Family Bonding Enhancer (weDeco)

by

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11247

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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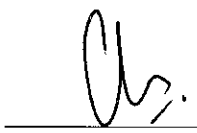
Approved by,



(Ms Elaine Chen Yoke Yie)

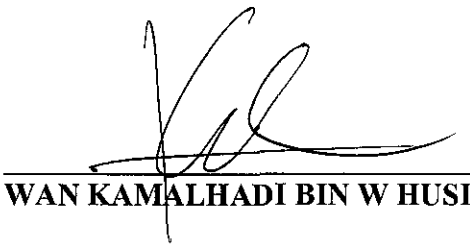
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



WAN KAMALHADI BIN W HUSIN

ABSTRACT

This project was invented mainly with one general objective of tightening the relationship between family members through one of home chores where all the members can join in and contribute, which is home decoration. The decision-making and implementation of the decorations are made more interactive and fun using the system that is built based on tangible interaction concept. Arranging the furniture will be easily done by dragging and dropping objects on the system platform simulating the real furniture and spaces. With this system, less energy and time will be consumed, enabling more effective communications throughout the decoration tasks. The integration or bonding between the family members will be enhanced stronger as the boring and exhausting home decoration work is turned into an interesting interactive teamwork task.

The project is developed using Instructional System Design methodology, applying ADDIE model. Image processing is the technology that has been utilized to develop this project. Using this flexible technology, object recognition has been instilled into the system to further enhance the interactivity of tangible interaction concept. With the system that enables fun and interactive home decoration activity, the family members would interact more, thus, enhancing the bonding between them.

ACKNOWLEDGEMENT

First of all, I express my highest gratitude to the God Almighty that with His blessing, I was able to undergo my years of degree study until this very final semester. As obligated for all the final year students to do the Final Year Project (FYP), I am very thankful that I have learnt a lot throughout the development of my project. This would be a very valuable experience and exposure for me to prepare myself before entering the actual working environment.

I must say that I believe I would not be able to finish this project if it is not for many persons that assisted me throughout the year, especially my FYP supervisor; Ms Elaine Chen Yoke Yie. I would love to thank her for all her assistance, and not to forget, for her perseverance in guiding me to all the way until I managed to finish this project.

It is a must for me to acknowledge all the helps and supports given by my family and friends that kept me motivated and inspired to finish this project. Many comments and compliments that I received have helped me to do and improve the project better along the way of its development.

Finally, again, I express from the bottom of my heart, thank you to all of you.

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CHAPTER 1
INTRODUCTION

5.1 Background of Study

Communication between family members is the key to a happy family. More time spent with the family will give more space to a person to be adapted by the family, and also at the same time, to adapt himself with the other family members. Once the family members are comfortable with each other, they will be able to live together more harmoniously with fewer problems. Every member will not be afraid or hesitate to point out their own points of view and discuss problems to reach an agreement on certain things. Less family problems or issues could avoid one family from falling apart.

In order to enhance a family bonding, this project was invented to give a chance for the family to spend more time together communicating with each other effectively doing a home chore which is decorating their house spaces. The system that will be developed throughout this project will help turning home decoration task that is said to be boring and mostly done by the mothers into an interesting, interactive and collaborative family task. Everyone can easily express their opinions on the decoration by simple drag and drop processes of objects on the system platform that will simulate the real furniture and spaces of their house. This chore is selected due to the fact of belonging feeling towards the house of the family members that hopefully will bring them together into joining the activity as they would love to have their opinions or ideas being heard regarding the house or space that they also live in.

This project will develop the system based on tangible interaction concept. Tangible interaction implements tangible user interface (TUI) which enables a person to physically feel and communicate digital information. For this system, the family members can physically feel like they are actually moving a sofa around the living

room until they find a suitable spot, for example, by dragging and dropping an object on the system platform. The TUI will make the decoration work more interactively visual and physical where every member can directly interact to express their opinions on agreeing or not with the decorations by keeping or changing the position of the object(s). This will enable more effective communications between the family members as less time and energy are consumed on actually moving the real furniture around to visualize the decoration idea.

This project also aims to be able to take multiple inputs from the users for the collaborative activity of home decoration to be performed. This will enable the users to communicate well by expressing their ideas through the multiple input mediums that will make the communication more interactive and dynamic - instead of static one by one input that would also make it less collaborative.

5.2 Problem Statement

Nowadays, most people are busy with their office works in order to gain enough money to support their lives as the living costs are getting higher day by day, neglecting their families at home. More time are spent outside with other people compared to home with their own family members. This leads to decrement in feelings of family togetherness and belonging. Children are getting only little attention and decide to rebel by joining many unhealthy groups and trends. Without proper communication, more family problems and issues are getting out of control and left unsolved leading to many family breakups as they have become nothing new anymore these days. In Malaysia, the divorce rate grows progressively every year. A study has shown that it went up from 9.9% to 12.8% in the year of 2000 to 2005.

Worse, even when a family spends time together, the time is not utilized efficient and effectively to enhance the relationship between them. In fact, nowadays, most of the families just sit together during dinner time which at average of 30 to 45 minutes out of the whole day. This is a very small portion of time to enable the members to really communicate with each other. Lack of communication could lead to bigger problems

especially when the smaller ones are not resolved effectively and keep occurring time to time.

Families nowadays also face difficulties in reaching agreements in many matters as they are lacking of understanding. This is due to the clashes of opinions that are not communicated well. One misunderstanding could lead to another one, and the loop will continue as long as no good communication method or activity is instilled or practiced in the family.

Apart from that, in term of family activity, home chores are left to the mothers themselves while actually they are activities that can be done together with the whole family in interesting ways. Doing the chores together will make the family interact more, thus, spending quality times together in an effective way to grow stronger bond between them. However, home chores are usually taken as boring and exhausting works. Like home decoration, people are complaining that it takes a lot of energy and time moving the furniture around the house with the fact that they might still not like the new arrangement and have to do it all over again. Plus, arguments easily happen when some family members do not agree with the new decoration as they cannot visualize or imagine the new decoration first before actually moving the furniture. The worse thing is that when one is physically tired, his emotion is hard to control and he would hardly solve a problem rationally which then could trigger to a bigger problem.

