DubTouch: Exploring Human to Human Touch Interaction for Gaming in Double Sided Displays

Oğuz Turan Buruk
Design Lab / Koç University
Istanbul / Turkey
oburuk@ku.edu.tr

Oğuzhan Özcan
Design Lab / Koç University
Istanbul / Turkey
oozcan@ku.edu.tr

ABSTRACT
Human to human touch interaction (social touch) has not been investigated thoroughly as a control apparatus for gaming purposes although it holds potential. Therefore, we have developed the concept of DubTouch which is an interactive environment comprised of double sided display and touch areas where two players can touch each other. To investigate its potential, we conducted two step research method comprised of a *user study* and a *design workshop*. As a result of the user study with 10 participants, 6 categories of social touch patterns are generated. Two of these categories, found both intuitive and exclusive to DubTouch according to our evaluations. *Design Workshop,* with 10 experts, concluded with two games. The properties of control schemes of these games match with the results of the user study. Moreover, our observations showed that both games have created uncommon gaming experiences by utilizing social touch and by benefiting face to face positions of players.

Author Keywords
Game; social touch; human to human interaction; double sided display; gaming; social; exertion games; exergames; touch patterns; gestures; tangible interaction.

ACM Classification Keywords
H.5.2 Evaluation/methodology - *Input devices and strategies* - *Interaction styles*

INTRODUCTION
The general concept of a double sided display is already provided with two computers connected to a network. This kind of structure lets players manipulate or control the content in their own screens separately, but we believe that an interactive environment with a double sided display is more meaningful if the players can physically interact with each other especially while playing games. In that sense, physical interaction may mostly occur with human to human touch (social touch). Differing from the sense of touch which is obtained by everyday objects, social touch refers to touch interaction between people [14].

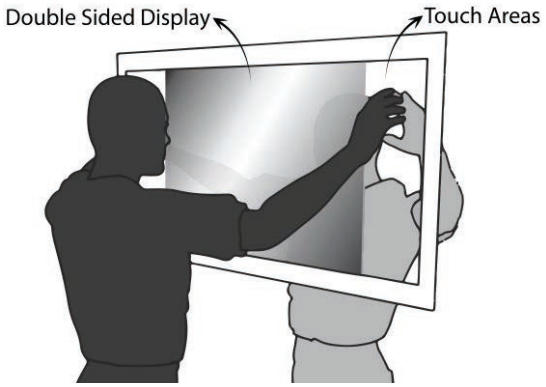

Figure 1: Concept of DubTouch

Utilization of *social touch* in digital gaming holds the potential to create new opportunities for innovations in gaming area. The use of social touch may let us design games which involves other humans and their body parts as control devices. The way two people *touch* each other shows great diversity and it is possible to create patterns according to the shape, intensity and the position of the touch. The different kinds of touches are actually considered specific symbols and they raise similar feelings and reactions in the bearer of touch as well as the receiver of the touch [11]. This fact indicates that it is possible to design games enhancing social interaction which can be played via social touch.

Therefore, we have developed an interactive environment concept called DubTouch (Figure 1) which two players can touch each other while playing digital games. In this respect we expect DubTouch, if it is successfully built, to create new gaming experiences with social touch and face to face positions of players emanated by double sided display and create a new control style based on social touch.

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To support this hypothesis, we have conducted a *two-step research method*. In the first step we ran *a user study* with 10 participants. In the second step, we organized *a design workshop with 2 game designers, 2 developers, 2 illustrators, 2 modelers and 2 interaction designers*. In this paper, we discuss the results to provide insights about the capability of DubTouch interactive environment to be used in the gaming area.

BACKGROUND AND RELATED WORK

Human to human interaction has been the subject of research in the digital gaming field. Although online or co-op games provide interpersonal interactions, gaming experience in the social context is not prosperous enough to be compared with face to face interaction of traditional games [17]. Several research projects named as *Fish Pong* [24], *Human Pacman* [5], *Touch Space* [6], *Pirates!* [2], *Propinquity* [22], *Pass the Bomb* [19], *i-dentity* [8], *JS Joust* [23] take human to human interaction to their base. The aims of the games in these studies are to blend the virtual environments to real life by creating social interactions between people which resemble the real life interactions. These studies are mostly built on the principle of spatial awareness of players differing from the online gaming by letting players to see and feel each other while playing. According to these studies, this type of interaction has the potential to enhance the gaming experience by adding social interaction opportunities. Nevertheless, all these games in the indicated researches have no or little use of *touch sense and tangible feeling* of players. The sense *of touch and its social properties* are not studied thoroughly in these works.

