Implementation of Art Therapy Expert System for Depression Using Center for Epidemiologic Studies Depression Scale

Eun-Mi Lee and Kang-Hee Lee

Department of Digital Media, Soongsil University,
369 Sangdo-Ro, Dongjak-Gu, Seoul, 06978, South Korea
kanghee.lee@ssu.ac.kr

Abstract

Art therapy is one of the most efficient auxiliary practices that uses art in order to relax a patient and treat the symptoms of mental diseases. In this paper, we propose an art therapy expert system using the Center for Epidemiologic Studies Depression Scale to provide art therapy for depression. Herein, we build a knowledge base to define the facts and rules about the unique abstract art painting techniques of Jackson Pollock's art therapy. The art therapy expert system collects input about the symptoms of a patient and provides an individualized therapeutic program to the patient. The art therapy expert system can be adopted for web applications, mobile applications, or PC applications at an affordable cost.

Keywords: Depression, Art therapy, Expert system, CES-D.

1. Introduction

In modern society, depression is one of the major causes of death via suicide and other causes. Treating depression requires much individual as well as social cost. Depression is a risk factor for all major disease-related causes of death; it is not limited to cardiovascular disease mortality or suicide [1]. Various psychotherapeutic and pharmacological treatments exist to relieve or to cure depression. Studies show that auxiliary therapy along with medical treatment is more effective than medical treatment alone, and most patients are more amenable to beginning auxiliary therapy than pharmacological therapy [2]. Auxiliary therapy includes music, art, sports, and so on. Art therapy is one of the most popular auxiliary therapies for depression. A wide range of studies discuss the effectiveness of art therapy for depression [3-6]. For example, as shown in Figure 1, action painting is not only a popular drawing technique of Jackson Pollock's, but is also one of most popular art therapy techniques used to treat depression. Jackson Pollock's action painting has been adapted into various forms for populations with psychological diseases including children, cancer patients, and others [7].

Because common therapy works well in the beginning phases of treatment or for patients with mild symptoms, the art therapy program must be customized to maximize its effects according to differences in gender, age, taste, state of mind, and symptoms [8]. The cost of customized therapy designed by experienced therapists is very high. Therefore, very limited numbers of patients can benefit from customized therapy. However, inexperienced therapists can execute customized therapy designs with a patient. In other words, if we can build a computer program that is capable of designing a customized art therapy program for each specific patient, the customized art therapy can be provided at an affordable cost without limitations of time and place.

We propose an automated art therapy recommendation system for patients with depression based on an expert system [9]. In our previous work, we specifically examined Jackson Pollock's art therapy for depression. In the late 1930s and early 1940s, Jackson Pollock worked with Jungian psychoanalysts to deal with his alcoholism and depression.

The therapists used Pollock's art as part of his treatment. In addition, we propose modified art therapy recommendations to enhance the previous expert system in [10]. Modern and accurate tests should be conducted to recommend and to maximize the effect of art therapy. Jackson Pollock's original art therapy is too old-fashioned to be applied without modifications. Therefore, propose a modified art therapy program that enhances the previous system.

Figure 1. Action Painting as Art Therapy

In this paper, we design an art therapy expert system using the Center for Epidemiologic Studies Depression (CES-D) Scale. The system is built to manifest the knowledge base and inference engine that includes facts and rules about the unique abstract art painting techniques of Jackson Pollock's art therapy and the Center for Epidemiologic Studies Depression (CES-D) Scale. The art therapy expert system collects input about a patient's symptoms and provides a therapy program tailored to the individual patient. The art therapy expert system can be adopted for web applications, mobile applications, or PC applications at an affordable cost.

2. Related Works

In this section, we present the motivation for this work and review the CES-D Scale and Jackson Pollack's art therapy.

2.1. Motivation

Although the effectiveness of art therapy for depression is widely known, most patients have not benefited from art therapy because of the high cost of art therapy and the lack of experienced art therapists [2-3]. Recommending proper art therapy usually requires advanced training and expertise. Even in medically advanced countries, experienced art therapists who can recommend the most suitable art therapy for an individual patient are available only in large cities. However, the number of art therapists who can perform a given therapy is relatively large. Therefore, if the recommendation for a particular type of therapy can be automated, therapy can be made affordable for more patients. The motivation of this work is to implement a prototype of the expert system that recommends suitable art therapy for patients with depression.

