MULTI-OBJECTIVE INTERACTIVE EVOLUTION OF FASHION ACCESSORIES FOR 3D PRINTER

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MULTI-OBJECTIVE INTERACTIVE EVOLUTION OF FASHION ACCESSORIES FOR 3D PRINTER

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DECLARATION

I hereby declare that this thesis, submitted to Universiti Malaysia Sabah as partial fulfilment to the requirement for the degree of Bachelor of Computer Science (Software Engineering), has not been submitted to any other university for any degree. I also certify that the work described herein is entirely my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

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July, 2015

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(Halimah Binti Manja)

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ABSTRACT

Although Evolutionary Computing has already expanded their realms into solving real life problems, there has been significantly less emphasis on their applications towards design of everyday aesthetic objects. Fashion accessories cannot be defined using a single objective fitness function but rather it requires a multi objective fitness function in order to solve this kind of problem. Prior research has used Genetic Algorithms to evolve the design. However, the typical Genetic Algorithm requires a genetic representation of the solution domain and a fitness function to evaluate the solution domain. Therefore, an Interactive Evolution Computing approach or other words as known as aesthetic selection in general is one of the methods of Evolutionary Computing that uses human evaluation. With the addition of multi-objective optimization, the challenge is which optimal decision is to be taken. By implementing a Pareto optimal solution method, the multi-objective approach will not be dominated by any other solution. In the experiments, the tuning parameters are based on the mutation rate and scale factor. Mutation rate had a low value if it was added to the gene, therefore enhancement of the shape mutation was more successful when being multiplied with the scale factor. The results of the experiment produced different shapes and many evolved shapes were successful in the optimization of their shapes. Subsequently, each successfully evolved object from the respective runs was chosen to be fabricated using 3D printing. The results from the human evaluation show that the rating of the physical object dropped compared with the nonphysical object in silico. The shape that was printed was not as smooth as how it appeared in the system. Therefore, the conclusion was that the user tended to give higher ratings to higher number of faces. However because of the low resolution of the available 3D printer, the object that was being printed was not as smooth as in silico. As the result, the human evaluated printed objects' ratings were not as high as the in silico evaluations.

ABSTRAK

(TAJUK DALAM BAHASA MELAYU)

Walaupun Evolutionary Computing telah pun berkembang kerajaan mereka ke dalam menyelesaikan masalah-masalah kehidupan sebenar, sana nyata sekali kurang keutamaan di permohonan mereka ke arah reka bentuk setiap hari benda-benda estetik. Aksesori fesyen tidak boleh ditakrifkan menggunakan satu fungsi kesesuaian yang objektif tetapi ia memerlukan fungsi kesihatan objektif pelbagai supaya menyelesaikan masalah begini. Kajian sebelumnya telah digunakan Genetic Algorithms berevolusi reka bentuk. Bagaimanapun , biasa Genetic Algorithm memerlukan satu gambaran genetik domain penyelesaian dan fungsi kesesuaian menilai domain penyelesaian. Lantarannya, pendekatan Interactive Evolution Computing atau lain perkataan seperti dikenali pemilihan estetik secara umum ialah salah satu cara Evolutionary Computing yang menggunakan penilaian manusia. Dengan tambahan pengoptimuman pelbagai objektif, cabaran ialah keputusan optimum yang mana akan diambil. Dengan melaksanakan kaedah penyelesaian optimum Pareto, yang pelbagai pendekatan objektif tidak akan dikuasai oleh apa-apa penyelesaian lain. Dalam eksperimen, parameter penalaan berdasarkan kadar mutasi dan faktor skala. Kadar mutasi mempunyai satu nilai rendah jika ia ditambah kepada gen oleh itu peningkatan mutasi bentuk lebih berjaya apabila dikalikan dengan faktor skala. Keputusan eksperimen menghasilkan pelbagai bentuk dan banyak berkembang bentuk telah berjaya di pengoptimuman bentuk-bentuk mereka. Kemudiannya, masing-masing dengan jayanya berkembang objek dari larian berkenaan dipilih akan dibina menggunakan sebagai percetakan 3D. Keputusan dari pertunjukan penilaian manusia yang penarafan objek fizikal jatuh berbanding dengan nonphysical membantah in silico. Bentuk yang telah dicetak bukan serata bagaimana ia muncul di sistem. Lantarannya, kesimpulan ialah pengguna menjaga memberi penilaian yang lebih tinggi untuk jumlah yang lebih besar muka. Bagaimanapun disebabkan oleh peleraian rendah pencetak 3D boleh didapati, objek yang telah dicetak bukan serata in silico. Sebagai keputusan, manusia menilai pengkadaran benda-benda tertera bukan setinggi penilaian-penilaian in silico.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will explain how designing fashion accessories have potential value to conduct an experiment by implementing Evolutionary Algorithm (EA). The sub theme in this chapter will include problem background, problem statement, theory, objective and scope of research. In problem background, we will briefly explain what the problem usually causes when designer fashion accessories and it have big chance to amend. In problem statement sub topic, we will briefly justify how disadvantage of traditional method can give chance to implement using EA and explain how to overcome this disadvantage. We also include the advantage using a 3D printing machine as one of solution manufacturing problems. For the theory, we will submit the anticipated effect of implementing EA in designing fashion accessories. Last and not less, is our state the objectives and the scope of the research before setting for the organization of the research report.

