Fuzzy Personality Model Based on Transactional Analysis and VSM for Socially Intelligent Agents and Robots

Carelia Gaxiola[1], Antonio Rodríguez-Díaz[2], Susan Jones[3], Manuel Castañón-Puga[4], and Dora-Luz Flores[5]

[1] Universidad Autónoma Baja California, Tijuana, B.C. México
cgaxiola@uabc.mx
[2] Universidad Autónoma Baja California, Tijuana, B.C. México
ardiaz@uabc.mx
[3] University of Sunderland, UK
susan.jones@sunderland.uk
[4] Universidad Autónoma Baja California, Tijuana, B.C. México
puga@uabc.mx
[5] Universidad Autónoma Baja California, Tijuana, B.C. México
dflores@uabc.mx

Abstract. This paper presents a model to add personality features to robots, the Transactional Analysis (TA) is used to define a psychological profile and the Viable Systems Model (VSM) is used to help explain the decisions made by the robot and how this impacts on its viability.

1 Introduction

Representing personality in multi-agent system (MAS) has been a key issue in recent years; agent behaviour is expected to reproduce human behaviour and thus, social phenomena in a MAS must replicate social issues in real life. In the beginning of the 90's, agent based systems where considered a significant advancement in software development [14], and software evolution [12]. Today agents are of great interest in a variety of fields in Computer Science. Characteristics such as autonomy, collaboration, reasoning, adaptability, mobility and goal orientation are among the main features that make agent oriented systems a great tool for social simulation [17].

However, humans have more than just these characteristics, since they have a personality profile, which plays a central role as suggested in [8][1][2][10][15][6].

Unfortunately, one of the first problems encountered while trying to model personality is that the term itself refers to a concept, which can be interpreted in many ways, thus uncertainty can arise. Also, it can not be observed directly, but indirectly by actions performed by someone.

There are many issues that require interacting with the person in order to be able to describe them. Things like thought and feelings can be "talked about", but others

O. Castillo et al. (Eds.): Evolutionary Design of Intelligent Systems, SCI 257, pp. 227–241.
springerlink.com

are not at the “conscious level”, so they need to be observed for a longer period of time. In other words, to study personality requires a long-term strategy.

Often, when we talk about someone, we talk about what makes this person different from others, or even what makes this person special. In [16] personality is defined as a style of behaviour.

In some Personality Theories, individual personality differences between persons are the main issue as stated in [5]. Nevertheless, personality theorists are also interested in what is common between people, i.e. their “internal structure”, how a person can be “ensemble” and how a person “works”. Most theorists try to explain personality and social dynamics in terms of a “soul”, ”consciousness”, “super ego” or even “spirit”, which are difficult to model and consequently difficult to program. So, if we are interested in programming a system in which some piece of software will represent a person with a personality, we must consider only those theories that use not so abstracts concepts.

One such model is Transactional Analysis (TA), which was created by Eric Berne [4] and it has been considered a very useful and practical tool by therapists all over the world [18]. Therefore, in this paper we focus in defining an internal structure of a robot based on TA that we will call Robot Personality (*RP*) which will be used to model personality.

Given that the trend in MAS research in general is to begin to model agents within a structural context, often using language and abstractions from the systems domain, one possible solution to this problem is to look into the systems domain itself for such ‘well-defined’ models and processes which could provide the framework required to examine macroscopic behaviour in MAS modeling and experimentation [9].

In [9] we propose the use of Stanford Beer’s viable systems model (VSM) to complement modelling approaches. In this paper we present a combined TA & VSM model approach, where we use TA theory in order to define the psychological profile of the robot and the VSM is used to help explain the decisions made by the robot and how this impacts on its viability or its ability to stay alive.

This paper is organized as follows: next section presents previous work related to modelling personality, especially in multi-agent systems. In section 3 we present information about our proposed model. Section 4 presents the experiment done and finally, section 5 deals with our conclusions.

2 Similar Work

In [11] a computational model of personality is proposed, the purpose of the model is to implement non-intellectual functions of the human mind on computer systems. The personality model was formulated based on psychoanalysis.

In [7] the Transactional Analysis Theory is used in order to define the inner structure of an agent along with the negotiation process occurred among them until the cooperation is established.