Touch as a *social interaction device* is a phenomenon. Social touch may be considered as a supportive communication device between people since it can be categorized due to its properties. Symbolic meanings of touch have been categorized under six different properties: *positive affection, control, playful, ritualistic, task related and accidental touches*[11]. Another categorization for social touch gathers the types of touches under three categories which are simple, protracted and dynamic. If a touch is limited to specific parts of the body like hand or arm, it is called *"simple touch"*. The other type, *"protracted touch",* refers to skin to skin contact involving pressure which is available for a longer time. The third type is the *"dynamic type"* which is continuous and mostly iterative such as stroking [14]. These types and categories show that different meanings or commands can be assigned to touch since it bears different patterns and meanings in itself. Several studies have made use of these kind of meanings [4,14,18,21] yet these meanings have not been considered as an input device which can be used in games.

Some studies examine *social touch as a digital interaction device*. *Freqtric Drums* provides audial feedback when the users touch each other to provide a musical interface [1]. *Enhanced Touch*, proposes an electronic bracelet which gives feedback when users touch each other and keeps track of touch patterns [15]. Another study, *Touching a Stranger,* provides audial feedback and visual feedback in results of touches to the different part of users' bodies [12]. Furthermore, *Musical Embrace* [13] is a game in which two players embrace a pillow-like controller and each other at the same time to control the game character. However, none of these studies investigate *social touch* as a detailed game control mechanism to which complex commands can be assigned.

Overall the information provided here indicates tha*t social touch* has not been explored thoroughly although it could be a valuable source for digital gaming. It could enlarge the possibilities of new game mechanics and at the same time create opportunities for social interaction which is lacking in computer gaming. Moreover, as seen in the studies about social touch, different touch patterns may carry different meanings which strengthens the possibility of social touch to be used as a control device.

Depending on these analyses, we designed the interactive environment, DubTouch, to try to fill specified gaps.

METHOD

We conducted a two-step research method to explore the potential of DubTouch. These steps are:

- *User Study* to understand users' expectations and impulses on social touch based control system
- *Design Workshop* to design games using social touch as a control scheme benefiting from the results of user studies

Our aim by conducting this study was to understand (1) if users can intuitively find touch patterns for commands, (2) if the proposed touch patterns have an exclusive value, (3) if these control commands can be categorized, (4) if games can be developed according to user expectations, (5) if designed games for DubTouch have potential to provide an added value for digital gaming.

Touch Patterns are defined as the characteristics of the social touches depending on the movement area and posture of the hand, touch style, one or two hand usage and collaboration of users.

User Study

In this first step, we conducted practices with users individually to elicit ideas from their suggestions and understand their expectations about the DubTouch environment. We used an experience prototype of DubTouch to conduct these user studies. Obtaining ideas from users and include them in the design process has also been used before in previous research[16].

Participants of User Study

In this step, we gathered 10 users (6 females, 4 males, Age Ave: 22; *sd* = 0,18). Half of the users play games actively

in their daily life while the other half does not play often and mostly prefer casual/mobile games. We preferred this kind of difference since we wanted to explore alternative reactions by different user types to explore the furthest possibilities.

The Experience Prototype of 'DubTouch'

Experience Prototype (Figure 2) means a representation of the product which is used for understanding the possible experience while interacting with it. Experience prototypes are suitable for understanding the user and exploring new ideas with them [3]. This prototype benefits us as we wanted users to be involved with the study from the very beginning. Our reason for using an experience prototype before implementing the working prototype is (1) to not restrict users with technological constraints during the conceptual development phase, (2) to explore distinctive ideas and reach the extreme alternatives, (3) to clearly understand user needs and expectations.

The conceptual setting of "Dub Touch" was designed as a double sided display which enables an interactive environment which Two Users can touch each other through touch areas. In the experience prototype, we used 100x70cm transparent acrylic sheet and two touch areas, cut out from cardboard, in both sides which were spared for users to touch each other. Both of these areas' dimensions are 24x53 cm. One of the touch areas also was covered with an elastic material which let players feel each other but restrict their movements. The other one is not covered and left empty allowing users to move their hands freely. We also wanted to understand if the users prefer a restricted or an unrestricted area to touch the other player. Other than that, the acrylic sheet used was transparent since we wanted to communicate with users during the user studies. In the design workshop, designers were allowed to modify the screen by attaching opaque paper to the acrylic sheet which prevents players seeing each other.

Phases of the User Study

Each sessions of the User Study were operated with only one user. User Study sessions were constructed from 4 phases which are *"Rigid Object", "Amorphous Object", "Emotional Recalling" and "The Game"* (Figure 3). In sessions, the designer was in the role of the 2nd user as well as the moderator. The participant was in the role of 1st user. In each session, the designer controlled the objects, which were assumed as the digital content, to help the user visualize the effects of their interactions with the 2nd user by social touch. Other than that, in the phases where we could not simulate the setting by using existing probes, the designer helped users to visualize the scenes by explaining the properties of the content in the screen. In sessions, we asked users to design touch patterns for specific commands. For example, we wanted users to define a touch pattern for "rotating the rigid object".

