Artificial Psychology

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Abstract. This paper describes the basis content of Artificial Psychology as well as Affective Computing and Kansei Engineering and other technology that are correlated with the research. Also it reviews the research history of Artificial Psychology theory and practice, and the future research direction of the Artificial Psychology is indicated.

Keywords: Artificial Psychology, Kansei Engineering , Artificial Intelligence, Affective Computing**.**

1 Introduction

It is well known that on the one hand, research into Artificial Intelligence has been done to a very high level. But on the other hand, its purpose has been limited to imitating human intelligence talents such as judging, deducing, proving, explaining, identifying, sensing, planning, learning and problem-solving. The main task of these activities is how to present, acquire and utilize knowledge. This is just the initial stage in the field of virtual human being research. This is not nearly a wide-enough research range since human psychology and related activities include not only sensing, believing, memorizing and thinking, but also emotion, feelings, willingness, character and creativity. The theory of ARTIFICIAL PSYCHOLOGY(A.P.=Artificial Psychology in following) [1]is aimed at a comprehensive understanding of human psychology, (especially feelings, willingness, character, and creativity) by means of a systematic integration of psychology, brain science, information science, neuroscience, computing science and novel theories of automation science. This paper describes the basis content of Artificial Psychology based on Affective Computing and Kansei Engineering and other technology that are correlated with the research. Also it reviews the research history of Artificial Psychology theory and practice, and the future research direction of the Artificial Psychology is indicated.

2 Theoretical Research on Artificial Psychology

The theory of artificial psychology based on information science, is the comprehensive machine realization (computation and algorithms) of human psychological activities. Application of this theory includes development of robots with feelings, emotion and

intelligence, human similar mechanics, and control patterns based on human brain. We know that the theory of human similar control is mainly the combination of weiner's "feedback" control theory and the artificial intelligence. It differs greatly from the control patterns of human brain because the control pattern of human brain is based on sense and the idea that sense decides behavior. But the current control system takes no account of the affective factors while making decision because it is not able to do that. There is a vast potential to apply artificial psychology theory to the design of more humanized commodities and to the development of market. The theory of Artificial psychology is the sophisticated stage of artificial intelligence. It is a new domain of automation and information science. Relationship between A.I(Artificial Intelligence) and A.P.(Artificial Psychology) is shown in fig.1. Its research will greatly promote the development of the theory of personification control, emotional robots, the design of humanized commodities and the market, and contribute to set up harmonious man-to-man and man-to-machine environment. The theory of Artificial psychology is an cross science. As shown in figure 2 its original basis is from brain science, psychology, physiology, ethics, neural science, anthropology, Kansei engineering, linguistics, aesthetics, jurisprudence, information science, computer science, automation science and artificial intelligence. The main applied areas are as follows: emotional control theory in robots, personification mechanics, the design of humanized commodity, sensible market development, Artificial Psychology Programming Languages, Artificial Creative Techniques, humanoid Techniques for Human Psychology Databases and Mathematical Models, Harmonic Interface for man-machine and IS multi-channel Interfaces.

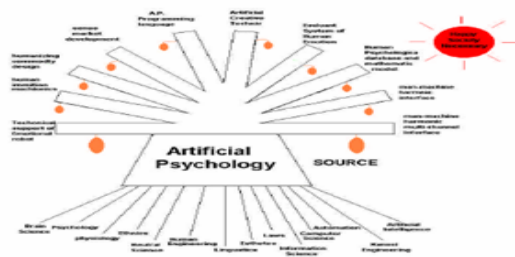**Fig. 1.** Relationship Between A.I. and A.P.

Fig. 2. Artificial Psychology - an Interdisciplinary Science

The research contents of the theory of artificial psychology are as follows:

1) To set up the theoretical system of Artificial Psychology(aims, rules, research content, application range, research methods), and especially to break the limitation of definitions, rules, and contents, make it conform to the moral rules of human beings which is not included in Artificial Intelligence.

2) To set up the theoretical system of Artificial Psychology by means of the theoretical achievements of A.I. and the relationships between A.I. and A.P.

3) To develop machine algorithms to repress bad emotions. It is decided by the rules of A.P.