1.2 Problem Background

Usually designer using traditional method to create design for fashion accessories. The method has several constraint needs to look at. First, commonly designer using plain of paper to create a design, mostly the design is abstract. Definition of designing an accessory is big. Either based on natural, human produce, object surrounding, or animal. They're also based on simple abstract such like geometric shape, which like circle, square, triangle, cylinder, etc. Second constraint is mostly the material to produce accessories is costly to the most designer. This made the design not be implemented well and at the same time wasting a good design of the product. Third constraints is time, which typically to design accessories need more time and same also to implement the design become an accessories product.

These constraints made the Evolutionary Computing (EC) as an opportunity to experiment with it. One the reason is EC ability to solve many complex design problems. The flexibly of algorithm gives a huge benefit for researcher to conduct an experiment on this kind of problem. Before this, EC already being implemented to create an art object or image. Result from research show that EC is capable to produce creativity art. As we know art is one of part of designing a product, especially on fashion accessories. Therefor this show us that EC able to produce good design fashion accessories.

1.3 Problem Statement

Implement EC in designing fashion accessories will give better way for the fashion industry. As we know, the EC has different type of algorithm which Genetic Algorithm (GA), Evolutionary Strategy (ES), Evolutionary Programming (EP) and Genetic Programming (GP). Each of this algorithm has different approaches to solve the problem. For this project we will implement GA into the test, the reason is why we choose GA is because it's already being implemented for creating art design. This gives advantages for me to continue the experiment but with different objectives. Winder, GA, they're sub topic that suitable for this experiment which is an Interactive Genetic Algorithm (IGA). IGA able made human evaluation act as fitness function. The reason why we choose IGA is to when defining fitness function for design, fashion accessories are impossible, therefore we need human evaluation one of the alternative to solve this situation.

By implementing IGA in this project, it gives huge different to design fashion accessories compare to traditional method. Using 3D environment, sketching designs on paper no longer need where designer able see in a 3D environment and give a better vision during the design at the same time reduce human mistake criteria. With 3D also, designer able made sort of time in designing, this will reduce costs to the produce product. For manufacturing the final product, we use 3D printer. Advantage of 3D printer is it reduces the cost of manufacturing and time to produce the product. This being proved by another company the successful appliance 3D printer one off solution.