2.2. Center for Epidemiologic Studies Depression Scale

The Center for Epidemiologic Studies Depression Scale (CESD) was created in 1977 by Laurie] Radloff [11] and revised in 2004 by William Eaton and others [12]. The CESD has been the workhorse of depression epidemiology since its first use in the Community Mental Health Assessment Surveys in the 1970s [13, 14] and its use in the National Health and Nutrition Examination Surveys [15]. It has survived transition to both an off-site and a self-administered version, and is usable with typically undercounted populations such as the elderly and the economically disadvantaged.

Table 1. CES-D

Center for Epidemiologic Studies Depression Scale (CES-D), NIMH
Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the past week.

	During the Past Week			
	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
Q1. I was bothered by things that usually don't bother me.	☐	☐	☐	☐
Q 2. I did not feel like eating; my appetite was poor.	☐	☐	☐	☐
Q 3. I felt that I could not shake off the blues even with help from my family or friends.	☐	☐	☐	☐
Q 4. I felt I was just as good as other people.	☐	☐	☐	☐
Q 5. I had trouble keeping my mind on what I was doing.	☐	☐	☐	☐
Q 6. I felt depressed.	☐	☐	☐	☐
Q 7. I felt that everything I did was an effort.	☐	☐	☐	☐
Q 8. I felt hopeful about the future.	☐	☐	☐	☐
Q 9. I thought my life had been a failure.	☐	☐	☐	☐
Q 10. I felt fearful.	☐	☐	☐	☐
Q 11. My sleep was restless.	☐	☐	☐	☐
Q 12. I was happy.	☐	☐	☐	☐
Q 13. I talked less than usual.	☐	☐	☐	☐
Q 14. I felt lonely.	☐	☐	☐	☐
Q 15. People were unfriendly.	☐	☐	☐	☐
Q 16. I enjoyed life.	☐	☐	☐	☐
Q 17. I had crying spells.	☐	☐	☐	☐
Q 18. I felt sad.	☐	☐	☐	☐
Q 19. I felt that people dislike me.	☐	☐	☐	☐
Q 20. I could not get "going."	☐	☐	☐	☐

SCORING: zero for answers in the first column, 1 for answers in the second column, 2 for answers in the third column, 3 for answers in the fourth column. The scoring of positive items is reversed. Possible range of scores is zero to 60, with the higher scores indicating the presence of more symptomatology.

2.3. Jackson Pollack's Art therapy

Jackson Pollock is an abstract artist known for his unique technique of what could be interpreted as 'an angry monkey randomly throwing lots of paint at huge canvases' [16]. In 1956, Time magazine named him "Jack the Dripper" for good reason. Pollock was fascinated by psychoanalytic readings of symbols, and had undergone several courses of therapy. Jackson Pollock is one of a few pioneers who recognize the powerful and effective therapeutic effects of art [17-19].

Figure 2. Self Portrait by Jackson Pollock c. 1930-3

Pollock had suffered from alcoholism, depression, mental disorganization, and homosexual tendencies and cured himself by performing action painting with his novel painting techniques. It was Carl Gustave Jung's analytic psychology that influenced artists including Pollock. Jackson Pollock's art therapy in Jung's analytic psychological perspectives is one of the most important origins of art therapy.

One of the most frequently used techniques in art therapy is to draw a self-portrait. Portrait drawing in its basic sense has evolved to other forms, such as drawing one's own house, family, subjective situation, and so on [5-7]. Jackson Pollock drew his portrait numerous times to deal with his mental anguish; an example is shown in Figure 2. Jackson Pollock is not only a great painter, but also a pioneer of art therapy. Although since the time of Jackson Pollock, art therapy has advanced, along with the fields of art, psychology, and medical science in general, Jackson Pollock's form of art therapy is still effective and is a fundamental basis of modern art therapy.

2.4. Jena framework

Apache Jena (or Jena in short) is a free and open source Java framework for building semantic web and Linked Data applications. It provides an API to extract data from and write to RDF (Resource Description Framework) graphs. Jena is a Java framework that includes a rule-based inference engine, an ontology API, and a query engine. Jena rule reasoner has the option of employing both of the individual rule engines in conjunction.