Figure 2: Experience Prototype of DubTouch

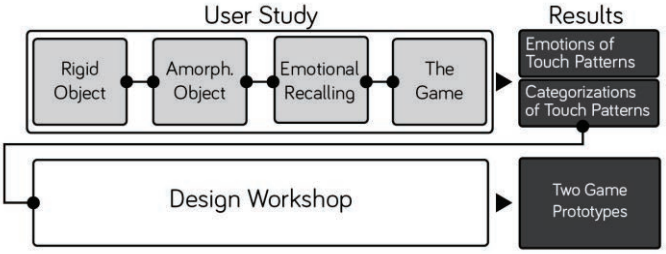

Figure 3: Structure of Research Method

Each participant was asked to conduct 27 tasks, which will be explained along with the phases in the paper, and they suggested between 27 to 35 patterns. The total number of the patterns designed for control commands is 340. However, this number does not reflect the unique number of patterns since some of them are the same or very similar.

Phase1: Rigid Object

The Rigid Object phase provided an insight about the capabilities of social touch interaction in controlling a rigid object by manipulating its basic transformation values. As an object, we used a *cardboard cube* (Figure 4/a) and we tested the commands *rotate, translate, scale, explode, smash, standing on a corner and morph*. The first three commands are the most used actions in games as the characters in most games perform three fundamental actions which can be counted as moving *forward, backward and sideways, turning and looking*. The other commands let us to understand the capability of touch patterns to provide control possibilities for actions falling outside range of the generic commands. Apart from the remarked commands we also asked users to propose an

Phase2: Amorphous Object

Since touching by the human hand can provide more organic interaction compared to using a game pad or keyboard, social touch may be appropriate for manipulating and controlling an amorphous object. To see the outcomes of the control commands for amorphous objects, we have used an *elastic fabric* which was fixed to two cardboard pieces (Figure 4/b). Our aim was to make users illustrate the movements of an amorphous object easily in their minds. In this session we asked users to design patterns for *expand, roll, twist and deform*.

Phase3: Emotional Recalling

Although the definition of game does not necessarily include the narrative, most of the digital games today adopt narrative as an important element. Narrative property of games evokes different kinds of emotional reactions in the user by using cinematographic representations. Moreover, according to Fagerberg et al., active loop concept iscons if a game reacts to the player, in the same direction with his/her emotional expressions, this will effect player's body and mind emotionally too [7]. Other than that, most touch is actually considered as specific symbols and they evoke similar feelings and reactions in the bearers of touch as well as the receivers of touch [14] which creates a potential for creating touch patterns which are capable of conveying recognizable emotions. Therefore, in this phase, we will explore if the touch patterns are available for conveying emotions and interpret whether they have the potential to be used in games with narrative. We refer emotions which are reflected through narrative experiences.

The Emotional Recalling phase has two stages. In the first stage we wanted users to name the emotions they felt when 2nd user touched their hands by using pre-defined touch patterns (Figure 5). We defined these patterns according to the categorization which gathers the type of touches under three categories: *simple, procreated and dynamic* [11]. We made every pattern should fit in these categories and be distinctive from each other to be recognized easily.

In the second stage, we wanted users to define touch patterns for specific emotions. The most recognizable emotions by humans are happiness, sadness, fear, anger and surprise [25]. In the direction of this information, we decided to ask users the emotions of *joy, love, melancholy, fear and thrill* considering that these are also the most emphasized emotions in game narratives.