In [8] a design of a rational agent based on decision theory is presented. Emotional states and personality are defined formally as a finite state automaton. Emotional states are considered as methods for decision making inside the agent.

Changes in external stimuli provoke changes of emotional state and, thus changes in agent's decision-making behaviour. Personality is defined as emotional states along with transition rules between states. Also, a probabilistic version is considered to model personality. An agent's personality can be predicted given an initial state and emotional inputs.

In [1][2] "affective agent"-user interface is considered. Personality is defined as a complex structure that distinguishes a person, nation or group. An emotion is defined as an affection that interrupts and re-directs attention (usually accompanied by a stimulus). In this model, the Five-Factor-Model (FFM) is used. The descriptive nature of FFM gives an explicit model of personality and makes it possible to concentrate in the use of the affective interface to express directly these characteristics. In this project, personality and emotions are used as filters that restrict decision-making process.

In [10] a basic structure for a dialog automata is described, which is used to model users. This structure tries to model psychological terms such as personality and emotions. This proposal is based on the analysis of finite states and offers a general perspective on which formal methods (algebraic in general) and results can be applied to a variety of problems.

In [15] a methodology is presented for the study of the mind as part of Artificial Intelligence. This paper presents an architecture for motivated agents; the architecture is composed by several modules that handle automatic processes in which reflexive administration of limited resources that include planning, decision-making, scheduling, etc. are involved, along with meta-administrative processes like internal perception and actions.

In [13] a synthetic character is built that generates emphatic behaviour based on cathexis flux.

In [6], an interaction model for decentralized autonomous systems based on Transactional Analysis is presented. Cooperation between agents is negotiated by stroke exchange. After collaboration is established, each autonomous system plays certain role trying to accomplish a specific goal. However, only parameter formalization and hints on how to use this structure are given, but no implementation is considered. On the next section, we consider this issue.

3 TA and VSM Personality Model

Definition 1. In our basic model a *robot's personality* is represented by a tuple

$$RP = < A, ES >$$

where:

1. A is the set of actions a robot can perform
2. $ES = \{P, A, C\}$. Ego States where P=Parent, A=Adult, C=Child

In the simplified model of TA used, each *ES* holds a series of rules that define how a *RP* should perceive the world under that particular *ES*. For each *ES*, rules are different inside *RP*, in the case of state *P*, rules are associated mainly with social behaviour and the way things should be done in each situation. The set of rules for state *P* can be considered the ”cultural background” of the *RP*. For state *A*, rules are mainly about information gathering and problem solving mechanisms. Finally, for state *C*, rules are about postures as an individual, i.e. what makes this *RP* different from others. In this case we can consider things like favourite colour, games, etc. Pre-logical reasoning and spontaneous reaction are considered in this state (see Figure 1).

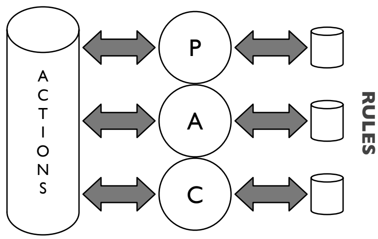


Fig. 1. Representing Rules-Actions and TA States

Another important concept is that of Personal Energy (*K*) which is equivalent (but not necessarily identical) to the cathexis concept in humans. Following Berne's model, *K* is divided in three parts: first, for each event that a *RP* perceives, the list of actions from *A* is scanned and assigned a weight for each state; this means that the same action will have three different weights, one for each state. This first value represents the Potential Energy (Kp) a particular event can give to an action for a *RP* in state X, i.e. how an event can trigger an action. As an example, consider action "To Play". For state *A*, Kp should be very low since playing is not an action a human would normally do when in this state. But for state *C*, Kp must be very high since this action is strongly related to this state. This assignment is independent for each state.

When considering which of the states will be the actual state that executes an action, we will consider the one that holds the maximum of Potential Energy, i.e. the highest Kp.

$$ES = max\{Kp(P), Kp(A), Kp(C)\} \quad (1)$$

Consider this: a *RP* perceives an event; this causes each of its *ES* to take the list *A* of actions and assign to each of them a weight. Then each *ES* sorts the list from higher to lower weight. After that, each *ES* takes the first action of its list and compares it with the action chosen by the other *ES*s. The one with highest Kp will be considered the actual *ES* (this means that the *RP* will be in that particular *ES*) and thus its action will be executed by *RP*. In Figure 2, action "To Work" of state *A* has the highest Kp and thus the *RP* will start working.