5.3 Objectives

To develop an interactive home decoration system that aims to:

- enhance family bond and pleasure among family members;
- utilize tangible interaction for creative home decoration;and
- keep record of their decoration designs after decoration activities;

5.4 Scope of Study

This project covers on the development of a tangible interaction system or tangible user interface (TUI) to enable the enhancement of family bonding. Studies will be done on how the interface would be able to physically simulate the real task of decorating the house. The interface would also need to be able to receive multiple inputs at one time to enable more interactivity between the system and users.

Human-Computer Interaction (HCI) knowledge will be used extensively to design a user-friendly and efficient interface for the system. The criteria of HCI such as user-friendliness, learnability and usability must be instilled into the system interface.

Image processing will also be studied to further enhance tangible interaction as object recognition will be implemented in the system. From the real-time image frames captured, object would be recognized through the processing that will then enable the users to manipulate the objects as what the users want them to be represented as digitally. Further research and study will be carried out in image processing area to enhance the current findings and solutions. For example, the extraction of the objects in an image for recognition and detection purpose would be tried to be enhanced by providing better and sharper extraction method.

In addition, researches on family bonding issues will be done to learn more ways the system could enhance the family bonding. More aspects will be covered such as communications and quality time of the family members. The system will need to tackle at least some general family issues in order to achieve the objective of enhancing the bond.

CHAPTER 2
LITERATURE REVIEW

There are many issues regarding family relationship. Generally, lots of things can be the reason to family relationship problems. Although problems are normal, some of them can be out of control and cause more unwanted consequences [1]. Those problems could be so critical that it might endanger one's life through illnesses [2]. Usual causes of the family problems are hard times and difference in opinions. However, looking at the bright side, these causes or problems are actually among the chances that would enable a family bond enhancement [3]. Related to this view, this project would manipulate a home designing or decorating chore where difference in opinions is normal to enhance the collaboration of the family members, thus strengthen the bond. Plus, collaboration or engagement is one of the best methods to enhance a family bond. This would open to more effective discussions and communications where certain conflicts can be resolved [4]. Many games are developed nowadays to invite more engagement among the family members, especially video games as they are almost a common medium that all the generations are familiar to [5]. This shows that fun collaborative activity is the preferable way to enhance a family bonding.

An article called "Benefits of a Tangible Interface for Collaborative Learning and Interaction" said, "*In addition, groups using the tangible interface collaborated better, explored more alternative designs, and perceived problem solving as more playful. Mediation analysis revealed that exploration was the only process variable explaining the performance for the problem-solving task.*" [6]. This statement shows that by implementing the tangible user interface (TUI), this project will enable better integration between the family members; hence, it will help the family members to reach an agreed-upon decision with lesser complication through the enjoyable environment the system would create for the users. This system would not only turn the home decorating chore into an fun task, but with the TUI developed, it is believed that the system would even effectively enhance the fun time with three enhancement factors: fantasy, aesthetics and physicality [7]. Spending more happy time together

plus good communications will enhance the bond between the family members as it will increase the feelings of belonging and trust toward each other. Bruno Nadeau and Amanda Williams also stated that collaborative tangible design is a great way of social engagement [8].

Danaë Stanton, Helen Neale and Victor Bayon in their research entitled "Interfaces to Support Children's Co-present Collaboration: Multiple Mice and Tangible Technologies" also support the benefits of tangible user interface. They believe that with more collaboration and interaction provided by the system, learnability can be increased greatly [9]. Besides that, the ability of tangible user interface (TUI) in increasing learnability is also support by another research. It is stated that "... *designers in TUI sessions perform multiple cognitive actions in a shorter time than in conventional graphical user interface (GUI) sessions.*" [10]. This means that TUI users require shorter time to understand how to use the system. These researches further support that multiple inputs and tangible concepts are two beneficial aspects that this project should develop.

Before the system is designed, a few basic attributes need to be confirmed first. One of the most important is the technology or platform the project will be based on. This would determine how the project would be developed later on. A few researches and studies were done to get as many data as possible to suggest, support and prove which technology or platform is the best for this project.

Potential technologies or platforms like multi-touch monitor, RFID, augmented reality (AR) and image processing were studied to learn advantages and disadvantages of each of them in aspect of being the backbone for this project. From the observations done, it is found that there are some quite similar projects done based on each of those technologies or platforms. This enables analysis to be conducted to compare which one is the best to be implemented in this project.

There are some projects done using multi-touch monitor. However the problem is the ability of the screen or monitor to detect objects that are put on it. As most of the

device monitors are captive wherein the monitor would only detect static electricity, it is a challenge to make them able to detect objects like a cube without static electricity. As an alternative to actually detect the item physically on the screen or monitor, a person shared on the Internet how he has developed an object recognition system by making the monitor detects a special code that is put under the base of the object. This code interacts with the monitor to enable the system to detect the object and also recognize it according to the set code for each of the objects. As shown in the video he shared, the system was developed on iPhone. However, that project can be considered doubtful, whether it is developed already or just an idea concept. From the researches I have done, there is no yet proven multi-touch monitor system that can detect the objects' positions and sizes that sit on it, other than palms/fingers and stylus. Besides, all those object recognition system that applies multi-touch monitor technology are usually customized with embedded camera system to assist the system in detecting the objects' sizes and positions, or any other attributes.

RFID is another potential technology of platform this project can be developed on. RFID works by scanning tagged objects. To learn the position of an object is by using multiple scanners and every scanner is recorded with its own number so that when respective scanner found a tagged object, the position of the object can be coordinated among the scanners arrangement. Drawbacks of using RFID are high cost (need many scanners), interference between scanners signal if they are put too close, blind spots (as scanners put far from each other to avoid interference) and every objects must be tagged to be detected. An improvement for this method was done by using mobile scanner. Instead of using many scanners, only one scanner is used. It will be mechanically moved around the covered area to detect any tagged objects there. However, this new method is more complicated as a mechanical mover has to be developed and the coordination of the scanner on every movement has to be recorded to keep track of the scanned objects. It could cost high also. Plus, the scanner will take a long time to scan the whole area (processing time); it might lose updates on rapid object movements.

Augmented Reality (AR) is a quite wide technology. I have found a lot of similar systems were developed under this technology. Mostly they make use of touch

screen concept; enabling drag and drop process to simulate the moving process of objects. Although this manages to simulate the real process, the simulated actions are still lacking in many aspects such as the feelings of physically handling the objects and many more. Another concern is that the users might not all get the same view of the system. As most of the AR systems are projected in virtual view, when it comes to collaborative usage, some users might not able to experience the virtual view like others do due to some technical or other issues.