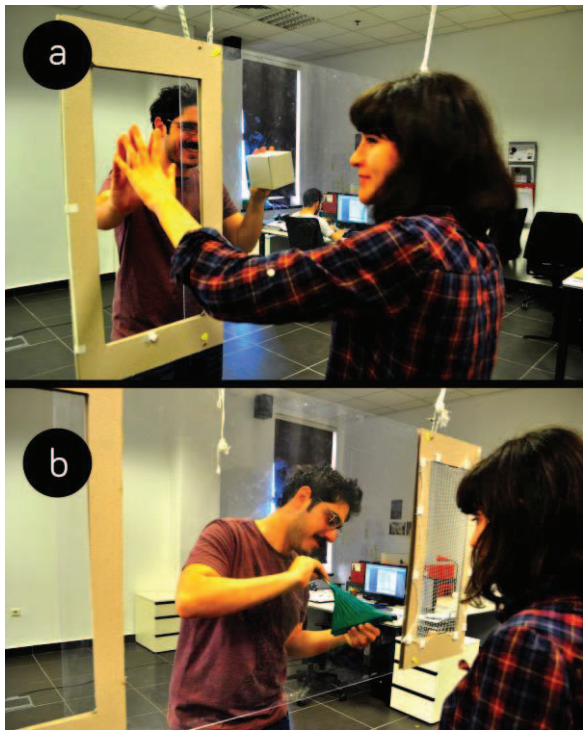

Figure 4: User Study: (a) Cardboard Cube (b) Elastic Cloth

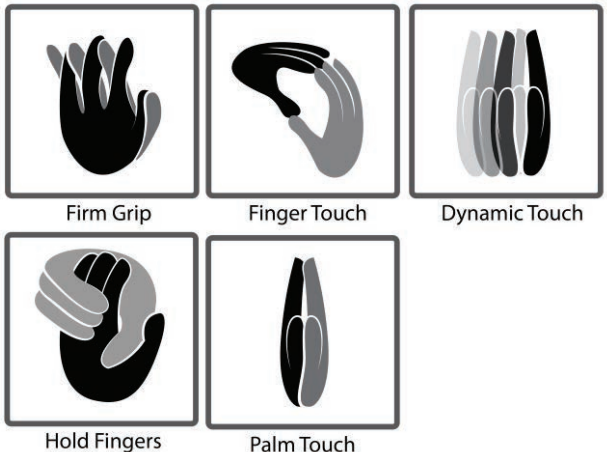

Figure 5: Pre-defined touch patterns which are used in Emotional Recalling Phase

Phase4: The Game

The last phase of the session is a two leveled game which creates space for users to test the patterns they designed. *The first level* of the game consists of a rigid object and an amorphous object. The aim of the level is to put the rigid object to the hole which is placed to the top right corner of the display. This hole is also covered with wood pieces and these pieces should also be destroyed. However, the player is not able to carry the rigid object to the hole since it is quite heavy to carry. The user needs to make use of the amorphous object like a trampoline for throwing the rigid object in the hole.

The second level of the game tests if the patterns produced in the *Emotional Recalling* phase can be used in meaningful actions. In this step, we imagined a scene where colorful cubes are tumbling around a complete black background. We wanted user to imagine this scene as if it is a cut scene in a game and to integrate emotions which would affect the narrative of the scene by using the touch patterns.

These two levels are conducted in a role playing format. The designer explained the scenes to the users to help them create these scenes in their imaginary worlds. The artifacts, rigid object and amorphous objects, were also used when they are needed.

The user study resulted with 6 different categories generated according to the characteristics of touch patterns proposed by users. The outcomes of the user study were used in "Design Workshop" by experts.

Design Workshop

The second step of our research method is the *Design Workshop.* In this step, experts benefited from the results of

the user studies to design games for DubTouch. The aim of the workshop was to understand if games which have added value and meet with the user expectations can be designed.

Participants of Workshop

2 sound designers, 2 programmers, 2 illustrators, 2 modelers and 2 interaction designers participated to workshop. These participants were divided into two teams. Each team had at least one participant from each expertise area. In each group there were 3 participants who are actively involved in game development.

Procedure of Workshop

At the beginning of the workshop, a presentation about the "design thinking" approach was presented to participants. Moreover, booklets which explain the results of user studies were given to participants to make them aware of user needs and expectations.

The experience prototype of DubTouch was also supported with pico-projectors allowing participants to project visuals to both sides of the screen. However, they had to simulate the touch commands with "The Wizard of Oz" method. In this method, two group members controlled the games from the computers while the players try to accomplish tasks by touching each other.

The workshop ran continuously for 48-hours like game jams. First 12 hour of the workshop was spent on the sketches about game mechanics and concepts. Participants actively used the experience prototype while sketching about games. After teams decided their game concepts, they spent the rest of their times to the development of the games. At the end of workshop we have obtained working prototypes of the games.

Two games were created at the end of the workshop, called *"d-Coder"* and *"Worm Hole"*.

RESULTS AND DISCUSSION

In user studies, as a result of *Rigid Object (Phase 1), Amorphous Object (Phase 2)* and *The Game (Phase 4)*, we have come up with *categorizations* of *social touch patterns* which can be used in gaming area. We have evaluated each

Figure 6: Design Workshop

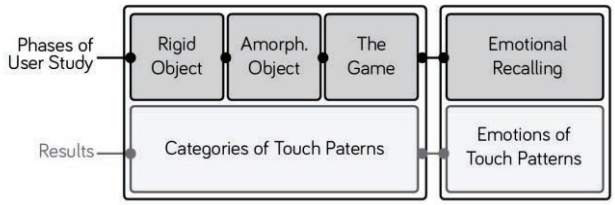

Figure 7: Relation of User Study with Results

of these categories in the means of 'exclusive value' and 'intuitiveness'. Moreover, we also have results of *Emotional Recalling (Phase 3)* which indicate that the touch patterns may convey same messages or feelings for different users.