4) To mathematically scale human psychological information whose main achievements were made by Japanese. Our national researchers also make some progress, such as the publication of <The analysis of fuzzy aggregate in psychology >, < measurement science of psychology>.

5) To set up a control mode of sense, feeling and emotion as the decision of behavior to imitate control mode of human brain. It is different from the control mode of A.I.

6) To probe the building-up of a programming language for Artificial Psychology. It is a challenging work. The programming language of A.I. is the presentation of knowledge and logical inference. In A.P., the programming language must be a kind of associative language whose character is associative inference, chaotic computation, divergent thinking and fuzzy induction.

7) Computation algorithm for emotion cultivation.

8) Machine realization of inspiration (scintillation).

2.1   The Unified Model of A.P

Mathematics must be introduced to the research of artificial psychology. Its premise is to build an unified model, in order to make a base for the future research and build a system. The research aims of the unified model of A.P is that :

Under a given condition, it can describe all the human emotion (Intelligence, imagination, study, memory, attention, consciousness, feeling and so on) or choose some small models from the big model. The small ones can not only describe one of psychology activities above, but also describe cognition—emotion, motivation—emotion—decision-making, and have the function of coordination, parallel, stratification, decision-making and control.

The general aims of the research:

The small models (recent aims) compose the big model (future aim). Much knowledge in multi-discipline should be used in the unified model. These knowledge include: psychology, brain system, neural science, endocrine science, physiology, the theory of complex system, the theory of the non-linear, system engineering, data structure, anthropology, behavioral science. Future aim: build big model recent aim: build feasible, useful and single-task, small model according to one of psychology activities.

The unified mathematical model we put forward preliminarily is as figure 3. Its characters are:

1) The small models are subordinated to the unified big model.

2) Modular small models table the big model.

3) The unified big model can describe all of human psychology activities, while the small ones can describe certain one individually.

4) The inside of the small models is the progress of control, while the big one is the progress of the cooperative decision-making by small ones. The relationship between small ones is coordination, parallel, time-share, and coupling.

5) During the progress of model-building, we should use the knowledge of computer and system structure as technologic means, make use of the electronic circuit, and be on the basis of the theory of system, control, and intableation.

Here, we just put forward a concept of theory frame and will continue to do more research work about it. In another word, this is a very difficult but also very important project at all aspects of theory thought, computing methods and the special realization.
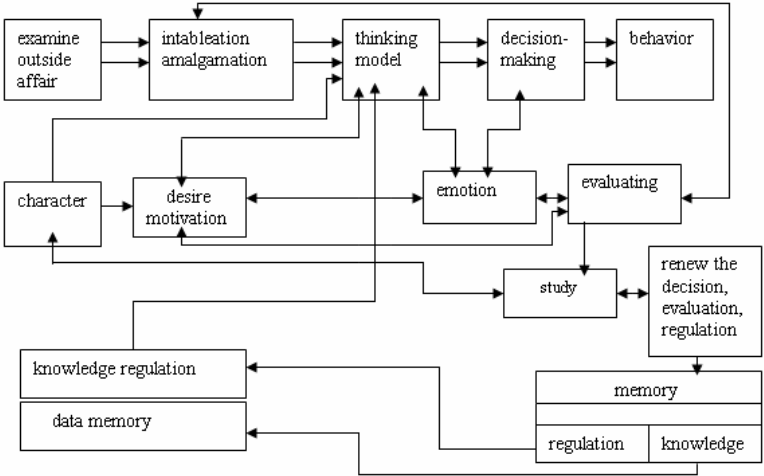

Fig. 3. The Unified Model of A.P

2.2   Affective Computing Model

The core of artificial psychology is that the effect of emotion at the psychology actives and the realization of the consciousness. The basic methods of artificial psychology are as follows: self-adjusting, positive emotion, coordinate work, energy balance, so the effective computing is the important content of artificial psychology. It has been considered an hard work and a   challenge to establish effective model but we have done many jobs about it.