3. Art Therapy Expert System using CES-D

We designed an expert system using CES-D to provide customized art therapy. Jackson Pollock's art therapy is used as an example and a prototype, because he is one of the most important pioneers of art therapy. In the age of Jackson Pollock, there was no quantifiable method like CES-D to measure the symptoms of depression. If there were CES-D, Jackson Pollock would perhaps have developed a more sophisticated art therapy and even cured himself more efficiently. Also, the proposed system can be applied and extended to other therapeutic techniques by replacing the knowledge base and inference engine.

Table 2. Formulation for CESD-R Categorization [12]

Concept	Relation
Sadness	Sadness is the symptom that is related to emotional condition of being affected with or marked by unhappiness.
Loss of Interest	Loss of Interest is the symptom that is related to inability to feel and experience pleasure.
Appetite	Appetite is the symptom that is related to desire or motive derived from a biologic or psychological need for food, water, sex, or affection.
Sleep	Sleep is the symptom that is related to a period of rest for the body and mind.
Thinking (Concentration)	Thinking (Concentration) is the symptom that is related to mental behavior wherein ideas, pictures, cognitive symbolizations, or other hypothetical components of thought are experienced or manipulated.
Guilt	Guilt is the symptom that is related to an affective state in which one experiences conflict at having done something that one believes one should not have done.
Tired (Fatigue)	Tired (Fatigue) is the symptom that is related to A condition characterized by a lessened capacity for work and reduced efficiency of accomplishment.
Movement (Agitation)	Movement (Agitation) is the symptom that is related to an abnormal mental state in which the brain is highly aroused for action, but does not know why.
Suicidal ideation	Suicidal ideation is the symptom that is related to thoughts about how to kill oneself.

In the system, users exchange input and output data through the user interface. A simple user interface provides a CES-D questionnaire to a user and inputs his/her answers. The inference engine creates an art therapy program which is most relevant to the answers.
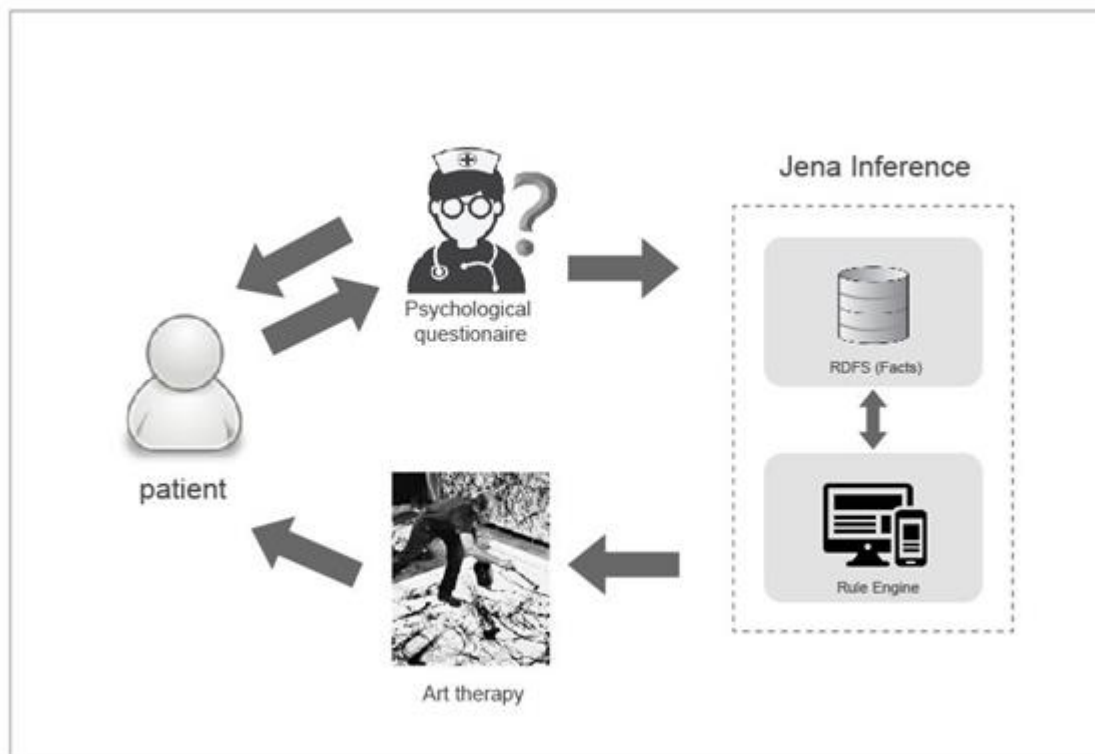
Figure 3. Proposed Expert System.