The Exclusive Value of patterns was evaluated by reviewing their different characteristics from the command languages of the existing environments like gesture controlled interactive systems and touch screens. We have considered patterns *exclusive* if their replication in the existing environment was not likely to create the same experience.

Intuitiveness is the respond time of the user to a specific feedback. The shorter the respond time, the more intuitive the feedback is [9]. In our research, we did not take account the time passed since the users were in the design process and were encouraged to think about the patterns while proposing them. Users created several different touch patterns for some commands. Our *intuitiveness* definition only includes the *first proposals* of the users.

Categories of Touch Patterns

To identify *touch patterns*, we took video records of each user and noted every touch pattern proposed by users. We analyzed touch patterns by observing from the videos and group those under six categories according to their distinctions. These distinctions are explained below:

1. **Direct Manipulation:** Direct Manipulation refers to actions which aim to control the content directly by manipulsating its physical properties. Although, our environment does not let player to touch the object directly over the screen, the patterns which are transferred directly from the touch screen interaction, which mostly depends on direct manipulation, falls under this category.
2. **Two Hand:** If the touch pattern requires the use of both hands, it falls under *Two Hand* category.
3. **Hand Posture:** This category represents the patterns which the user makes use of the different kinds of touch postures. For example, usage of a *firm grip* or a *fist* belong this category.
4. **Two Users:** Patterns which are composed of the different or synced actions of Two Users were put under the category of Two users. In general, it may be expected that the nature of the DubTouch will force

users to design patterns in a way that include both of the users in the action. However, some patterns are proposed as if they are conducted without the contribution of the second user. Therefore, the patterns which is involves both users effectively are put under this category.

5. **Physical Impact:** The Physical Impact category indicates the patterns which depend on the force applied by users to each other. For example, strongly pushing to each other's hands with a force.

6. **3D Space:** Some actions led users to make use of the 3D Space in the touch areas. Users mostly prefer this kind of movement if the related action requires movement or presence in 3 dimensional space.

Category	Total Number	Intuitive Patterns	Evaluation out of 10
Direct Manipulation	88	73	10
Two Hand	34	25	4
Hand Posture	65	56	9
Two Users	88	69	10
3D Space	26	24	3
Physical Impact	38	33	4
Total	**340**	**280**	

Table 1: Total and Intuitive Pattern Amount

We have evaluated these categories in the means of intuitiveness and exclusive value. *Intuitiveness* measurements guide us in the user's expectations and impulses about human to human touch interaction in a digital interactive environment. **Table 1** shows number of the intuitive touch patterns falls under each category. *Direct Manipulation, Hand Posture* and *Two Users* are the categories under which "intuitive" patterns are clustered. The evaluation out of 10 is done according to the category which has the highest number of intuitive patterns. We set the grade 10 for "Direct Manipulation" and rated the others proportionally.

It is not surprising that *Direct Manipulation* is among one of the most intuitive categories since it has become a standard for interacting with 2D objects [20]. However, *Two Users* and *Hand Posture* categories bear more importance since the structural nature of DubTouch proposes an interaction which focuses on hands and collaborative usage. Thus, these results indicate that the DubTouch environment can be used intuitively by users in the way we illustrate.

Table 2 presents the number of patterns with *Exclusive Value* under each category. The evaluation out of 10 is calculated according to the ratio of patterns with exclusive value to the total amount of patterns distributed under the same category. According to the evaluation, patterns falling under the *Physical Impact, Two Users and Hand Posture* categories are mostly original patterns which are not encountered in existing game control languages.

Category	Patterns with Exclusive Value	Evaluation out of 10
Direct Manipulation	14	3
Two Hand	6	3
Hand Posture	39	8
Two Users	51	8
3D Space	8	4
Physical Impact	30	10

Table 2: Exclusive Value of Touch Patterns

Two Users and Hand Posture have exclusive value, since in gaming field face to face positioning and use of hand postures are not common. Another category having high exclusive value is Physical Impact. Although it is not valued as intuitive in our research, commands requiring physical force such as "explosion" and "smash" are mostly responded with patterns under the *Physical Impact* category. The *Two Hand, Direct Manipulation* and *3D Space* are expected as non-exclusive categories since WIMP, gestural interfaces and touch interfaces include the control styles matching the characteristics of the touch patterns of these categories.