Lastly, under image processing technology, there are many similar systems especially object recognition-related systems being continuously developed. It is easy to manipulate, low cost and flexible. It only requires image capturing or recording of respective area where the physical objects will be handled and then every aspect of image can be processed, including the numbers of objects exist in the area, their positions, their sizes, and their many other attributes as long as they are recorded in the covered area. It is the common way to distinguish an object by its visual appearance as there many characteristic can be analyzed. Object recognition and detection can be easily implemented using image processing technology. Plus, it will enable the use of physical objects to enhance the simulation of the real process.

Every technology was researched and all the data was gathered. The researches were done several ways such as studies on existing projects, expert reviews, and online discussion and conference. The criteria for this project were also listed to make it easy to find the most suitable technology to develop it on. The criteria of the system were agreed to be ability of using physical objects, wide covered area, portable model and ability of object recognition.

Based on all the advantages and disadvantages of every technology and how it fits the criteria, the best one for this project was decided so that the design process can be conducted before a prototype can be developed based on that design for testing purposes. Hence, the chosen technology or platform is image processing; implementing object recognition.

As image processing was decided to be the platform where the project will be developed on, many things have to be considered. One of the problems in implementing object recognition using image processing nowadays is the ability to scan for distinctive features of respective objects in order to differentiate them. Combination of multiple features is a suggestion by many people. Serge Belongie, Jitendra Malik and Jan Puzicha are some of them who tried to combine a few key features or characteristics of respective objects for recognition purposes [11]. The relation between those features can differentiate one object from the others [12]. Other than that, existing object comparison is another suggestion by many developers. The idea is once an object is detected, the object will be compared and matched to a list of recognized objects in the database [13].

Those suggestions are certainly working solutions. However, many other aspects also have to be taken note on. For example, as explained by Paul Viola and Michael Jones, adding more features analysis would increase the computation time of the system [14], which is a drawback that a system must avoid. Also, usually, working with images, there are many distortions involved and this might ruin the results of the recognition processes [15]. Based on these views, besides its set objectives, this project will try to develop a better solution at the same time.

There are a few virtual home decoration systems or software available in the market that enables users to virtually design and arrange spaces of their house but most of them do not apply the tangible interaction concept, instead, mostly they are developed based on mouse drag-and-drop and augmented reality concept which makes the systems become more likely a one-man controlled system. This is because these concepts usually enable only one and limited system input. The inputs to the systems are limited mostly to only the keyboard and mouse which disable interactivity of multiple inputs at one time that would enhance to better collaboration. For example, the user can only interact with the system using the mouse and this means that the person who holds the mouse is the only person who can give input to the system, neglecting the other users who should be collaborating with him in the activity.

Other than that, the existing systems also give less physical interactive experiences when they did not implement the tangible interaction concept. The users would less physically feel the process of decorating the house as they only control the computer keyboard and/or mouse in deciding the decoration, as compared to handling the real tangible objects representing the furniture like the project is trying to implement.

CHAPTER 3
METHODOLOGY

3.1 Applied Methodology

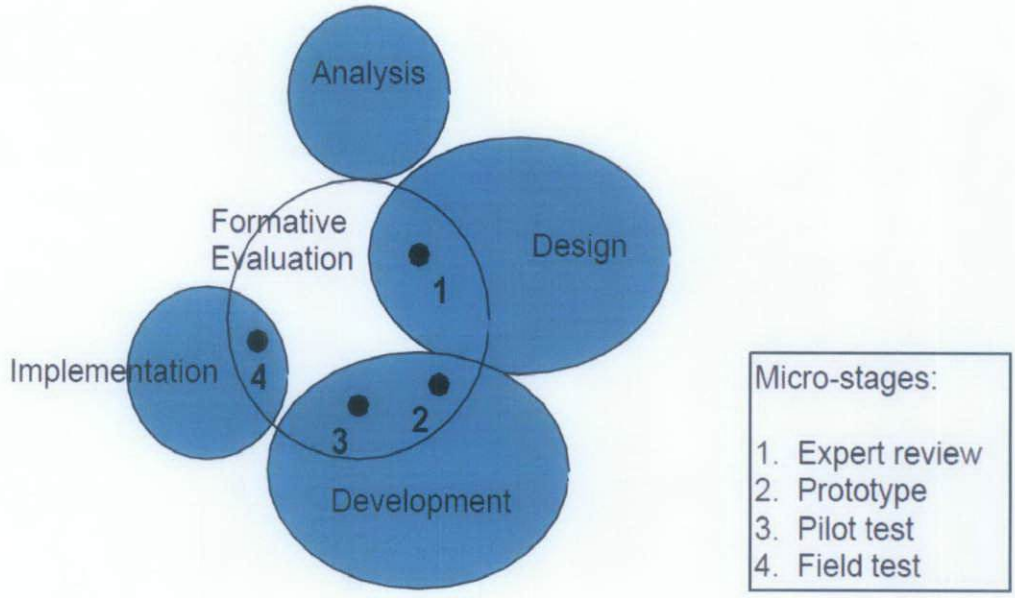

Figure 3.1 *Instructional System Design (ADDIE model)*

This project has been developed using Instructional System Design (ISD) methodology. The ISD model applied is called ADDIE which basically consists of 4 phases which are analysis (A), design (D), development (D), and implementation (I). By applying this model, it ensures that formative evaluation (represented by the E letter) and data collection takes place at each phase and its micro-stages as the data are very crucial in order for this project to come out with the best solution for the stated problems. Every phase is very important for the project because at each phase, there are certain outcomes that need to be produced in order to feed or help the next phase to be carried out until the final product or the actual system is done. In other words, every phase is dependant to one another.

3.1.1 Analysis

In this first phase, certain researches and studies have been conducted to collect all the necessary data especially regarding family issues and tangible interaction concept. Literature review was a part of the analysis in order to find any supports or ideas or arguments that should be taken into account for the betterment of the project outcome. Other than literature review, some indirect or unofficial surveys and questionnaires also helped in collecting the data for analysis purpose. The main target for this analysis was to solve how the physical activity of home decoration can be simulated into a digital system. The analysis also gave an assumption on the feasibility of the project in proving the idea's ability to enhance interaction, thus, family bonding.

