

Development of the Sandtray Play Therapy Platform based on the Multi-Touch Table

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Abstract: This study deals with the transfer of sandtray play therapy to a Multi-Touch Table (MTT) and propose multi-touch table-based sandtray therapy platform. Through the proposed system, it is possible to separate the diagnosis process and the treatment process simultaneously from the sandbox play, thereby providing an environment where the treatment can be concentrated. MTT-based sandtray therapy allows a person to construct his or her own microcosm using colored MTT and miniature toy. Similarly, the scene created acts as a reflection of the person's own life and allows him or her the opportunity to resolve conflicts, remove obstacles and gain acceptance of self. The proposed system recognizes the arrangement of the figures and diagnoses the client's psychological state using the expert system.

Key words: Sandtray, sandplay, therapy, multi-touc table, psychological diagnosis, figure

INTRODUCTION

Sandtray play therapy is a treatment developed by Victor Lowenfeld (Baxter *et al.*, 2012, 2013; Anonymous, 2018a, b). It is a therapy technique for playing through sandboxes. It uses various kinds of small items (people, animals, trees, flowers, cars, houses, fences, iron springs, natural objects, robots, Jesus, buddha, beads, feathers, candles, etc.) It is to express the unconscious world through various expressions (Baxter *et al.*, 2012; Armstrong *et al.*, 2015). This process is based on the concept that a client has self-healing ability through corrective and positive experience in the treatment process. Subjects may be children with emotional disturbance such as tic disorders, ADHD, personality disorders, disability adjustment, stuttering and nocturia.

Sandbox play can be used in a variety of ways, including psychological diagnosis and psychotherapy. The therapist uses a typical interpretation/analysis method to determine the psychological type (Armstrong *et al.*, 2015). In this study, we move the whole process to the multi-touch table environment and automatically measure the figure type, layout and production behavior, and apply the rule-based expert system (Davis *et al.*, 1993) to the measured data to simplify and automate the diagnostic system.

MATERIALS AND METHODS

Design of the multi-touch table based on the rear DI system and infra-red image processing: In this study, a

multi-touch table is designed to replace sandboxes. Various types of methodologies can be used to implement a multi-touch table such as Frustrated Total Internal Reflection (FTIR), Laser Light Plane (LLP), Diffused Surface Illumination (DSI), LED Light Plane (LED-LP), Front Diffused Illumination (Front DI), Rear Diffused Illumination (Front DI) and Rear Diffused Illumination (Rear DI). The most common way to create a multi-touch table with infrared is Frustrated Total Internal Reflection (FTIR). FTIR is a method in which all of the internal reflection properties of light are used. It has a structure able to directly emit an infrared ray on the inner screen with a predetermined thickness. However, the screen of a FTIR-based touch table must be positively touched by objects such as fingers. In other words, unlike the rear DI-based touch table, it is impossible to recognize a black-and-white marker. This study focuses on a multi-touch table employing the Rear DI system. Rear DI (Anonymous, 2009) is a method of recognizing the IR LEDs (infrared LED) that emit the infrared light reflected on the contact surface which is in the space opposite a user's fingers.

To configure a rear DI-applied Multi-Touch Table (MTT), five components of an Infrared (IR) Light camera, IR LED Emitters, a Diffuser, a reflection-mirror and a beam projector are required. The diffuser is located above the remaining components. The reflection-mirror angle and the beam projection are configured to match the screen size with the projection area. The IR camera is also configured to recognize the total area of the beam projection while the IR LED emitters facing the diffuser are

placed in other areas. The recognition rate of infrared light is improved when it is evenly emitted to the full-size screen. Therefore, the half angle (half-width) of LEDs must be more than 50° as shown in Fig. 1.

The IR camera simultaneously accepts the image of the infrared light reflected by the contact surface and the visible region outside the surface. To improve its recognition efficiency by filtering the unnecessary visible light, the IR band-pass filter is mounted on the IR camera lens of which the cut-off wavelength is 850 nm.

After considering the above factors, the following specification is determined as shown in Fig. 2. The MTT is modeled with dimensions of 1182 mm in width, 880 mm in length and 800 mm in height. The rear screen diffuser and the touch glass are mounted on the upper frame. A wide-angle projector an IR camera and IR LEDs are located below the screen and cooling fans are included. Based on these specification analysis, the multi-touch table is fabricated as shown in Fig. 3.

The MTT should recognize and track user's multi-touches and markers. The software Core Community Vision (CCV) 1.5 (Anonymous, 2011; Bencina *et al.*, 2005) for binary image processing is used to recognize the user's fingers and the markers in contact with the top position (Fig. 4).