According to our evaluations, these results support our conceptual environment since the structural nature of the DubTouch requires the collaboration of *Two Users* and utilization of *hand postures*. Therefore, we propose that touch patterns which falls under these two categories will work better for the DubTouch games. In addition, all users designed patterns falling under the *Physical Impact* category for the "explosion" and "smash" commands. Thus, this study needs to be expanded by investigating touch patterns for other commands commonly used in the gaming field. Moreover, low grades of the *Two Hand* category in intuitiveness measures may be the hint for using hybrid control mechanisms. Since one hand of the users is not usually used, the social touch control mechanism may be combined with gestural or touch interfaces.

Some of the touch pattern categories like *Direct Manipulation, 3D Space* and *Two Hand* express similar properties with the mid-air [10] and 2D gestures used in games. However, this study is based on the investigation of the touch patterns which can occur as a result of hand to hand touch of two people. These 3 categories were not the aimed results of this study being opposite to categories of *Hand Posture, Two Users* and *Physical Impact* which have high grades in the aspect of exclusive value. Therefore, these categories combine novel control mechanisms which cannot be encountered on previous platforms using mid-air,

2D gestures and tangible interfaces including kinesthetic and haptic feedback.

Emotions of Touch Patterns

The Emotional Recalling Phase is a two-staged phase. As a first stage, we touched the user's hand with previously designed patterns (Figure 5) and wanted the user to express the feelings or messages received. In the second stage, we wanted users to design touch patterns for specific feelings: *joy, love, melancholy and thrill.*

Table 3 gives the number of users who ascribe the written feelings to the predefined touch patterns. For example, two users relate the feeling of "commitment" with the "firm grip" pattern.

Pre-Defined Touch Patterns	Emotions, Meanings and Feelings			
Firm Grip	Commitment *(2 User)*	Intimacy *(3 User)*	Merger *(3 User)*	
Hold Fingers	Help *(2 User)*			
Finger Touch	Exploration *(3 User)*	Transfer *(2 User)*	Distant *(2 User)*	Neutral *(2 User)*
Palm Touch	Collaboration *(5 User)*			
Dynamic Touch	Warning *(8 User)*	Confusion *(2 User)*	Collaboration *(5 User)*	

Table 3: Number of users who expressed indicated emotions for pre-defined touch patterns. Only the emotions expressed more than one user are counted.

According to the results, the users expressed mutual feelings in some of the touch patterns. Although it is clear that they did not share same feeling on one pattern, especially in some patterns like "Dynamic Touch" and "Palm Touch", a higher number of participants expressed mutual feelings. Other than that, commitment, intimacy and merger are related feelings all expressed in the context of a firm grip. The other patterns, *Hold Fingers* and *Finger Touch* do not express a strong agreement although some of the feelings are expressed by more than one user. Nevertheless, touch patterns may carry similar messages or emotions for users if they are designed correctly. Our results are also supported by the previous research about social touch which claims that similar touches convey similar meanings for people [11].

The second step of this phase was to propose patterns for specific feelings which are *joy, melancholy, love, tension and fear.* As seen in *melancholy*, *love*, *tension* and *fear,* the ratio of users who proposes similar patterns have higher numbers (Table 4). If the emotions have a strong connection with touches, similar touch patterns are likely to be proposed for these.

Emotions	Proposed Touch Patterns			
Happiness	Grip and Shake *(2 User)*	High Five *(2 User)*	Giggle *(3 User)*	Caress *(3 User)*
Melancholy	Move Downwards *(6 User)*	Close Fingers *(3 User)*		
Love	Firm Grip *(8 User)*	Caress Gently *(2 User)*		
Tension	Shake *(4 User)*	Dynamic Touch *(2 User)*	Hold Tight *(2 User)*	
Fear	Intense Shake *(3 User)*	Sudden Touch *(3 User)*	Spontaneous Grip *(2 User)*	

Table 4: Number of users who defined indicated touch patterns for specified emotions. Only the patterns proposed more than one user are counted

This phase shows that specific touch patterns may carry similar meanings or raise similar feelings for different users. Clearly, it is not possible to generalize this statement to all kinds of touch patterns. Therefore further study for filtering specific patterns which convey the same feelings to most users need be conducted. We believe that this filtration will benefit us to implement touch patterns to the narrative quality of the games.

Two Games of 48-Hour Workshop

Our 48-hour workshop has resulted with two game prototypes named as *d-Coder* and *Worm Hole.*

d-Coder (Figure 8)

"d-Coder" is a game which combines the properties of a table-top card game and a digital game. In the game, two players have different roles as the *messenger* and the *cracker.* The aim of the game is to progress with the *cracker* cracking the codes via the help of the hints from the *messenger*. The nature of the game is both collaborative and competitive as the code should be solved by the contribution of both players while any mistake will cause loss of points for the mistaken player.