On the other hand, it must be taken into account that humans have a tendency to continue an activity, which we consider interesting or important, either because

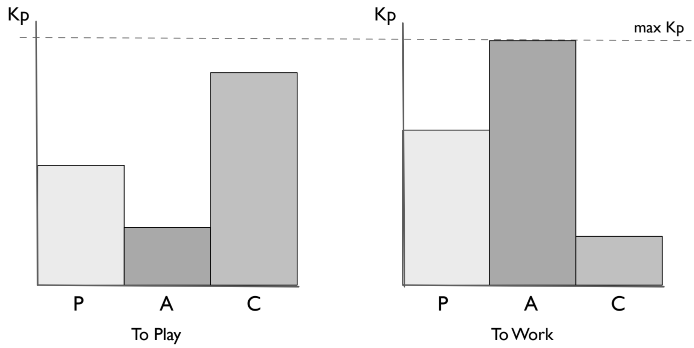


Fig. 2. Action "To Work" of state *A* has the highest Kp and thus the *RP* will start working

we feel obligated, it is convenient or we are just like it, and to discontinue activities that are no longer interesting or important. This kind of cathexis can be thought of as "the interest" a *RP* has and we will call it the Kinetic Energy *Kc* of the *RP* to executing an action. If we consider that, when a *RP* starts executing an action X, Kp(X) starts to be "consumed" (diminishing); but if there is an interest $Kc(X)$, this consumption will be compensated and thus, *RP* will execute *X* a longer period of time (see Figure 3a).

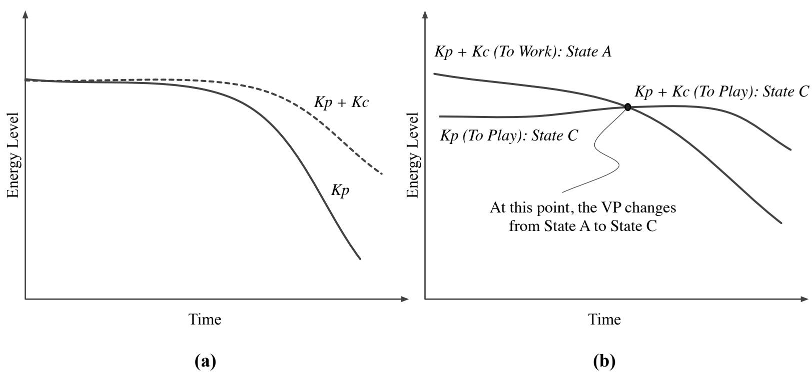


Fig. 3. Comparision between Potencial Energy (Kp) vs. Potencial Energy + Kinetic Energy ($Kp+Kc$) on action X

An interpretation of this can be as follows: each unit of time we must decide what to do, those actions that are most important will normally make us decide on them first, our interest on executing them will continue as long as we still consider them important. If for some reason the interest disappears, we will stop doing this action and turn to another. As can be seen in Figure 3b, as action "To Work" is executing, it is also being "consumed." When Kp("*ToPlay*") is higher than Kp("*ToWork*"), the *RP* will change from state *A* to state *C* and will start executing action "*ToPlay*".

Once a function to determine the "actual *ES*" is defined, it is possible to see the changes of *ES* of any *RP* and thus the possible action that will be executed, given a sense of "personality". On the other hand, the opposite can be considered, from events in the virtual world, to infer which *ES* a *RP* is in any moment. In fact, this is what a TA therapist will do with a client. By asking questions, hearing "the story" and some other signs like body language, expressions, attitudes, etc., he will try to infer when, how and why the changes in the patient's states take place. In this case, experience is crucial to be able to do a correct inference.

The third kind of cathexis is more complex and will not be taken into account for this paper.

3.1 Viable System Model

The Viable Systems Model looks at an organisation interacting with its environment. The organisation is viewed as two parts: the Operation which does all the basic work and the bits that provide a service to the Operation by ensuring the whole organisation works together in an integrated way. These bits are called the Metasystem.