In short, the outcomes from analysis phase are literature reviews and researches data and results.

3.1.2 Design

Moving to the next phase, design; the data collected and analyzed was applied to determine the best possible design of the solution or system. All aspect of the system design was thoroughly considered, such as material to be used. Every time a possible design is sketched, expert reviews would be collected. They might consist of supports or ideas or arguments that should be taken into account for the betterment of the project outcome in term of design before finally the design is improvised and finalized, then taken to development phase. This is important in any project development process because it would avoid wasted time, energy and money in case of weak or flaw proposed design. Any possible changes or improvements on the design should be implemented to ensure the best design for the system.

In short, the outcomes from design phase are process flow, system architecture, design reviews and finalized system design.

3.1.3 Development

After the best design was ready, the development phase was carried out. This was where the solution or system started to be built. Based on the design, a prototype was developed. This prototype is very crucial as it would represent how the actual system would look and work later on. By prototyping also, many cost can be saved because it would cost much lower than the actual system especially in case of failures. This prototype would also help the project to embark on a pilot test, where it would provide real feedbacks and responses regarding the system that would be developed. Some exclusive testers from the industry and also possible users would be invited to test the prototype on every aspect such as learnability, usability and user-friendliness. Any possible changes or improvements on the prototype will be implemented into the actual system that would be developed in the next phase. Currently, this project is still at this phase due to some in-progress challenges.

In short, the outcomes from development phase are prototypes, small-scale tests, bugs fixing and improved prototypes.

3.1.4 Implementation

During the implementation phase, the actual system will be developed. The field test then will be carried out using the finished actual system. The system would be presented to public for their feedbacks and responses. Data will be collected to see how the system would be able to help enhancing a family bonding, or it would not. This is a very crucial stage as it would highlight the successfulness of the project, and also the evaluation of the project.

In short, the outcomes from implementation phase are the actual system, field test, project evaluation

3.2 Research & Steps

Basically, the project would develop a tangible interaction system to simulate the home decoration activity. The users would place the objects or artefacts on the system platform easily as if they are positioning the location of the furniture around the house space. However, without proper plan and data, this project's main objective to develop a system that could help enhancing the family bonding would be a very challenging journey, so a proper plan of steps was structured and a few data was researched and collected to support the project development.

3.2.1 Research Elements

In order to come out with the proposed system, some research elements were collected to support the project development processes. For this project, these are the elements that have been researched:

- Research on ways that family bonding can be enhanced.
- Research on general family issues.
- Research on tangible interaction concept.
- Research on human and computer interaction (HCI) criteria of system.
- Research on what platform/tools the system should be developed on.
- Research on image processing methods and programming.
- Research on how to design a good system interface.

3.2.2 Project Development Steps

Supported by the data collected and analyzed from the researches, the structured steps in developing the system were enabled to be carried out properly.

Steps that have been carried out:

a. Sketch or design the overall process flow and look of the system.

b. Design and program how the tangible objects would be represented and manipulated to simulate the furniture.

c. Design and program the system to be able to detect multiple objects on the platform as multiple inputs.

d. Program the system to distinguish the different objects on the interface so that the users' designed layout of home decoration is correctly generated.

e. Design and program the system to generate of the decoration blueprint or design layout, enabling the users to save it, if wanted.

f. Develop a functioning prototype for the system to be practically tested and real feedbacks collection for improvement.

Steps to be carried out (next steps):

g. Handle and fix any bugs or challenges found in prototype.

h. Implement all possible improvements and build the actual system.

3.3 Tools Used

For this project, some software and devices was chosen as the project development tools. In term of programming software, the project was coded in Microsoft Visual C# Express 2010. Thus, all the programming or coding related to this project is done using C Sharp or C# language. As most of the functions needed for the project

features are on image processing, AForge.NET Library was utilized. AForge.NET Library provides many functions and flexibility for image processing processes.

For device, obviously, the project uses camera as it requires images to be processed and only then generate the wanted outcomes. For prototyping and testing purposes, 3 types of camera device were used. They are Acer Aspire 4736G Built-in Webcam, Migix MS-825 USB Webcam and CSL G4 Handset Camera.