In this paper, we present an art therapy system using CES-D that recommends Jackson Pollack's art therapy-based techniques in an individualized manner. In the expert system, users input data and receive output through the user interface. A simple user interface is a CES-D questionnaire that the user answers. From the answers, the expert system creates a program that is most relevant to the individual's symptoms. The inference engine provides some art therapeutic techniques to help the user relieve depression. The expert system recommends one of Jackson Pollock's art therapies that is most suitable to the symptoms of the patient.

In a previous work, we conceptualized and formalized Pollock's techniques to define facts and rules. Our analysis, given the key symptoms of depression and the painting techniques used by Jackson Pollock, revealed that portrait, performance art, all-over painting, action painting, and dripping are related to the key symptoms of depression. Based on our formalization, we derived the rules for the inference engine. We classified art therapy into 5 therapy groups and defined 15 rules on which we built the knowledge base and inference engine for the expert system [9].

In this paper, we proposed an extended system of art therapy for depression based on the CES-D to enhance the effect of Jackson Pollock's art therapy. Since the legacy of Jackson Pollock's art therapy, for obvious reasons, does not match the 9-symptom category in the CES-D, it cannot be applied directly. The proposed art therapy system has been modified to utilize the Center for Epidemiologic Studies Depression scale in an automated manner.

Table 3. Knowledge Base of Modified Jackson Pollock's Art Therapy

No		Condition (IF)	Conclusion (THEN)
Sadness	Rule 1	IF Q2 is occasionally or most of all,	THEN SYMPTOM is Sadness.
	Rule 2	IF Q4 is occasionally or most of all,	THEN SYMPTOM is Sadness.
	Rule 3	IF Q6 is occasionally or most of all,	THEN SYMPTOM is Sadness.
Loss of Interest	Rule 4	IF Q8 is occasionally or most of all,	THEN SYMPTOM is Loss of Interest.
	Rule 5	IF Q10 is occasionally or most of all,	THEN SYMPTOM is Loss of Interest.
Appetite	Rule 6	IF Q1 is occasionally or most of all,	THEN SYMPTOM is Appetite.
	Rule 7	IF Q18 is occasionally or most of all,	THEN SYMPTOM is Appetite.
Sleep	Rule 8	IF Q5 is occasionally or most of all,	THEN SYMPTOM is Sleep.
	Rule 9	IF Q11 is occasionally or most of all,	THEN SYMPTOM is Sleep.
	Rule 10	IF Q19 is occasionally or most of all,	THEN SYMPTOM is Sleep.
Thinking	Rule 11	IF Q3 is occasionally or most of all,	THEN SYMPTOM is Thinking (Concentration).
	Rule 12	IF Q20 is occasionally or most of all,	THEN SYMPTOM is Thinking (Concentration).
Guilt	Rule 13	IF Q9 is occasionally or most of all,	THEN SYMPTOM is Guilt.
	Rule 14	IF Q17 is occasionally or most of all,	THEN SYMPTOM is Guilt
Tired	Rule 15	IF Q7 is occasionally or most of all,	THEN SYMPTOM is Tired (Fatigue).
	Rule 16	IF Q16 is occasionally or most of all,	THEN SYMPTOM is Tired (Fatigue).
Movement	Rule 17	IF Q13 is occasionally or most of all,	THEN SYMPTOM is Movement (Agitation).
	Rule 18	IF Q22 is occasionally or most of all,	THEN SYMPTOM is Movement (Agitation).
Suicidal ideation	Rule 19	IF Q14 is occasionally or most of all,	THEN SYMPTOM is Suicidal ideation.
	Rule 20	IF Q25 is occasionally or most of all,	THEN SYMPTOM is Suicidal ideation.
Final rules	Rule 21	IF rule 1, 2 and 3,	THEN RECOMMANDATION is portrait.
	Rule 22	IF rule 4 and 5,	THEN RECOMMANDATION is performance art.
	Rule 23	IF rule 6 and 7,	THEN RECOMMANDATION is performance art.
	Rule 24	IF rule 8 and 10,	THEN RECOMMANDATION is dripping.