Design of the multi-touch table-based sandtray play therapy platform:

Figure 5 shows overall architecture of sandbox play psychological diagnosis system. First, through the MTT, visual combinations of sand box which means figure combination, array state and time are input. Then we inject these input values into the inference engine to ignite the rules. In the inference engine, the rules are ignited one after the other and the second stage recognition book observation of the diagnostic method is carried out. Emotional figure type and emotional array type are also presented. And once again, the rules are ignited and the created world type value comes out due to the structure evaluation which is the third step.

Rule-based expert system is the system that enables diagnosis or prediction through an inference engine based on knowledge bases and facts (Davis *et al.*, 1993). In this study we implemented a MTT-based sandbox play diagnostic expert system by applying this rule-based expert system.

First, emotional observation is performed by mapping the visual information perceived in MTT with the emotional meanings of each. Assigned figures were defined as 'aggression', 'depression' and 'distraction'. Arrangement conditions include 'empty', 'parallel', 'blocked', 'hostile', no person, 'disorder'. There are a total of six types. 'Empty' and 'closed world' are mapped to 'depression'. 'Parallel' and 'disorder' are mapped to 'distraction'.

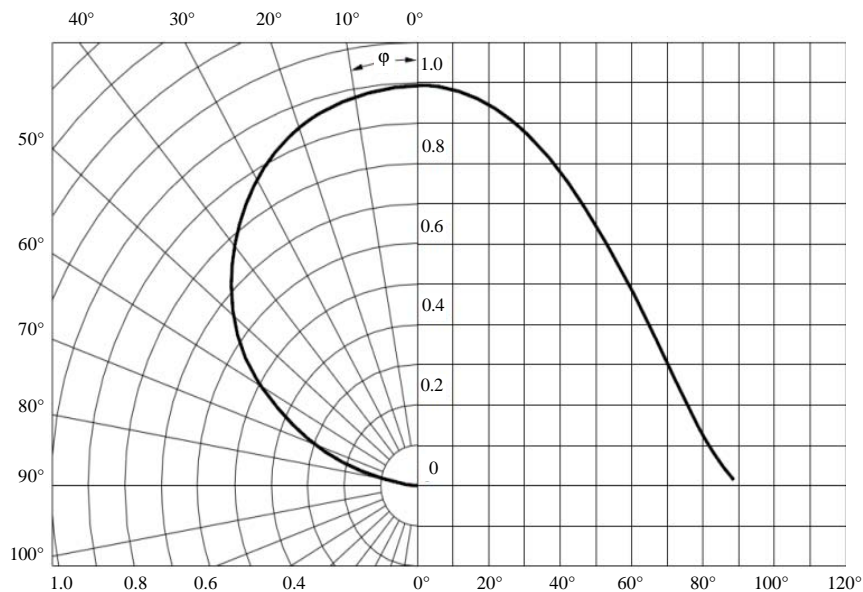


Fig. 1: LED light and angle datasheet

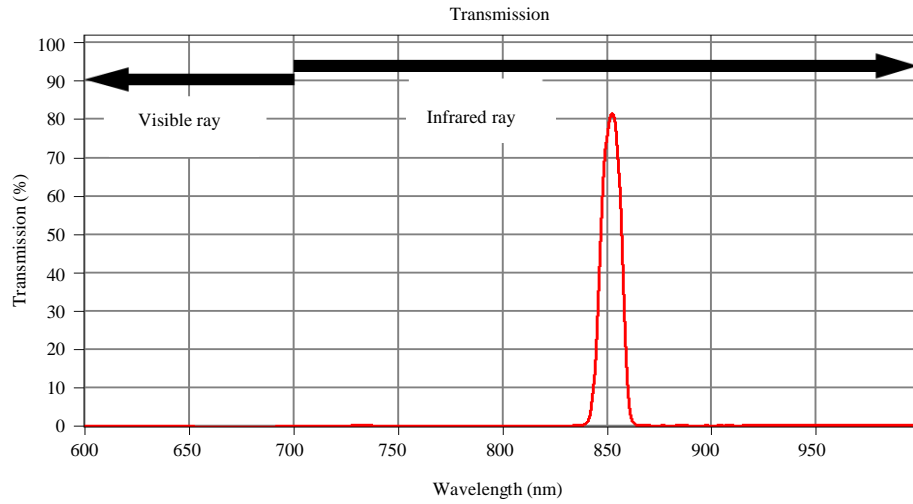


Fig. 2: IR pass filter datasheet

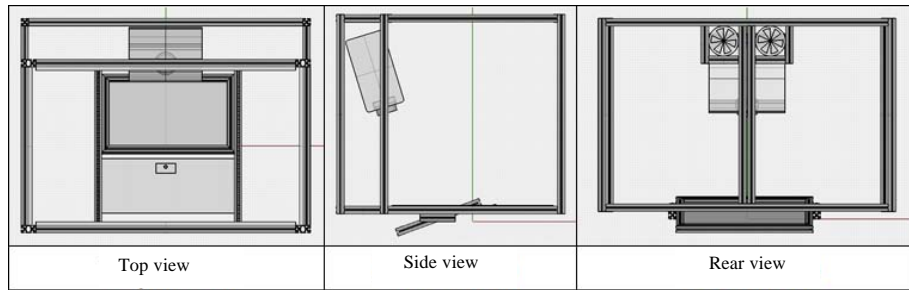


Fig. 3: Three dimensional modeling of the proposed multi-touch table

