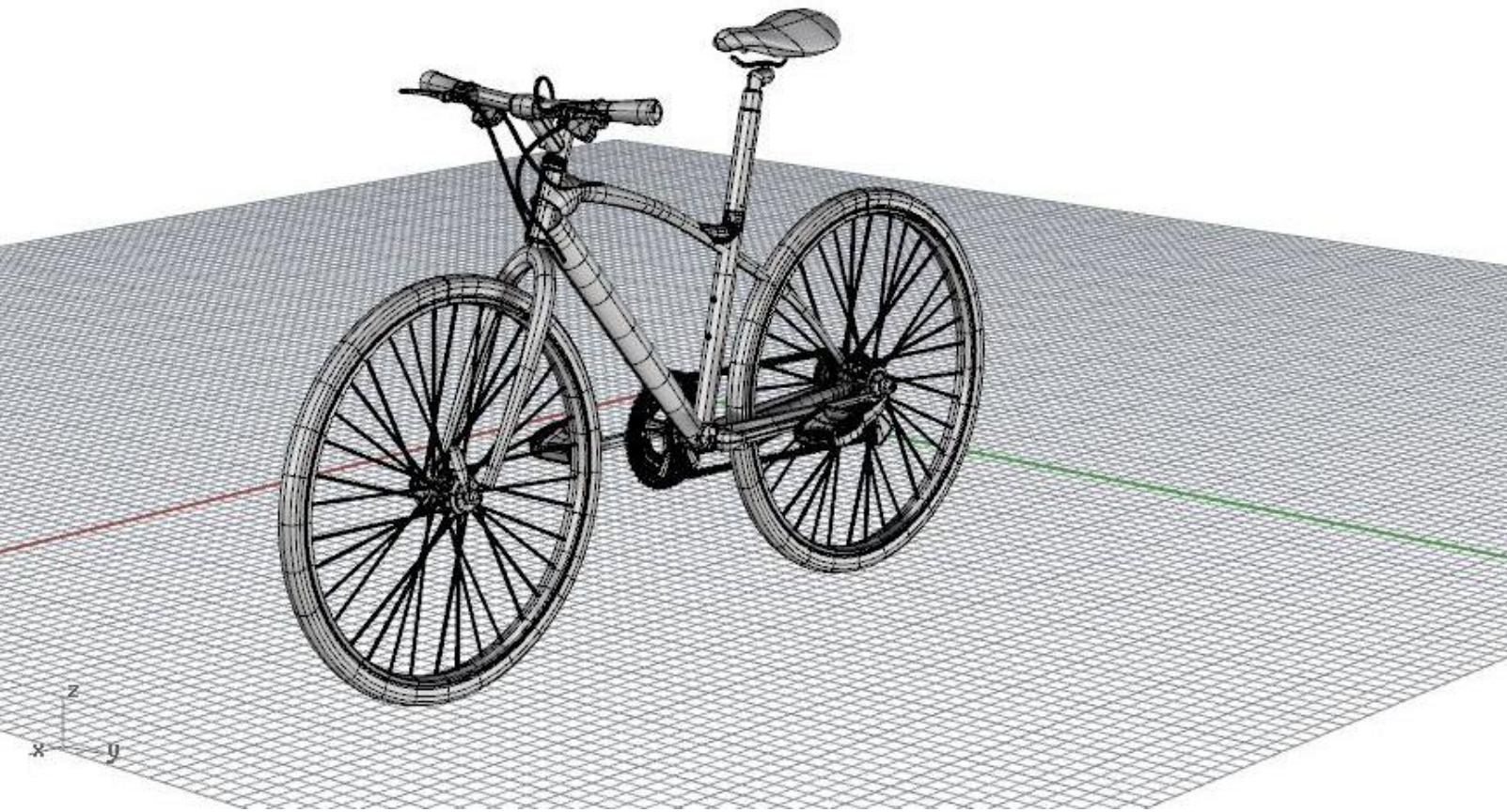
Case Study

Generate component-review table and mapping table

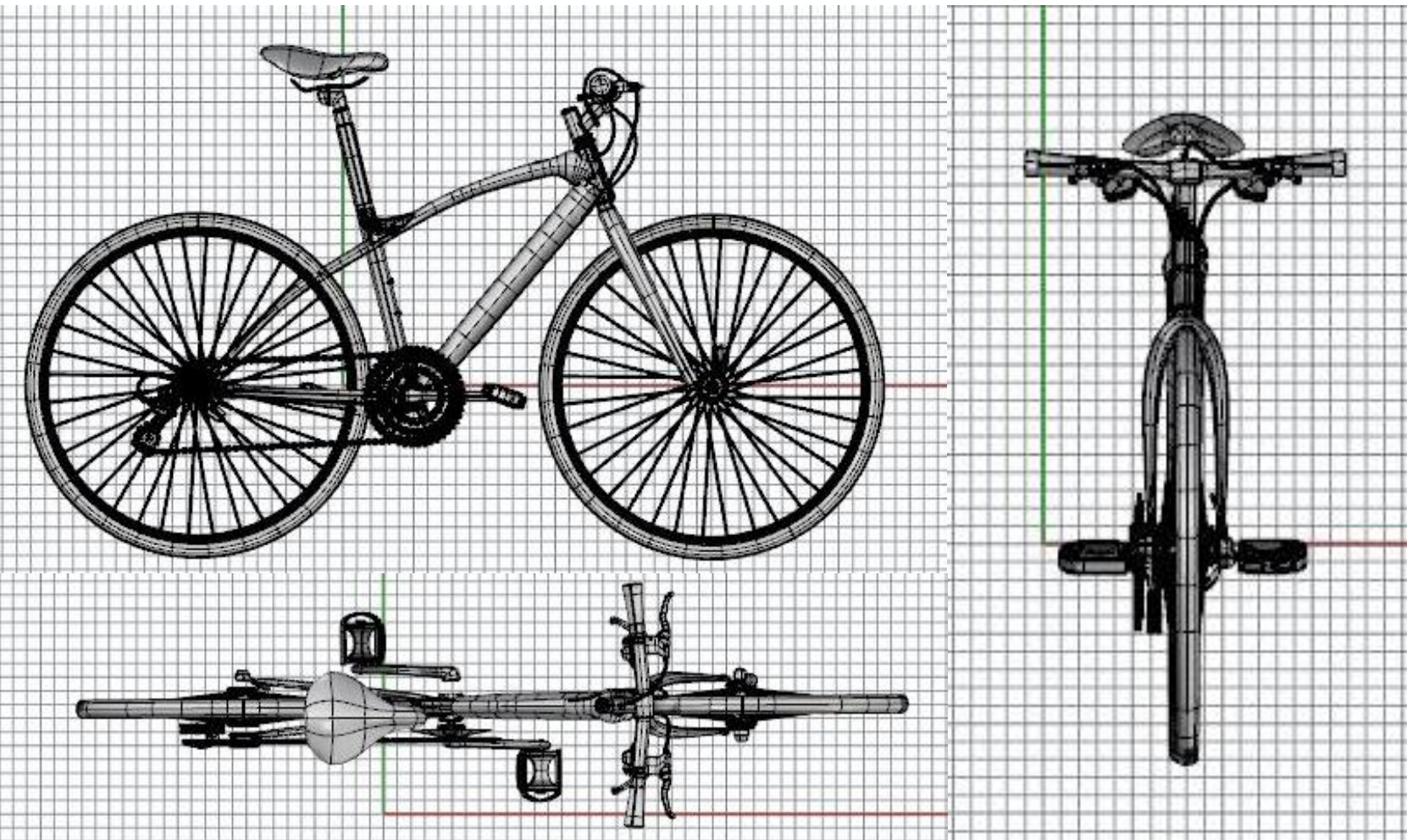
Component ↴	Brand ↴	Number of Sentences ↴	Positive ↴	Negative ↴	Score ↴	Selected ↴
Frame ↴	<u>CoMax carbon fiber frame</u> ↴	6 ↴	6 ↴	0 ↴	6 ↴	✓ ↴
	GIANT ALUXX Aluminum frame ↴	2 ↴	0 ↴	2 ↴	-2 ↴	↴
Fork ↴	GIANT ADVANCED carbon fiber fork ↴	Depend on <u>CoMax carbon fiber frame</u> ↴				✓ ↴
	GIANT <u>CrMo Chromium-molybdenum alloy</u> ↴	Depend on GIANT ALUXX Aluminum frame ↴				↴
Color ↴	Black / gray ↴	8 ↴	8 ↴	0 ↴	8 ↴	✓ ↴
	ANYROAD COMAX ↴	3 ↴	3 ↴	0 ↴	3 ↴	↴
Handlebar ↴	GIANT CONNECT XC 31.8 ↴	6 ↴	5 ↴	0 ↴	5 ↴	✓ ↴
	GIANT Aluminum 25.4 ↴	1 ↴	1 ↴	0 ↴	1 ↴	↴
	Giant Connect XR ↴	1 ↴	0 ↴	1 ↴	-1 ↴	↴
Stem ↴	GIANT Connect Aluminum ↴	Depend on GIANT CONNECT XC 31.8 and Giant Connect XR ↴				✓ ↴
	GIANT Aluminum 25.4 ↴	Depend on GIANT Aluminum 25.4 ↴				↴