"d-Coder" was designed as a table-top card game at the beginning. Therefore, the digital feedback turned out to be make-up for the game rather than a functional element as it is added later. However, the game mechanics hold potential for richer interaction if the double-sided display takes the place of the cards by producing more explorative puzzles by using the computational power which will exist in working prototype. Designers of d-Coder also added some commands which can be considered as embodied interaction like step dancing. Therefore, while designing games for DubTouch, touch patterns including full body interaction may be included in control schemes. Nevertheless, this should be justified with further user studies.

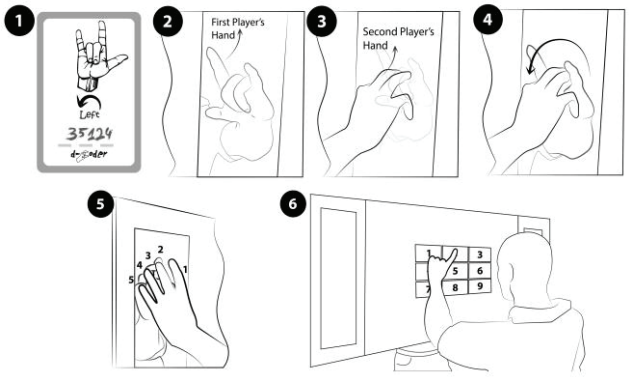

Figure 8: d-Coder Rules; (1) Take a Card (2) First player shapes his/her hand as on the card (3) Second player makes a complementary gesture (4) Second player tries to guess which direction to turn (5) Messenger gives the code with fingers every one of which has a number assigned (6) Second player tries to crack the given code by touching the screen

Worm Hole

The second game, "Worm Hole", was also designed with card game properties at the beginning. However, different from the d-Coder, Worm Hole is meant to be played at a fast pace which is not possible as a conventional card game. Therefore, the properties of the double-sided display were used in a more functional way compared to d-Coder. In Worm Hole, both players see some objects which carry different meanings in their screens. Each object can be destroyed with a touch pattern which can be only formed with the contribution of two players. Gestures have a key & lock relationship and each should be responded with the right complementary gesture by the opposite player. As a result, each player needs to do the right gesture for their own object and at the same time pay attention to the other player's gesture to provide the complementary gesture. In worm hole, except for the rules which are dependent on the digital content, there is also a rule which restricts "speaking". Therefore, all the messages should be transmitted by touching or signing to other player with hands. These kinds of meta game interactions enrich the digital gaming experience since they propose game mechanics about bodily interactions as in party games.

Worm Hole also creates physical interaction mechanics with the touch patterns it uses. There are four touch patterns in the game which match with four objects. Figure 9 lists the touch patterns and the related objects. The touch

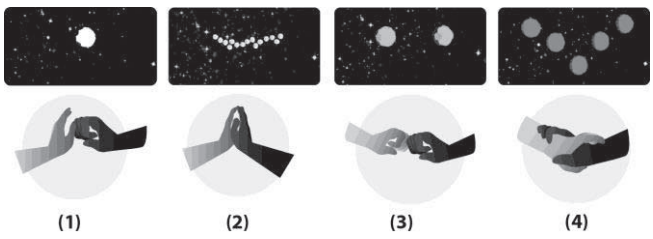

Figure 9: Four types of touch patterns in Worm Hole: (1) Power (2) Collaboration (3) Togetherness (4) Energy

pattern, called *Energy*, requires both players to hold their hands firmly along for 2 seconds which mandatorily makes players miss some tasks. This action restricts them to do another action not mentally but physically. They cannot do any other move not because they will lose points, but because they are literally unable to do it.

Discussion for Games

In our workshop, our main aim was to understand if games propose an added value for gaming field and if command languages of DubTouch games match with the results of user studies. Our criteria for added value are (1) emergence of a control language which is not seen in existing platforms, (2) proposal of a game style which differs from existing, (3) hints and, if possible, guidelines for visual presentations and (4) audial presentations of games in DubTouch.

We observed that emergence of *new control languages (1) are possible* since both games have made use of the categories of *Hand Posture, Physical Impact, Two users and Two Hand* which have higher exclusive value. Moreover, if these touch patterns are replaced with keystrokes, they would not carry the same experience. For example, an explosion can also be activated just by a keystroke, however; touch patterns in the category of *Physical Impact* mentally fit to an explosion action which also create more joyful experience for the players.

The design workshop also showed that properties of double sided display and use of social touch patterns propose game styles which differ from previous research (2). Before anything else, social touch patterns require two players to act together and physically interact with each other by *holding hands.* This condition adds physical rules and mechanics to the digital games. For example, some tasks can be achieved only if players hold their hands for several seconds. Different from conventional control devices, these kinds of rules restrict users physically rather than mentally.