Based on emotion psychology, we define the mathematic space describing the emotion. In this space, we use mathematic theory to bring forward the effective

computing methods which are easy to realize by computer and can simulate the producing, changing and transferring of the human emotion according to the rules of human emotion changing. We have bring forward and realized the emotion models which are based on geometry space, which are using HMM method based on probability space and which are the nonlinear dynamic model based on emotion dimensions. What mentioned above are the main research contents of artificial psychology.
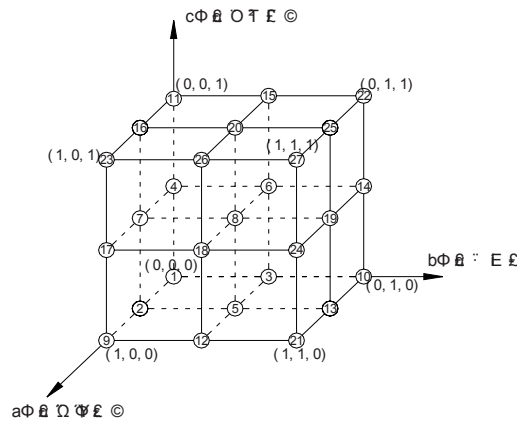
Fig. 4. Emotion Model Based on Geometry Space

1) Emotion model based on geometry space

On the work of self-closed effective computing model based on geometry space, we introduce the outside incentives and the concept of individual characters and use the joint method of HMM and BP artificial network to describe the main and the other psychology characters of human and to make it simulate the transferring of human emotion by ignoring the positive cross points.

2) HMM method based on probability space

First, we define two states of emotion — frame of mind and enthusiasm and accorded two basic transfer procedure and put forward the probability space of emotion states. Then we bring forward two models — One is based on Markov chain, another is based on HMM and emotion transfer model to simulate the two basic transfer procedure of emotion. We both define the emotion energy and emotion intension and emotion entropy to describe the emotion characters and emotion states. It is proved by computer simulation that these models can correctly describe the self-transfer procedure of emotions and the dynamic procedure of transferring and changing when outside incentives exist. They also can describe the emotion intension's changing rule under the influence of the outside incentives, present emotion state and personal character. They provide a new method for the theory research of effective computing and automatic creating.

3) nonlinear dynamic model based on emotion dimensions

According to basic emotion theory in emotion psychology and emotion dimension theory suggested by Wundt.W, we consider emotion procedure as a random dynamic

procedure which controlled by a nonlinear dynamic equation. The general style of equation is as follow:

$$X=f(\ x,\ t\ )+g(\ x,\ t\ )u \tag{1}$$

The x represents the expectation value of emotion state and u represents the outside incentive.

We consider the machinery emotion procedure as a composed procedure of mood and enthusiasm. The mood procedure is used to simulate human mood and describe the steady state of machinery emotion. It is expressed by balance state in systematic dynamic equation when incentive equal zero. This balance state may express as isolated balance point or limit ring.
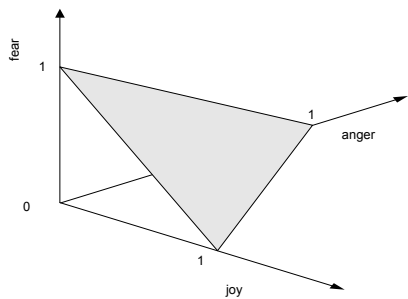
Fig. 5. The Identical Triangle in The Probability Space of Emotional State
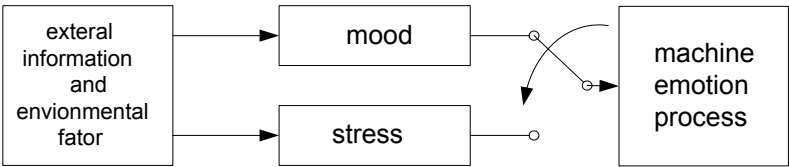
Fig. 6. Machinery Emotion Procedure
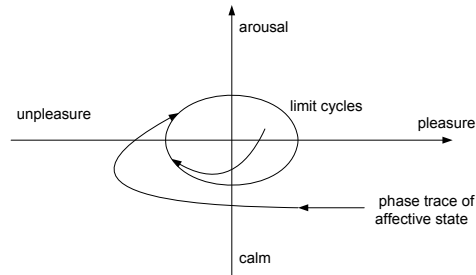
Fig. 7. The Transfer of The Machinery Emotion State

The enthusiasm procedure is used to simulate human enthusiasm and to discern the communicator's emotion through machine. The incentive is decided by environment. The enthusiasm procedure of machine is the respondent procedure of system to the environmental incentives.