Beer's first insight was to consider the human organism as three main interacting parts: the muscles & organs, the nervous systems, and the external environment.

These are generalised in the Viable Systems Model as follows:

- The Operation (O). The muscles and organs. The bits that do all the basic work. The primary activities. In RP the operation is *A*, and everything in the robot related to perform the actions in *A* correctly.
- The Metasystem (M). The brain and nervous systems.
- The Environment (E). All those parts of the outside world that are of direct relevance to the system in focus.

The following diagram illustrates the basic VSM.

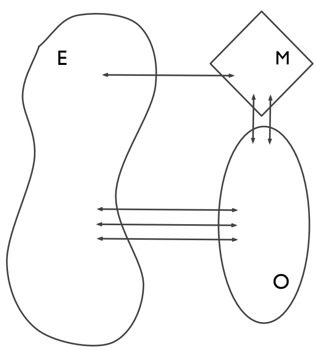


Fig. 4. Basic VSM

The arrows indicate the many and various ways that the three parts interact. The Operation will consist of a number of Operational units. The Operational units themselves must be viable, and thus can be looked at as smaller Viable Systems embedded in the larger system [3].

The main functions of the Metasystem are:

1. Look at the entire collection of Operational units and deal with ways of getting them to work together in mutually beneficial ways, and with the resolution of conflicts. This function is called "Internal Eye".
2. Look at the external environment, assess the threats and opportunities and make plans to ensure the organisation can adapt to a changing environment. This function is called "External Eye".
3. Establish the ground rules, which set the tone for the whole organisation. This is the Policy System. Is in the Policy System where the *ES* are located.

A need N_i takes the *RP* to the state S_i, i.e. the need of "food" takes the *RP* to the state "hungry". The Metasystem identify "needs" and following the rules imposed for the Policy System determine what action the Operation will perform. When the action is being executed another necessity can appear, this will take the robot to another state, i.e. in order to exit from "hungry" state the robot need food, the action related is "To Eat", but while the robot are eating the need to work appears, the robot will be then in the "Responsible" state.

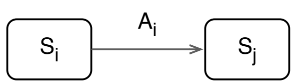


Fig. 5. Transition from state S_i to S_j due the execution of the action A_i

In the Figure 6 we can see an activities diagram of the action decision-making process in *RP*.

4 Case of Study

4.1 Experiment Protocol

The experiment begins with a new robot (*RP*) defined as "software being" that "lives" inside a virtual world. The robot needs to work to meet a specific goal. For work undertaken the robot earns the equivalent of monetary tokens, but the battery level decreases and also the performance level slowly depreciates. With the tokens earned, the robot can pay to recharge its batteries but must also pay for maintenance services to restore its performance levels to the state they were at the beginning of the simulation.

Besides parameters defined in section 3, we will use other parameters for these study cases:

$BatL(t) = \{1..100\}$: Battery Level. This parameter defines the amount of "physical energy" (different from cathexis) that a *RP* has a time t. This parameter will decrease by work and rest in order to simulate energy consuming, so $BatL(t) > BatL(t+1)$, if for some reason $BatL(t) = 0$, the *RP* will die, to avoid this the robot

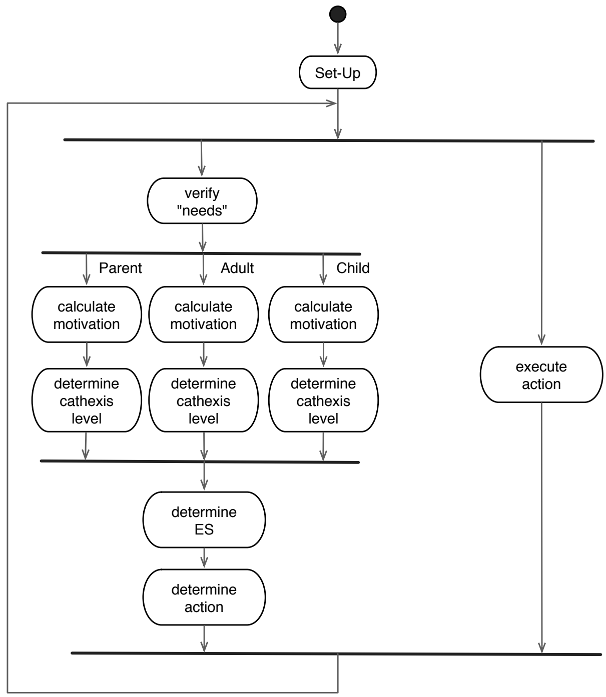


Fig. 6. Activities diagram

can pay to “eat”, this means recharge its batteries. All *RP*s should estimate when they need to “eat” in order to keep alive.