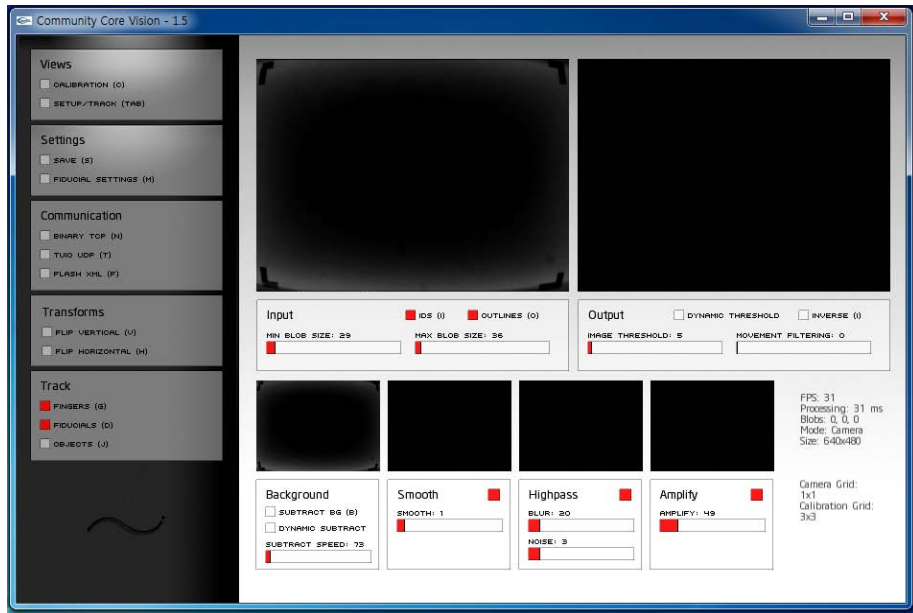


Fig. 4: User interface of CCV-touch tracking software

'Hostile' and 'no person' worlds are mapped to 'aggression'. If the time it takes for the client to allocate figures is within the average time range, there is no emotional meaning. If the elapsed time is short, it means 'distraction'. If the elapsed time is long, it means 'depression'.

Second, allocated figure types can also be mapped to emotional meanings. The figures are classified into four types as human, predator, prey and ride and the combination is examined. Predators tend to attack, predators are depressed and mounts are distracted. A person figure has no meaning in itself. But here, figurines can be another reference element as to how many figures of the same kind are used.

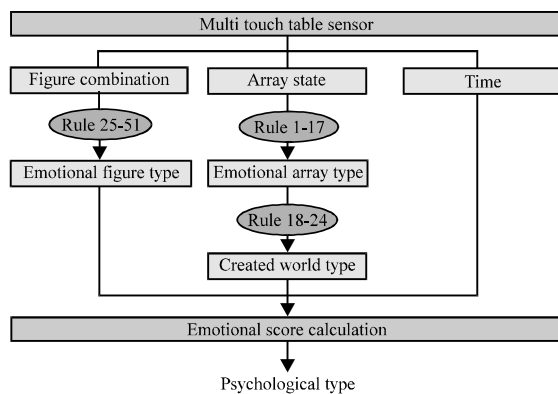


Fig. 5: Overall architecture of sandbox play psychological diagnosis system

Therefore, if more than 50% of the figures of each kind were used, high level was given to the emotional element and low level if <50% was used.

Third, each element of the array structure, production time and figure combination was weighted according to the ranking that is important in psychological diagnosis in the actual sandbox play technique.

RESULTS AND DISCUSSION

Demonstration of multi-touch table-based sandtray play therapy platform: The MTT sandbox psychological expert system is implemented in the SWI-Prolog environment through the logical programming language Prolog. Prolog can define objects and rules as one of the languages that can implement rule-based systems. Figure 6 is a screenshot where rules are ignited according to input values and conclusions are derived.