CHAPTER 4
RESULT & DISCUSSION

4.1 System Process Flow

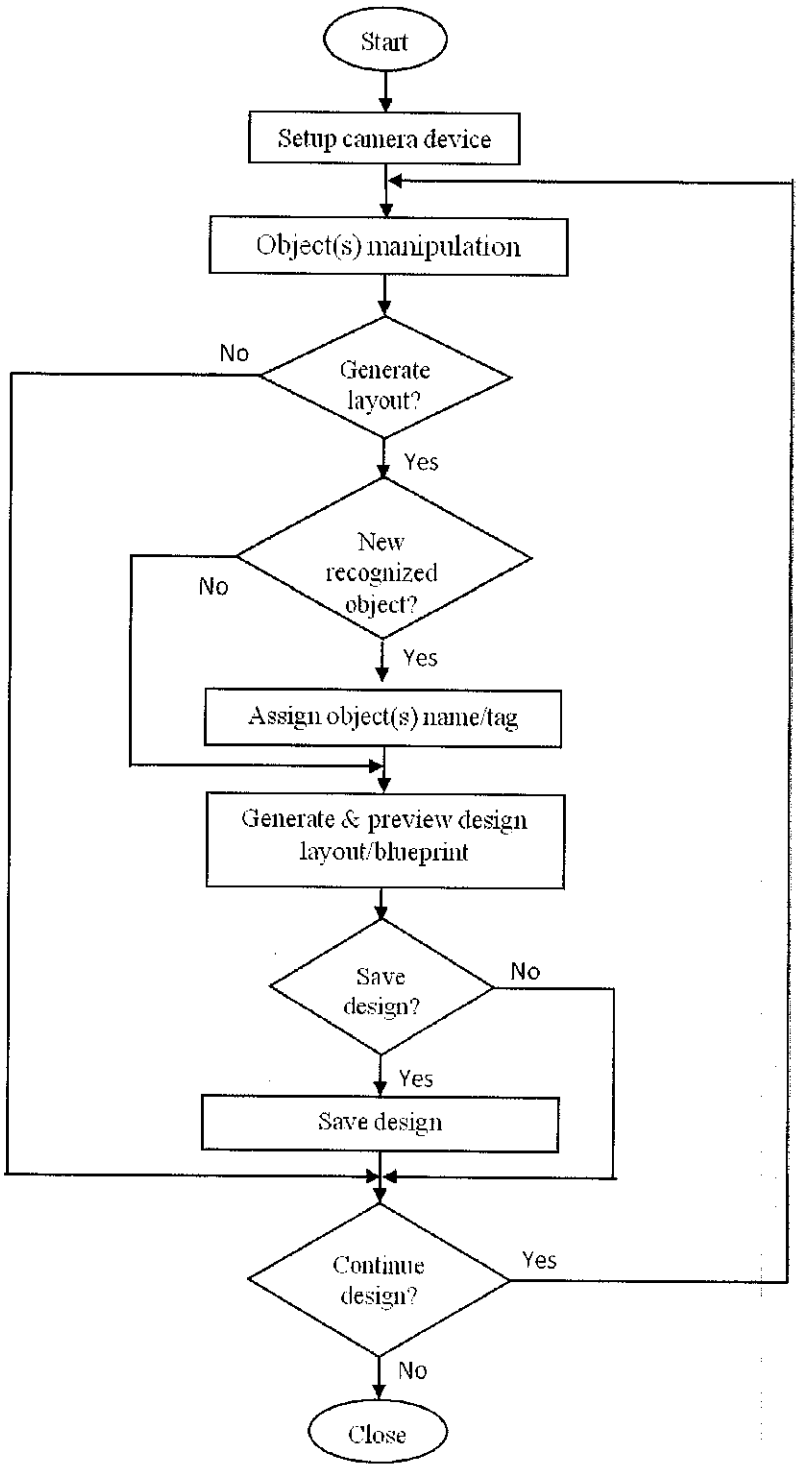

***Figure 4.1** System process flow*

4.2 System Architecture

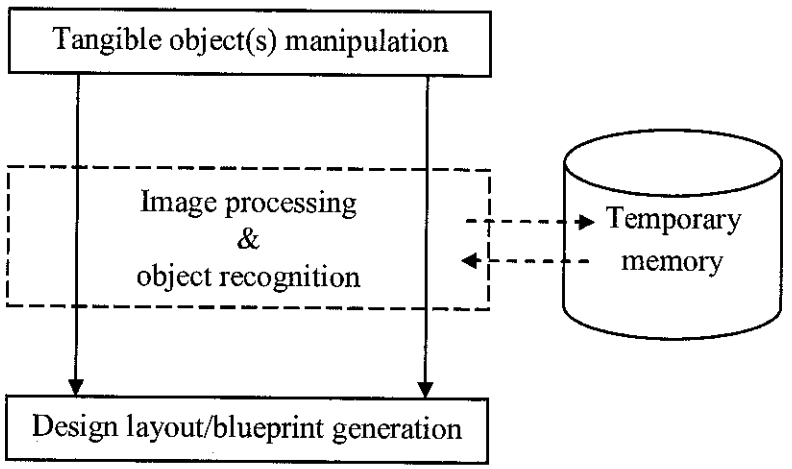

Figure 4.2 *System architecture*

Images of the platform will be captured through the camera device. From the images, any object visible on the platform will be detected through the images processing. This will enable the system to recognize the objects. In order to keep track of the recognized objects, the data will be stored temporarily in the memory. All the data will be cleaned once and every time the system is closed. After all the image processing and memory check and retrieving, the design layout or blueprint can be generated.

Here is the sketch on the proposed setup of the system implementation;

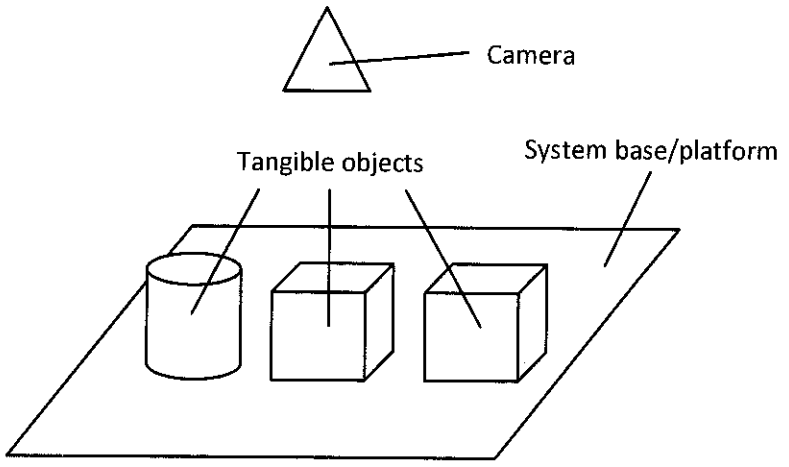

Figure 4.3 *System setup sketch*

4.3 Prototype & Screenshots

After the design was finalized, a prototype for the system was developed. This prototype was built for the purpose of testing before the actual system is developed. This will help to save costs in term of money, energy and time as the prototype will show if the design has any flaws. The prototype will be tested and analyzed to find any improvement that can be put into the design for the implementation of the actual system later on.