The same scene and incentives may produce different emotion changing procedure because human's emotion is changefully so using random parameters to describe the changing procedure of emotion is appropriate. We consider the enthusiasm procedure as a random procedure using human mood as the initial state. The expectation value of the random procedure moves along the track of systematic dynamic equation. The rules of the machinery emotion procedure are that when no outside incentives exist, it express as the balance state of mood － systematic dynamic equation and when outside incentives exist and the balance state used as the initial state, it express as the random procedure which use the systematic response as the expectance curve.

2.3 The Correlation Research of Color-Emotion-Expression

In the research of Artificial Psychology and Affective Computing, it is very important that how to create the emotion and expression by means of machine. Here, we put forward that color creating emotion by the research of color theory and emotion cone theory of Plutchick; using basic emotion to create compound emotion, Figure 8 presents the emotion cone of Plutchick from Figure 8.
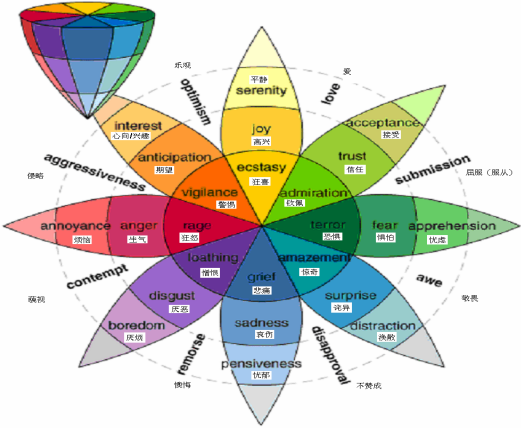

Fig. 8. Plutchick's Emotion Cone

3   The Technology Research of Artificial Psychology

The purpose of engineering is application. The creation of engineering is the creation of technology. So, the highest stage of the research development of Artificial Psychology is application. The most important point is to consider the human psychology and emotion component in the artificial systems, and make the artificial control systems and computer systems to adjust to human emotion , to realize

harmony between human、 man-computer and finally achieve the purpose of serving the people.

Our main works on application research about Artificial Psychology are as follows:

- **Research and Application of Personality Intelligent Fashion Shopping System Based on Network (Ma yun)** [2]

We use the method of integrating HSV color model algorithm and design theory of dress to derive its color eigenvalue, then improve features space, remedying the deficiency of original system by considering human vision system to color perceptual knowledge, dress variety and structure of dress, raising accuracy of clothing feature description. In order to overcome the problem that the fitness function of intelligent system is hard to express explicitly, improved IGA has been proposed firstly to implement on-line learning. Through IGA, human intuition and emotion is integrated into the evolution process to realize on-line retrieval by human-computer interaction. What is more, to deal with the problem that the user may tend to be tired arising from that the user has to evaluate a large number of individuals when the evolution time is too long, RBF neural networks is used for off-line learning to alleviate human fatigue.

Finally, a personality intelligent fashion shopping Website is established, and the experimental results demonstrates the effectiveness of our approach. Users think this system can express his or her kansei demands and be accord with human psychology characters.

- **Research on Modeling Artificial Emotion Based on HMM and Techniques Correlated with Virtual Human (Gu xuejing)** [3]

We realize an affective virtual human system based on the theory of artificial psychology. We build the dialogue engine for virtual human with the method of AI. We use frame structure to classify and store knowledge, this structure make data searching more quickly and make it easy to enlarge knowledge. It is more efficient for data searching and understanding by using the technology of pattern matching in our dialogue engine. The basic theory and method of HMM is studied before constructing the emotion model. We program the forward-backward arithmetic and Baum-Welch arithmetic by Visual Basic. It is the rational basis of the emotion model construction. Constructing emotion model is the key technology of virtual human system. Here, we present an artificial emotion model based on HMM. We get the parameter of matrix of emotion transfer probability and the vector of expression output probability. During modeling of emotion, we propose a definition of emotion entropy. We propose that emotion entropy is a scale to measure the stability of emotion and use it to restrict the initial emotion transfer probability matrix. It can help us measure one's character quantificationally. The results of emotion model test indicate that the emotional reaction of virtual human is according with human reaction. It means that this method of emotional modeling is feasible.