$PerL(t) = 1..100$: Performance Level. This parameter defines the state of “Health Level” that a *RP* has a time t. This parameter will decrease by work and eat in order to simulate health depreciation, so $PerL(t) > PerL(t+1)$, as the performance level drops, the time taken to carry out the work to meet the goal takes longer, so the robot can pay to “rest”, this means restore its performance level. The cost of the maintenance service is high and the time taken to undertake maintenance is lengthy, in comparison to charging the battery, which is relatively quick.

4.2 Goal of the Experiment

The goal of the experiment is to demonstrate that a robot with some kind of pathology, a lazy robot or a workaholic, will die earlier than a robot without such pathologies. The workaholic robot will not perform its own personal maintenance because of their intrinsic focus on their work. This will eventually lead to bad performance, which will ultimately affect the productivity of the robot because it is a workaholic who will spend more time working. Eventually the performance will be so low that the robot will not recharge its batteries and it will die.

4.3 Representation of Three Ego States

The program used to simulate the psychological states of the robot and to control the actions it takes based upon its decision-making, has been developed using LabView from National Instruments.

The psychological profile of each Ego State i.e. Parent, Adult and Child is defined by two physiological needs, namely the need to eat or acquire energy, the need to rest or undertake preventative maintenance and the social need to work or engage in meaningful activity.

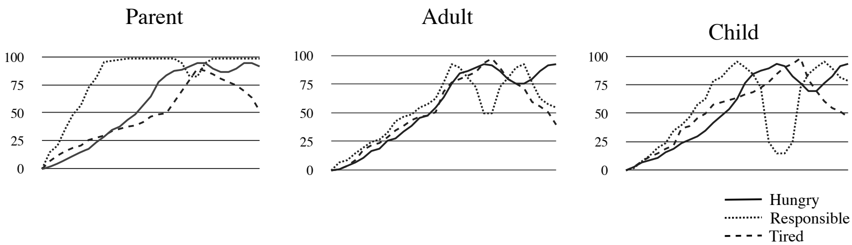


Fig. 7. Psychological profile of the robot

The user interface includes a set of controls to define the ‘interest’ that each ego state has for a particular need. The decision is taken in accordance to the “motivation” level at any particular moment in time. Each Ego State is plotted on a graph, which records the motivation level for undertaking an activity against time. At any one time, the level of each of the three states is presented to help the user to demonstrate the predominate state of the robot with respect to the three “needs” (Figure 8).

4.4 Control of Decision Making by the RP

The decision making process is controlled by the cathexis level, which are illustrated by three tanks (see Figure 8), each tank representing the cathexis level of each Ego State, that is the Parent, Adult and Child. The decision of which activity is to be performed is taken by the ego state with the highest level in the tank.

4.4.1 Fuzzy Inference System

Since the Kp is determinant in the decision making process of the *RP*, we define a FIS to calculate it, taking into account the personality profile (pp), the interest level in performing an action i and the need indicator that triggers action i, i.e. in the process of calculating the Kp for the ES Parent and the action “$ToEat$” the input is the pp, the interest level that the ES Parent has in ‘eat’ and the $BatL(t)$, then the output is the Kp for the action “$ToEat$”.

Table 1 shows the linguistic values for the input variables of the FIS, they are $InterestLevel$ and $NeedLevel$, the personality profile (pp) is fixed for each simulation, describing the personality profile of a *RP*. Table 2 shows the linguistic variable Kp, the output of the FIS.