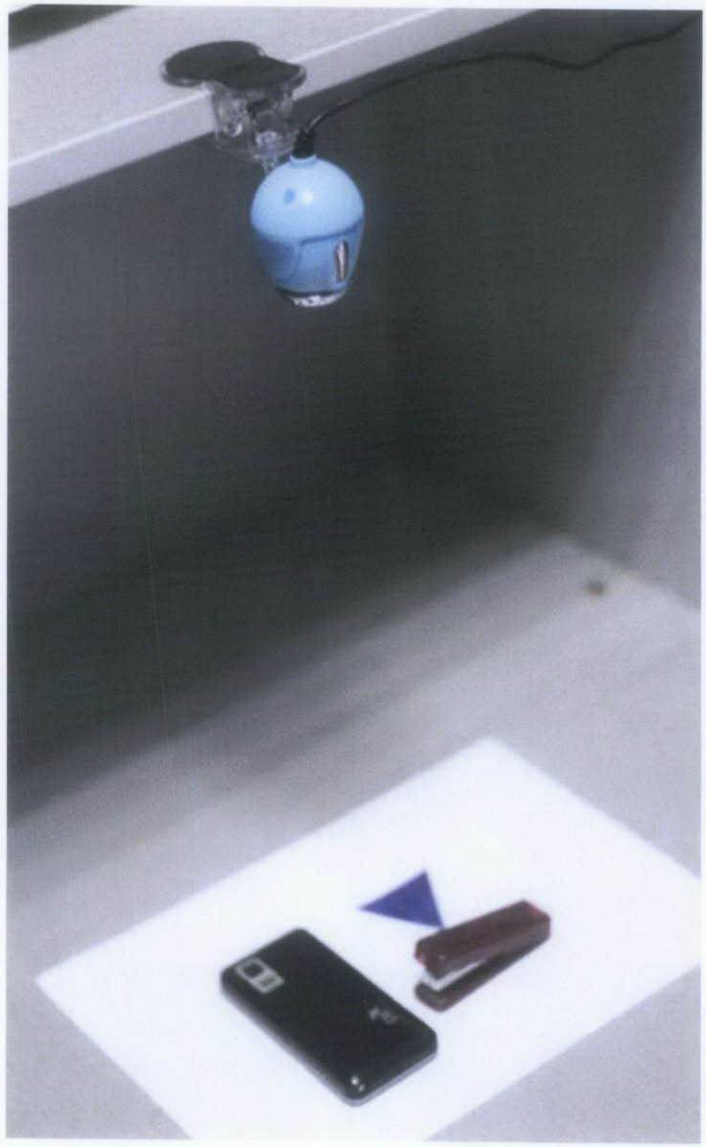

Figure 4.4 *Prototype setup*

The setup for the system prototype is as shown in Figure 4.4. For the prototype and testing purpose, few random objects were used to test the ability of the system to detect them. The base or platform need to be contrasting with the objects colour, so a white paper was used for the prototype test.

Figure 4.5 *Main interface*

After the camera device is selected and run, the image captured from the device will be displayed on the system interface. The system provides three views. The first view is directly from the camera so that the users can learn the area covered by the system. This will avoid the object manipulation outside the covered area by the users. The second view labelled "Color Differentiation" displays the extracted image through colour extraction. This will help the users to see what objects are detectable and what are not. This will give them the idea on what colour and size of the object should at least be in order to be detected by the system. Then, they can manipulate the setting of the object detection by changing the colour of extraction, range of the colour, and also the minimum size of the objects in the images. On the third view, the layout is previewed. This will help the users to decide whether they are satisfied with their design yet or not. Once the users have satisfied with the design, they can generate the layout in blueprint view by clicking the "Generate Layout" button on top of the preview screen.

The technical process behind this part is started with capturing frames of the video produced by the camera. From the frames, every image will be processed which make the system actually runs in real-time process.

The image will be converted first into greyscale mode. This greyscaled image then would be filtered using the wanted colour range. This colour range can be changed according to the users and situation preferences. The colour range filtering means that the colours that in the selected range will be removed from the image if it exists in the image. This will then produce an image with only the wanted objects appear in it (if the correct base colour range was filtered).

With the objects appearing and base colour filtered image, the edge points of every object can be detected using Blob finder function under AForge.NET Library. Based on the edge points, a border can be drawn around each object for object highlight and layout generation.

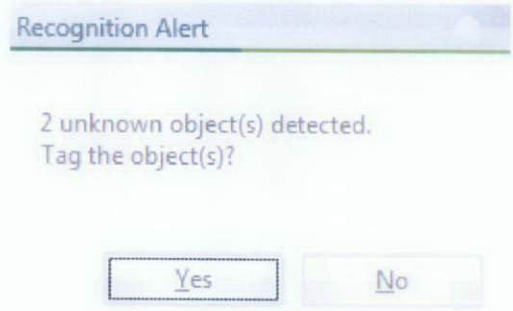

Figure 4.6 *Object recognition alert message*

Once the users decided to generate the layout the system will calculate how many unrecognized objects are found in the to-be generated design. A pop-up message box will appear to inform the number of the unrecognized objects and prompt the users whether to specifically tag those respective items with names for further manipulation, or not.

The technical process behind this part is done by first counting the number of detected objects in the latest processed image when the "Generate Layout" button was clicked. This number of the detected objects is then used for creating a temporary array of class object with the size of it for later labelling purpose. Next, each detected object will be compared with the ones saved in the memory before (if they are any). If the object is proven to be matched or same with the any of the ones saved, it will be considered as already recognized and one from the sum of the latest detected objects will be subtracted. This process will be done until all the latest detected objects are compared. From that, the number of the unrecognized objects will be gained. If all the latest detected objects are matched with any of the ones saved in the memory, the number of unrecognized objects would be zero, which would not make the popup message appear; skipping a few processes and the system then would eventually show a window similar to the one shown in Figure 4.8.

However, for the current state of the project, the comparing process is still not running correctly. An unsolved challenge or bug was found on this part of the system. The bug is caused by the changing values or characteristic of the detected objects which make even the same object is failed to be determined as already recognized, same or matched after being saved once.

Slight change in lighting or shadow or movement affects the objects' characteristics in the latest processed image, even just because of only a tiny pixel change. This generates great differences for comparison, causing unrecognizable saved or tagged objects. Until this bug is fixed, the popup message will always appear indicating new unrecognized objects are found and prompt the users to choose whether to again tag them or not.

***Figure 4.7** Object recognition/naming interface*

If the users click "Yes" to tag the unrecognized objects, the window as shown in Figure 4.7 will appear. This window enables the users to name each object (in sequence of size as indicated with the red border highlight) by typing desired name in the textbox and then clicking the "Assign" button. Once assigned, the system will keep track of the object as the data of the object is saved into the temporary memory. If the users click "Skip", the object would be automatically named "Unknown", no data would be saved upon this choice. In case of the users click "No" on the popup message as shown in Figure 4.6 before, all the objects is assigned "Unknown" temporarily for that layout generation.

For this part, there are a few technical processes. First is in term of highlighting the on-focus object and the other one is in saving certain information into the memory. The original unprocessed image is taken and used for this purpose. Based on the detected objects, a loop is developed enabling one by one object's edge points to be gathered and drawn into border. The border is drawn on the original image (around the actual object image) in red colour as the highlight of the on-focus object.