Other than that, the double sided display creates face to face positions which two players cannot see or partially see each other. These positions cause game mechanics to occur dependent on the physical positions and physical interactions of the players. For instance, when players do not see each other they cannot communicate with facial expressions which load important tasks to hands and hand gestures. Besides, designers come up with ideas like adding "boosts" to games which enable players to see each other as a reward. One of the groups expressed that this would increase the social interaction. Moreover, the double sided display also encouraged designers to assign different roles to the players. These different roles can be observed in both games. Therefore, games designed for DubTouch may also propose different mechanics for the players in the opposite sides of the display.

Another aim of the workshop was to observe if the games for DubTouch reflect different representations in the *visual*

language of the game (3). We observed that neither of the groups produced remarkable hints or guidelines for visual elements. Although the visual elements are partially related to the touch patterns, they do not have properties which can be considered unique to DubTouch. The participants of the workshop also agreed that the visual representations are not different from the existing visual languages of games. They expressed that, not enough time was spared for this aspect since they spent most of the time to explore the social touch concept and DubTouch environment.

In *audial representations* we succeeded to detect some hints which differ from the audio properties of existing systems. Our findings are (1) a requirement for supporting the process of finding the right touch pattern which is a continuous and an ambiguous act with *continuous audio feedback,* (2) assigning audio feedback only to major changes in the game world instead of every command as it is in existing systems, (3) using spatial audio effects to help players concentrate on the game. Moreover, sound designers also proposed applications like letting players activate some perks or boosts by using voice input or integrating audio sources with players' bodies.

The touch patterns of the d-Coder and Worm Hole did not differ from the users' impulses according to the results of our user studies. The command schemes for the games match categories which are intuitive and exclusive. However, both games also made use of the *Two Hand* category. We believe that this difference originated from the sophisticated command scheme of the games requiring more than one steps which can be realized only with two hands opposite to the single step commands in user study. Other than this confliction, participants did not propose any interaction in the emotional context opposite to what is expected. Although a game concept dependent on the happiness and anger of the players was produced during the design process, this idea was left in the further parts of the workshop. We still think that this emotional aspect of the touch patterns should be investigated more in further studies with workshops focusing on the narrative part of the games rather than the mechanics.

In addition, we also had some feedback on the ergonomic use of the DubTouch. The width of the screen is found surplus by participants that they needed to open their arms too wide which resulted in a position too close to the display. They proposed a decrease in the width of the screen. Participants also expressed that the touch areas are not wide enough and they proposed to remove them completely. However, they also expressed that it is better to define the touch areas, yet this should not be done in a way which creates physical restrictions.

As a result of our workshop, we have seen that it is possible to design games for the DubTouch environment which meet with the user expectations. Moreover, these two prototypes showed that DubTouch games hold potential to create new gaming experiences since face to face positions of people and social properties of games proposes uncommon interaction possibilities.

CONCLUSION

We began this study believing that the DubTouch environment has a potential to create new gaming experiences with social touch and face to face positions of players emanated by double sided display and create a new control style based on *social touch*. To support this idea, we used the process of two-step research method comprised of a *user study* and *a design workshop.* As a result of our user studies we produced 340 touch patterns with users categorized under the 6 categories named as *Direct Manipulation, Two Hands, Hand Posture, Physical Impact, Two Users, and 3D Space* and we have found that *Two Users and Hand Posture* categories are both *intuitive and exclusive to* DubTouch. Therefore, we believe that the games designed for DubTouch should include touch patterns falling under these two categories primarily. Other than that, we found that identical touch patterns recall similar meanings and emotions for different users. Therefore, this finding will help further studies to understand the emotional reflections of social touch on game narrative.

In *Design Workshop* experts benefit the outcomes of the User Study. At the end of the workshop, two games called *d-Coder* and *Worm Hole* was designed and implemented to be experienced with the experience prototype of DubTouch. We observed that the control schemes (used touch patterns) of both games match with the results of the user studies. Moreover, collaborative game styles differing from existing research emerged due to the face to face positions of players originated by use of double sided display and control schemes based on social touch. These outcomes show that the DubTouch environment will satisfy our expectations about creating new gaming experiences and proposing a new control style.

As the gaming field prospers in the way that involves the full body interaction, collaborative game play of that kind may be expected to utilize *social touch* of the players. Therefore, we believe that the outcomes of this study can be considered as guidelines for the future game developers of exertion games and games based on collaboration and full-body interaction. Moreover, DubTouch environment can be a platform which the *social touch* in gaming context can be investigated in the aspect of sociology and psychology as it has an important part in child development and relationships.

The result of early study in this project encouraged us taking this study further by improving especially ergonomic form of DubTouch, focusing on the visual representations of games, filtering the touch patterns to obtain standardizations of control commands and conduct conceptual development for the emotional aspects of touch patterns.

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