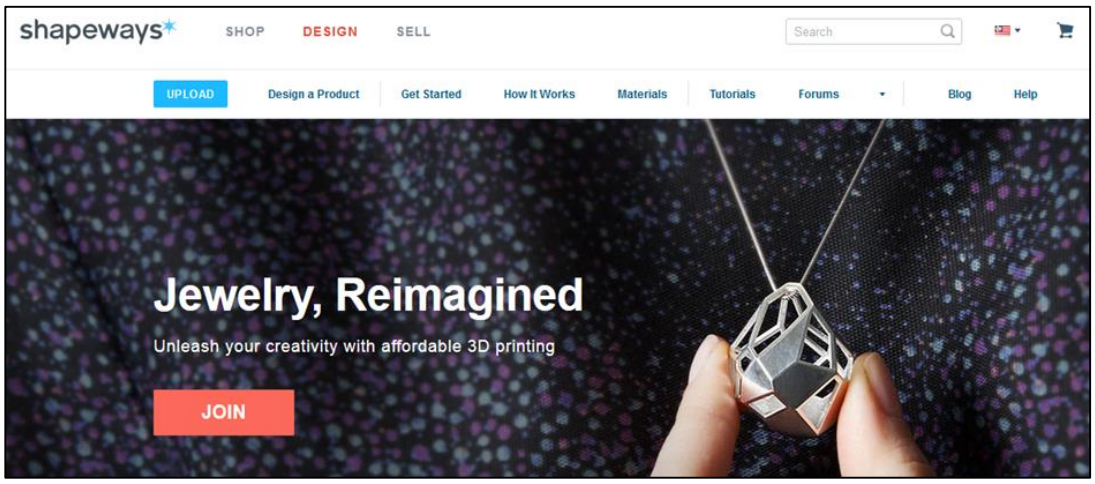

Figure 1.1 One of company successful using 3D printer

1.4 Hypothesis

IGA one of the best alternative to show the fashion industry by producing good design. The design will focus more geometric shape which easy to implement using an algorithm. The research also will implement a user interface for designer easy interaction with the object. With the interface, user evaluation appear after finalize object shape. The evaluation will have multi-objective that needs to achieve in order to get a better candidate solution. The end of human evolution, we can produce the product using a 3D printer.

1.5 Objective

- Defining the suitable encoding in evolving object fashion accessories.
- Implementing user interface for fashion accessories in interactive evolution.
- The test interactive evolution of multi-objective and evaluate fashion accessories using a 3D printer.

1.6 Project Scope

- Scope this project only cover one algorithm in order to evolve the object.
- The project will focus only one of the accessories such like ring, earring, necklace, pendant, and bracelet.
- Evaluation of the object only focuses on the shape of the object, excluding the colour of the accessories.
- The shape will based on geometric object.

1.7 Organization of Project

This report contains seven chapters and they are organized in the following manner; chapter one will introduce the overview of EC and IGA in problem background and problem statement. The following problem statement, we will suggest the hypothesis for this research. We also determine our objectives which served as research inspiration. This chapter end with scope of research.

Chapter two brief introduction of Evolutionary computing (EC), Evolutionary Design (ED), Interactive Genetic Algorithm (IGA) and Multi-Objective Optimization. This will follow with how this algorithm gives impact into the industry especially fashion industry. We will discuss do EC have conducted the experiment in any area of the fashion industry. We will summarize the research and ended with justifying the weakness and strength each algorithm being used in the relate research. This chapter concludes with the proposal of some open research question.

Chapter three explains the methodology used. The first sub topic will explain which model of Software Development Process being used and the reason why that type of model being selected to implement the research. Second sub topic describes which algorithm of EC being used during this research. The chapter will end with state the software and hardware requirement used during this research.

Chapter four will discuss how the design structure implemented in this research. It consists system design, and algorithm design. In this chapter will explain how algorithm being implemented in the system using flow charts.

Chapter five it about how implemented the algorithm in the system. The chapter will contain the screen shot of the final system, and how to use the system. It is also contented of briefly explains how algorithm IGA being implemented in the system.

Chapter six discusses how conducted an experiment. The content will be the experimental setup, the result of each experiment, analysis for each experiment. Overall graph for each experiment also being used. Each experiment, I will show the final shape to compare each user.

Last chapter, which chapter seven is about the conclusion during the research. Explain what my finding is during this research and do I able completed my overall objectives. I also discuss what my limitation during the research and what is my future work.

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