The loop is paused with the popup of the prompt window. If the users click "Assign" button, a new object of class for recognized objects will be created in the memory. The string text in the textbox will be picked and set as the class object's tag name variable value. Other characteristics of the object such as mean colour, size and edge points' position would also be gathered and stored as the values of the new created class object's respective variables. These are the values used for the comparing process. At the same time, the tag name and the center coordinate of the object is also stored into the earlier created array. On the other hand, if the users click "Skip", no new object of class for recognized objects will be created in the memory. Instead, string text of "Unknown" is assigned as the tag name to the temporary array object values, together with the center coordinate of the object for labelling purpose later.

Only after either one of the "Assign" or "Skip" button is clicked, the loop is continued and the same process repeats until all unrecognized objects are highlighted. Every time a new red highlighting border would be drawn, the one drawn before it would be cleared first, leaving only the current on-focus object to be bordered with the red colour line or appeared as highlighted. By the time the loop is finished, the temporary array will contain all the detected objects' names and center coordinates for later labelling purpose.

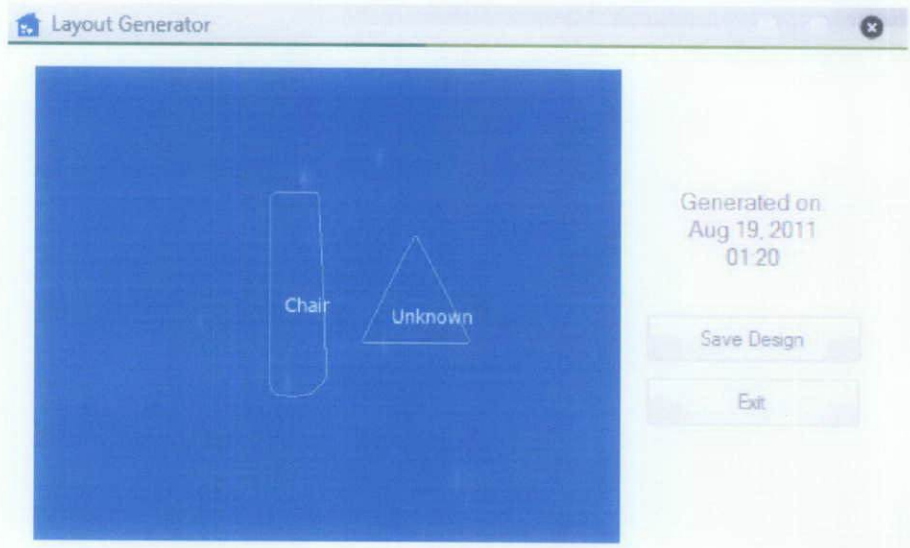

Figure 4.8 *Layout generator interface*

After the object recognition process is done, the layout or blueprint will be displayed as exampled in the Figure 4.8. The users can choose whether to save the design or not. If yes, the users can pick the directory and save the file wherever they want. The format of the saved file is in image format. JPEG, GIF, PNG and Bitmap are the format types that the blueprint can be saved in, according to the users' preference. By default, the format type is JPEG. Else, if the users choose not to save the design, the users can exit and go back to the main system interface for further design or to fully exit the main system.

In this blueprint layout generation part, the technical processes are basically only on converting the layout preview image colour, and the retrieving the tag names and center coordinates for labelling purpose. The image in Design Preview view as you can see in the Figure 4.5 when the "Generate Layout" button was clicked is captured and used for the final blueprint layout generation. This is because the layout to be generated is the same as shown in the Design Preview view, except it only needs to be converted into blue and white colour like the other usual blueprint layouts. In order to do so, a loop through every pixel of the image is done. Every black pixel will be changed its colour into blue, while every green pixel is changed into white – producing blue and white blueprint layout.

All left then is to retrieve the tag names and center coordinates for the layout labelling. Using all the values in the earlier created temporary objects array, all the respective object tag names are written on the layout according to their own center coordinates. This results into the production of the finalized labelled blueprint layout of the decoration design that will be shown in the Layout Generator window. The layout is then available for the options of the users to choose whether to save it or not, and continue with the tangible objects manipulation until the system is closed.

4.4 System Flexibility

A few tests on the system flexibility have been conducted. The system has been setup using a few different types of camera device and also tangible objects. This is to test the system flexibility in term of the device used and detection ability.

4.4.1 Camera Device

The prototype has been setup using different camera device to see whether the system needs certain specification of the camera in order to be able to work with the system or any device can actually be used to work with it. Here is the summary of the test.

Device used	Detection by system	Image production	Image resolution (pixel)	Frame rate (fps)	Layout / Blueprint generation
Acer Aspire 4736G Built-in Webcam	Yes	Yes	320x240 640x480	20	Yes
Migix MS-825 Webcam	Yes	Yes	640x480 1280x960	15	Yes
CSL G4 Handset Camera	Yes	Yes	640x480	25	Yes

Table 4.1 *Camera device flexibility test result*

This test has proven that the system is flexible in working with various types of camera device as all the laptop built-in webcam, external webcam and handset camera functioned well with the system. All the devices were detectable by the system and able to produce the real-time image for the system to process.

Although each device produce different image resolutions, and run at different frame rates, all the layouts or blueprints that have been generated were same. This proves that different device used does not affect the layout or blueprint generated although they worked in different resolutions and frame rates. The

result was conserved throughout the entire device test. This shows that the system is flexible in term of device used which makes it easier for different users to setup the system using their own preferred device.

4.4.2 Tangible Objects

The prototype was further tested by using different tangible objects. The orientation of the objects was varied in colours and shapes to see whether the system would be able to detect them in many different attributes. For the test, some variable has been fixed, for example, the filtered base colour range and minimum detectable object size was not changed, white paper has been used as the base of the system, and Migix MS-825 Webcam was selected as the camera device.

Object	Colour	Area/size ($pixel^2$)	Height (cm)	Shape	Detection Level
1	Black	2500	2.0	Square	High
2	White	2500	2.0	Square	None
3	Dark blue	2000	0.4	Circle	High
4	Dark blue	2000	0.4	Triangle	High
5	Soft blue	3000	1.0	Triangle	Low
6	Pink	3000	1.0	Abstract	Low
7	Dark red	3000	2.0	Abstract	Low

Table 4.2 *Tangible object flexibility test result*

From the test result, the tangible object flexibility of the system is quite low. The system cannot clearly detect object that possesses similar or almost similar colour with the base colour. However, different size, height and shape do not really affect the object detection of the system.