- **Study on Gait Feature Extraction and Human Identification Based on Computer Vision (Han hongzhe)** [4]

Gait recognition has recently received growing interest within the computer vision community. An efficient background updating algorithm based on Dynamic Intableation Window (DIW) is proposed. Updating decisions are made according to the pixel-wise Dynamic Intableation Window. Chromaticity distortion is measured in an effective way. The real time experiments have been done on a surveillance system in indoor environments as well as outdoor environments. Moreover, a new gait

recognition method based on hidden Markov models (HMMs) and Fourier descriptors (FD) is put forward. The body contours are processed by Fourier descriptors. K-means clustering method is used to analysis the image sequence within a gait cycle, and gait is represented by key stances. The hidden Markov models are applied to model the gait, where the key stances are considered as analogues states of the HMMs while the distance vector sequence is considered as the observed process. Finally, the experimental results demonstrate that our approach using linear discriminating analysis and support vector machine has a better recognition effect than other similar methods.

- **Research on Face Recognition Based on Kernel Function(Wang lijuan)** [5]

Because of the clustering character of skin color in the color space, skin color area can be detected based on YUV color space, and the face in video from complex background can be detected based on skin color density combined with horizontal and vertical gray projection. Then, the method of combined kernel function is proposed to recognize face based on the traditional Principal Component Analysis and Fisher Discriminating Analysis in this paper. By using kernel function, face features are extracted in the high-dimension space by using linear discriminating analysis to form nonlinear optimal features. Further more, focus on small sample leaning problem, we propose a one-to-rest method to extend the capability of support vector machine. Combined with nearest neighborhood classifier, the extracted face features are trained and classified. Experiments with ORL face-database and the images we collect from video show that when adopting the kernel method in the process of face recognition, the efficiency of feature extraction and the generalization ability of classification will be improved significantly and the real-time character and the recognition rate of the system is enhanced greatly.

- **Study and Implementation of Control and Communication System for Multi-Agent Robot System(Liang feng)** [6]

First, calculating model base on the agent abstract description is proposed. This model is composed of agent core and several function modules. Communication model, communication method, communication language and the functions of communication servers can be establish by this model. Secondly, the control system of the robot is designed and realized. The control system hardware makes up of servo control module, cable communication module, wireless communication module, behavior data storage module and power module. Software is the core of the control system. In this software, Function modules are designed as sub-agent, and scheduled by the agent core. This software can be easily replanted in different micro controllers and configured for controlling 1 to 24 degree-of-freedom robots. Ant colony Algorithm is chosen for the real-time schedule of the MARS after compared several common real-time schedule schemes, and optimized for real-time schedule application. Finally, this paper propose the realize steps about the improved Ant colony Algorithm.

- **A Teaching Assistant System Based on Affective Modeling (Meng xiuyan)** [7]

Based on Psychology and the theory of Artificial Psychology, a humanistic computer teaching system is presented in this paper. The core of this system is the affective interaction between teacher and student. An emotion-learning model is developed. Emotion space, four kinds of basic emotion and basic learning psychology

are defined according to the Emotion psychology Theory in this model. The mapping between emotion and learning psychology is also established. The student's psychology can get through the expression being processed by affective model, and the psychology can be evaluated to get a value for teacher. Finally, this system was realized by using the recognition method that is based on digital image processing technology.

4   Conclusion

Artificial psychology is still a new conception and the research on it is sill in a primary stage, but it has an exciting perspective. For the future, our research is going to concentrate on the following fields:

1. Application of artificial psychology in cognitive teaching.
2. Research of human behavior and psychology components in intelligent transportation systems.
3. Novel algorithms in expression recognition.
4. Domestic affective robots.
5. Construction of affective computing model.
6. Construction of integral model of artificial psychology.
7. Theoretical study and intercross application in multidisciplinary field such as information science, psychology and brain science.

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