Brake ↴	TRP <u>Spyre</u> ↴	4 ↴	4 ↴	0 ↴	4 ↴	✓ ↴
	TEKTRO HD-M290 ↴	1 ↴	1 ↴	0 ↴	1 ↴	↴
	<u>Tektro</u> TK837 ↴	1 ↴	0 ↴	1 ↴	-1 ↴	↴
Chain wheel ↴	SHIMANO 105 50/34T ↴	2 ↴	2 ↴	0 ↴	2 ↴	✓ ↴
	SHIMANO FC-105 50x34T ↴	1 ↴	1 ↴	0 ↴	1 ↴	↴
	Shimano FC-M131 28/38/48 ↴	1 ↴	0 ↴	1 ↴	-1 ↴	↴
Freewheel ↴	SHIMANO 105 11-32T, 11S ↴	3 ↴	3 ↴	0 ↴	3 ↴	✓ ↴

Case Study

Phase 2. Conceptual Design Generation



Case Study



Conclusion

Contribution:

A new approach for automatic product design based on the techniques of text mining is provided.

Limitation:

1. the sample size of customer reviews in case study is not abundant.
2. The specifications of components cannot be provided in a flexible way.

Future Research

- This method may applied to other products.
- Can combine with solid works, prototype the new product in time.
- Add adv. into considering comments, that can extend our grading items.

Thank you

Q&A