	Rule 25	IF rule 11 and 12,	THEN RECOMMANDATION is dripping.
	Rule 26	IF rule 13 and 14,	THEN RECOMMANDATION is all over painting.
	Rule 27	IF rule 15 and 16,	THEN RECOMMANDATION is dripping.
	Rule 28	IF rule 17 and 18,	THEN RECOMMANDATION is performance art.
	Rule 29	IF rule 19 and 20,	THEN RECOMMANDATION is all over painting.

4. Implementation

Jena supports the abstract process of deriving additional information and uses the term 'reasoner' to refer to a specific code object that performs this task. A user's answers are converted to RDF files containing facts. Jena inference recommends a course of action based on the rule base that has the final rules combined by RDFS. The final 9 rules are derived from the combination of all rules. Table 4 shows some RDF files generated from user input. Table 5 shows the final rules that the Jena rule engine uses.

Table 4. RDF Implementation Example

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:ex="http://example.com/artTheraphySystem#">
  <ex:Attitude rdf:about=" Sadness ">
   <ex:name> Sadness </ex:name>
   <ex:Symptom rdf:datatype="http://www.w3.org/2001/XMLSchema#string"> Q2 </ex:
Symptom >
  <ex:Symptom  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">  Q4  </ex:
Symptom >
  <ex:Symptom  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">  Q6  </ex:
Symptom >
   </ex: Sadness >
</rdf:RDF>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:ex="http://example.com/artTheraphySystem#">
  <ex:Attitude rdf:about=" Loss of Interest ">
   <ex:name> Loss of Interest </ex:name>
   <ex:Symptom rdf:datatype="http://www.w3.org/2001/XMLSchema#string"> Q8 </ex:
Symptom >
  <ex:Symptom  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">  Q10  </ex:
Symptom >
   </ex: Loss of Interest >
</rdf:RDF>
```

Table 5. Result Rule Example Inferred by Jena Reasoner

```
@prefix ex: http://example.com/culturalassetManagement#
[FinalRule_1: (?s rdf:type ex:portrait)
        <-
        (?s ex:recommandation 'ok' ^^xsd:string)
        (?s ex: Symptom' Sadness' ^^xsd:string)
]