The implemented system uses jpl library of SWI-Prolog in eclipse environment to link Java and prolog. Then, the system derives the value from the inference engine again and the time value is further added in the java code and the score is calculated on the emotional element value to derive the percentage of each element (Fig. 6 and 7).

Figure 8 shows the feasibility of the proposed multi-touch table-based sandtray play therapy platform. Figure 8 shows available figures and interaction process between a user and the MTT. A user places the figures on the MTT. The MTT recognizes their positions and types using CCV (Fig. 4). Figure types, arrangement and user behavior are measured successfully. Figure

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SWI-Prolog
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (threaded, 64 bits, version 7.6.2)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit http://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?- start_diagnosis.
Hello. This is diagnosis system using sandtray.

what status of array does it have?
|: empty.

single_depressionwhat kind of figure does it have?
|: people0+predator2+prey0+vehicle1.

complex_high_aggression_low_inattention
finish!
true.
    
```

Fig. 6: Prolog-based expert system: array state, figure combination and elapsed time are asked

```
<terminated> JavaApplication3 [Java Application] C:\Program Files\Java\jdk1.8.0_111\bin\javaw.exe

empty

people0+predator2+prey0+vehicle1

normal
3 28, 2017 9:46:54 diagnosisCul prologCall
: consult('testjava.pl') succeeded
3 28, 2017 9:46:54 diagnosisCul prologCall
: result_diagnosis(empty,people0+predator2+prey0+vehicle1,X,Y) succeeded
3 28, 2017 9:46:54 diagnosisCul prologCall
: X=single_depression, Y=complex_high_aggression_low_inattention succeeded
3 28, 2017 9:46:54 diagnosisCul prologCall
: depression=3, inattention=1, aggression 2
depression : 50% , aggression : 33% , inattention : 17%
```

Fig. 7: Java-prolog test: array state, figure combination and elapsed time are reconfirmed and depression 50%, aggression 33% and inattention 17% are diagnosed

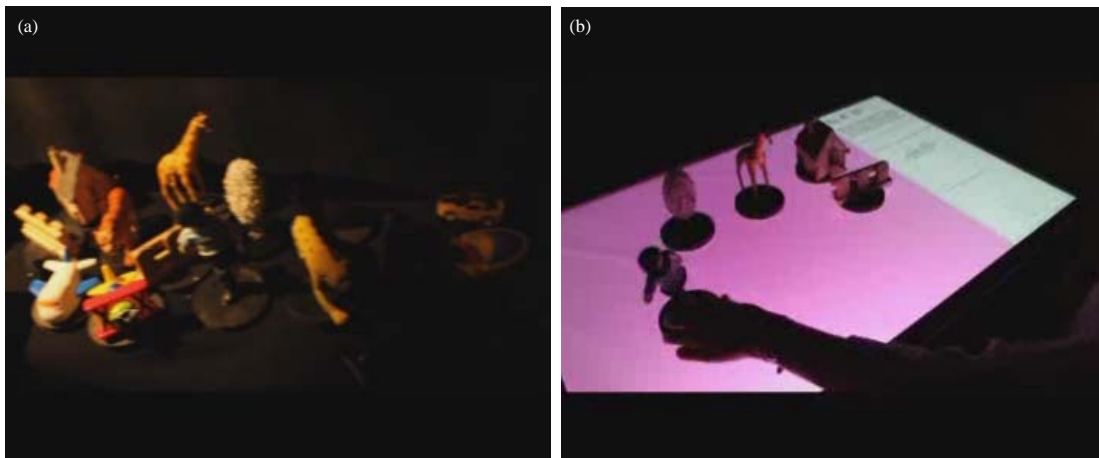


Fig. 8: Demonstration of MTT-based sandtray play therapy platform: a) Figures are prepared and b) MTT recognizes positions and types

types, arrangement and user behavior are measured successfully. In the future we will use this system in the actual play therapy process and we will test the change of the client 'sconcentration and the therapist's therapeutic efficacy.

CONCLUSION

In this study, we have implemented the MTT-based sandtray platform to diagnose psychological type by inputting instantly the value of figure type, arrangement of figures and production time which are diagnostic elements of sandbox play technique. In the process, the inference engine and the rule-based expert system were also designed. Through the proposed system, it is possible to separate the diagnosis process and the treatment process simultaneously from the sand box play, thereby providing an environment where the

treatment can be concentrated. The client can have independent time in the process of making the sand box, so that, it is possible to express more freely inside. The diagnostic system using MTT has the effect of simplifying and automating the complex diagnosis process in the current sandtray play method.

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