Although most of the objects are detectable, the detection level is quite low for objects with abstract shape, as the system cannot really read the edges of the object, hence, producing slightly different shape of the objects.

Basically, this test results in the fact that the system can be used with random tangible objects for flexibility of the users, as long as the objects are contrast with the base colour for easier and better object detection by the system. This will enable more creative and fun home decoration activity whereas many random items can be used to represent the furniture.

CHAPTER 5
CONCLUSION & RECOMMENDATION

5.1 Conclusion

Supported by the researches and theories done and found throughout the development of this project, the system should be able to encourage more interaction between family members, thus foster stronger family bond. This is the result from the studies on family issues which help the system to be built with features and benefits that would tackle some of those general issues in order to improvise or enhance the family bonding. The most important feature of the system is it enables fun collaborative home decoration activity which would encourage more time to be spent together, better understanding and communication, and also happy environment in the family. All these things will benefit into a stronger bonding among the family members.

Next, for further future development of this project, more testing should be carried out in order to collect more valid data to measure and support the successfulness of this project in achieving its objective to enhance the family bond. The unsolved challenge or bug in the comparing process should be solved or fixed to produce fully functioning prototype which is important for more realistic tests. With reliable data from the testing, the system itself might also be improved in term of the idea and also technical. More features could be added into the system to further encourage the interaction of the users, thus, support the system to achieve the objective successfully. Plus, the bug that this project currently encounters is actually one of the common unsolved yet problems also faced by the other programmers in image processing field, so by solving the problem, not only this project would benefit, but the whole field.

Finally, once all the system features are complete and actual system is developed, User Acceptance Test and field tests should be conducted and only then the project success can be really measured or determined.

5.2 Recommendations

As stated in the Conclusion part, many still have to be done in order to really finish this project and evaluate its success.

For the unsolved bug, a suggested comparing or recognition algorithm was designed and yet to be developed to fix it. It is suggested that a few layers of comparing process must be conducted until the result is gained. The suggested comparisons are in terms of first, mean colour of the object, second, area or size of the object and last, object's edge points position. Only when the earlier layer of comparison results in match or same, the next one will be conducted. This will help reducing unnecessary processes and save processing time as the later layers would not have to be carried out if even the first layer of comparison already produces unmatched result which means the compared objects are different and there is no point to further compare them. The comparison layers are arranged in that sense based on the sequence of shorter to longer computational time so that more computational time can be saved. Still related to the challenge encountered, this algorithm would not run correctly due to the changing values, so a suggested solution is to find an acceptable range of value for each comparing characteristic. In order to find the acceptable ranges, further studies have to be done on the basic formula of each value calculation.

Other aspect that can be improved is the lighting and/or shadow filtering. The system should be able to retrieve sharply only the object perimeter shape (ignoring the shadow pixels) so that more consistent characteristic values can be obtained for comparing process. More flexible tangible objects usage feature should be also tried to be enabled and implemented into the system in the future. One of the ideas is to have better handling of shiny objects developed.

Other than that, the coding of the system should be reviewed. Any possible improvement should be implemented especially in reducing processing time so that the system can be used in more realistic real-time mode – without delay of the processing lag. There is believed to be many other better code structures can be implemented especially in looping and argument processes to replace the basic structure the current system is currently developed with. Smooth running system would grant the project another advantage as surely it would satisfy the users.

REFERENCES

[1] Lifeline. (2010). *What are Family and Relationship Problems?*

[2] Steele, R. G., Forehand, R., & Armistead, L. (1997). The Role of Family Processes and Coping Strategies in the Relationship Between Parental Chronic Illness and Childhood Internalizing Problem, *Journal of Abnormal Child Psychology, Vol 25, No. 2,* pp. 83-94.

[3] Walsh, F. (2006). *Strengthening Family Resilience.* Guilford Press. p. 7.

[4] Kakli, Z., Kreider, H., Little, P., Buck, T., & Coffey, M. (2006). Focus on Families!: How to Build and Support Family-Centered Practices in After School, *Harvard Family Research Project.*

[5] Video Games & Family, *Entertainment Software Association website,* http://www.theesa.com/gamesindailylife/families.asp, retrieved on 7th July 2011.

[6] Schneider, B., Jermann, P., Zufferey, G., & Dillenbourg, P. (2010). Benefits of a Tangible Interface for Collaborative Learning and Interaction, IEEE *Transactions on Learning Technologies, IEEE computer Society Digital Library. IEEE Computer Society.*

[7] Hoonhout, H. C. M., & Fontijn, W. F. J. (2007). Functional Fun with Tangible User Interfaces, *Proceedings of the The First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning,* pp.119-123.

[8] Nadeau, B. & Williams, A. (2009). Tactful Interaction: Exploring Interactive Social Touch Through a Collaborative Tangible Installation, *Proceedings of*

the 3rd International Conference on Tangible and Embedded Interaction, pp. 147-152.

[9] Stanton, D., Neale, H., & Bayon, V. (2002). Interfaces to Support Children's Co-present Collaboration: Multiple Mice and Tangible Technologies, *CSCL '02 Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community International Society of the Learning Sciences.*

[10] Waldner, M., Hauber, J., Zauner, J., Haller, M., & Billinghurst, M. (2006). Tangible Tiles: Design and Evaluation of a Tangible User Interface in a Collaborative Tabletop Setup, *OZCHI '06 Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments.*

[11] Belongie, S., Malik, J., & Puzicha, J. (2002). Shape Matching and Object Recognition Using Shape Contexts, *Pattern Analysis and Machine Intelligence, IEEE Transactions on, Vol. 24, No. 4,* pp. 509-522.

[12] Sadr, J., & Sinha, P. (2004). Object recognition and Random Image Structure Evolution, *Cognitive Science, Vol. 28,* pp. 259–287.

[13] Riesenhuber, M., & Poggio, T. (1999). Hierarchical Models of Object Recognition in Cortex.

[14] Viola, P., & Jones, M. (2001). Rapid object detection using a boosted cascade of simple features, *Computer Vision and Pattern Recognition, IEEE Computer Society Conference on In 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Vol. 1*, pp. 511-518.

[15] Patnaik, R., & Casasent, D. (2008). Object recognition benefits from fast new algorithms, *SPIE Newsroom.*