@prefix ex: http://example.com/culturalassetManagement#
[FinalRule_2: (?s rdf:type ex:performance art)
        <-
        (?s ex:recommandation 'ok' ^^xsd:string)
        (?s ex: Symptom'Loss of Interest ' ^^xsd:string)
]
```

The prototype of the proposed system is implemented using Jena Semantic Web Framework. The prototype uses the Jena API to enact the rules of the inference engine. The Jena inference subsystem is designed to allow a range of inference engines or reasoners to be plugged into Jena. Such engines are used to derive additional RDF assertions, which are entailed from some base RDF together with any optional ontology information and the axioms and rules associated with the reasoner. The primary function of this mechanism is to support the use of languages such as RDFS and OWL, which allow additional facts to be inferred from instance data and class descriptions. However, the machinery is designed to be quite general and it includes a generic rule engine that can be used for many RDF processing or transformation tasks.
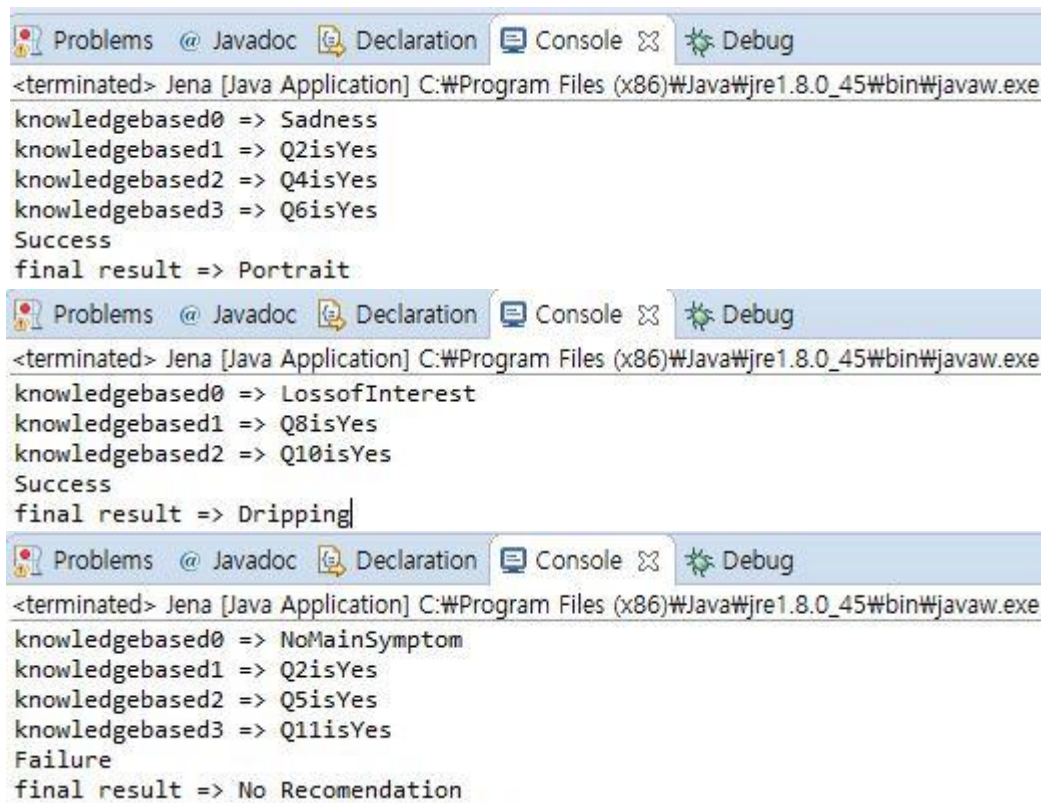

Figure 4. Results of Implementation

5. Verification and Evaluation

Verification of an expert system entails determining that the system is built according to its requirements and specifications. To detect anomalies of rules in the knowledge base, the consistency, completeness, correctness, and redundancy of the rules is verified by examining all combinations of rules. The proposed Jena rule base and inference engine was verified by ensuring that there are no conflicts or contradictions by examining all possible cases of firing rules. Since the number of rules in the proposed knowledge base is relatively small, every set of answers could be verified manually. The proposed knowledge base and inference engine are derived from common and representative art therapy developed by experts. Therefore, any quirk of an individual expert is not included in the system.

To evaluate the performance of a medical expert system, strict clinical testing is required. However, clinical testing is out of the scope of this paper and existing studies show the performance and effectiveness of Jackson Pollock's brand of art therapy for depression. In future work, strict clinical testing should be done to evaluate the performance of the proposed system.

6. Conclusion

Art therapy is one of the most efficient auxiliary practices that uses art in order to relax and treat the symptoms of mental diseases. Since the cost of customized therapy designed by experienced therapists is very high, an extremely limited number of patients can benefit from customized therapy without automation. Therefore, we aimed to build a computer system that provides customized art therapy programs; it provides customized art therapy at an affordable cost without limitations of time and place.

In this paper, we designed an art therapy expert system using the Center for Epidemiologic Studies Depression (CES-D) Scale. The expert system is built to realize the knowledge base and the inference engine that includes facts and rules about the unique abstract art painting techniques of Jackson Pollock's art therapy and applies the CES-D Scale. The art therapy expert system collects input about a particular patient's symptoms from the CES-D Scale and provides a therapeutic program targeted to the individual patient. The art therapy expert system can be adopted for web applications, mobile applications, or PC applications at an affordable cost.

Acknowledgements

References

[1] A. Mykletun, O. Bjerkeset, M. Dewey, M. Prince, S. Overland and R. Stewart, "Anxiety, depression, and cause-specific mortality: the HUNT study", Psychosomatic medicine, vol. 69, no. 4, (2007), pp. 323-331.

[2] A. Park, G. Oh, K. A, Hwang, J. Kim, K.Y. and Y, Baik, "Relationships between Functional Status, Activities of Daily Living and Depression by Time since Stroke Onset in Elderly Patients with Acute Stroke", International Journal of Bio-Science and Bio-Technology, vol. 7, no. 2, (2015), pp.71-78.

[3] S. Riley, "Using art therapy to address adolescent depression", Handbook of art therapy, (2003), pp. 220-228

[4] D. Gussak, "The effectiveness of art therapy in reducing depression in prison populations", International Journal of Offender Therapy and Comparative Criminology, vol. 51, no. 4, (2007), pp. 444-460.

[5] W. Reynolds, M. L. Nabors and A. Quinlan, "The effectiveness of art therapy: Does it work?", Art Therapy, vol. 17, no. 3, (2000), pp. 207-213.

[6] J. Wood, M. A, Molassiotis and S. Payne, "What research evidence is there for the use of art therapy in the management of symptoms in adults with cancer? A systematic review", Psycho-Oncology, vol. 20, no. 2, (2011), 135-145.

[7]   F. Thachil, A. R. Mohan and D. Bhugra,"The evidence base of complementary and alternative therapies in depression", Journal of Affective Disorders, vol. 97, no. 1, **(2007)**, 23-35.

[8]   V. R. Crespo, "Art therapy as an approach for working with schizophrenic patients", International Journal of Psychotherapy, vol. 8, no. 3, **(2003)**, pp.183-193.

[9]   E. Lee and K. H. Lee, "Proposal of Jackson Pollock's Art Therapy Recommendation System for Depression", International Journal of Software Engineering and Its Applications, vol. 9, no. 10, **(2015)**, pp. 75-84.

[10] E. Lee and K. Lee, "Proposal on Modified Jackson Pollock's Art Therapy for Depression based on Center for Epidemiologic Studies Depression Scale", Advanced Science and Technology Letters, vol.122 (IRTT 2016), **(2016)**, pp.126-129.

[11] L. S. Radloff, "The CES-D scale: a self-report depression scale for research in the general population", Applied Psychological Measurement.; vol. 1, **(1977)**, pp.385-401

[12] W. W. Eaton, C, Muntaner, C, Smith, A, Tien and M, Ybarra, "Center for Epidemiologic Studies Depression Scale: Review and revision (CESD and CESD-R). In: Maruish ME, ed.", The Use of Psychological Testing for Treatment Planning and Outcomes Assessment. 3rd ed. Mahwah, NJ: Lawrence Erlbaum, **(2004)**, pp. 363-377.

[13] G. W. Comstock and GW Helsing. "Symptoms of depression in two communities", Psychological Medicine. vol. 6, no. 4, **(1976)**, pp. 551-563.

[14] L. S. Radloff and B. Z. Locke. "The community mental health assessment survey and the CES-D Scale. In: M. M. Weissma, J. K. Myers, C. E. Ross , eds.", Community surveys of psychiatric disorders. New Brunswick, NJ: Rutgers University Press, **(1986)**, pp. 177-189.

[15] W. W. Eaton, L. G. Kessler, "Rates of symptoms of depression in a national sample", American Journal of Epidemiology; vol. 114, **(1981)**, pp.528-538

[16] J. Birtchnell, "Art therapy as a form of psychotherapy. Art as therapy: An introduction to the use of art as a therapeutic technique, **(1984)**, pp. 30-44.

[17] S. Riley, "Group process made visible: The use of art in group therapy", Routledge, **(2013)**

[18] L. Emmerling, "Jackson Pollock", Taschen, **(2003)**.

[19] J. J. Schildkraut, A. J. Hirshfeld and Jane M. Murphy, "Mind and mood in modern art, II: Depressive disorders, spirituality, and early deaths in the abstract expressionist artists of the New York School", The American journal of psychiatry vol. 151, no. 4, **(1994)**, p.482.

Authors

Eun-Mi Lee, she received her B.S. degree in Fine art - Painting from RMIT University, Melbourne, Australia, in 2003 and received her M.S. degree in Art Education from Hongik University, Seoul, Korea, in 2008. Since 2013, she has been a Ph.D. student in the Department of Digital Media, Soongsil University. She is a committee member of the Korea Fine Artist Association. Her current research interests include the areas of convergence of contemporary art and information technology and artificial intelligence systems in order to understand abstract art and knowledge-based reasoning systems. Contact her at vivienne@ssu.ac.kr.

Kang-Hee Lee, he received his B.S., M.S., and Ph.D degrees in Electrical Engineering and Computer Science from Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea, in 1999, 2001, and 2006, respectively. Since 2006, he has been a Senior Engineer at the Digital Media & Communication Research Center, Samsung Electronics Company, Ltd., Korea. He has been a dispatched researcher in the Robotics Institute, Carnegie Mellon University, since 2008. Since moving to Soongsil University in 2009, he has been with the Global School of Media, Soongsil University, Seoul, Korea. His current research interests include the areas of ubiquitous robotics, evolutionary robotics, emotional robotics, media robotics, cognitive task planning systems, and knowledge-based reasoning systems. Contact him at kanghee.lee@ssu.ac.kr.