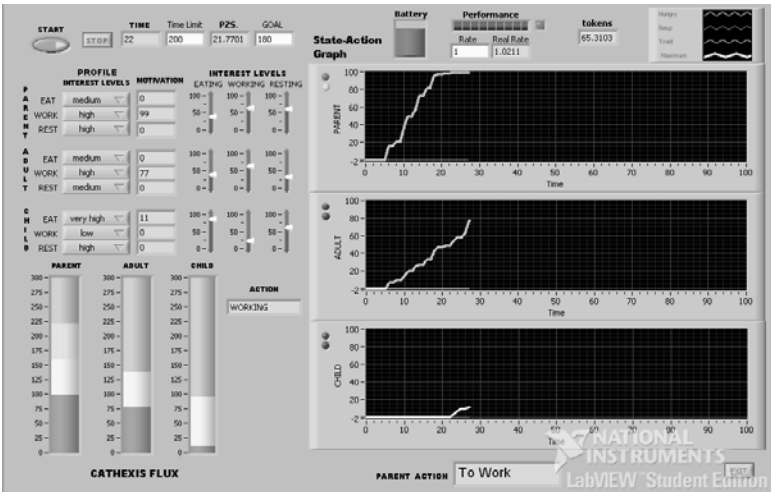


Fig. 8. Screenshot of the user interface

Table 1. Linguistic variables *InterestLevel* and *NeedLevel* and their Linguistic variables

Linguistic variables	Linguistic values				
InterestLevel	"veryLow"	"low"	"medium"	"high"	"veryHigh"
NeedLevel	"veryLow"	"low"	"medium"	"high"	"veryHigh"

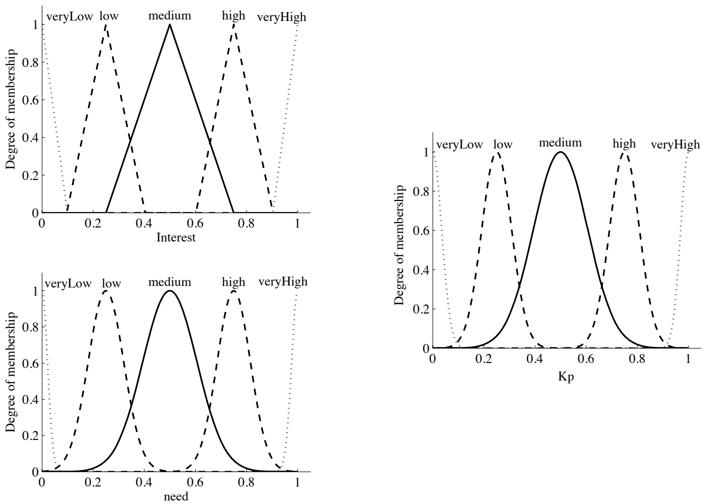
Table 2. Linguistic variable *Kp* and their Linguistic variables

Linguistic variable	Linguistic values				
Kp	"veryLow"	"low"	"medium"	"high"	"veryHigh"

The membership functions of *InterestLevel*, *NeedLevel* and the output *Kp* are represented in Fig 9

For each action in each ES a FIS is defined. The rules for each one are the same. There are two cases when the *NeedLevel* determines the *Kp* without evaluating any other input, the first one is for the case when the *NeedLevel* becomes critical to the viability of the robot, e.g., the $BatL(t)$ is "veryLow", and the other one is for the case when the need becomes fulfilled, e.g. the $BatL(t)$ is "veryHigh".

If *NeedLevel* is "veryLow" then *Kp* is "veryHigh"
If *NeedLevel* is "veryHigh" then *Kp* is "veryLow"



(a) (a)

Fig. 9. (a) antecedent MFs and (b) consecuent MF

An example of the rules that evaluate *InterestLevel* and *NeedLevel* are described below

If *NeedLevel* is “veryHigh” then *Kp* is “veryHigh”
If *NeedLevel* is “veryLow” then *Kp* is “veryLow”
If *InterestLevel* is “low” and *NeedLevel* is “medium” then *Kp* is “low”
If *InterestLevel* is “medium” and *NeedLevel* is “medium” then *Kp* is “medium”
If *InterestLevel* is “high” and *NeedLevel* is “medium” then *Kp* is “high”
If *InterestLevel* is “veryLow” and *NeedLevel* is “high” then *Kp* is “low”
If *InterestLevel* is “low” and *NeedLevel* is “high” then *Kp* is “medium”
If *InterestLevel* is “medium” and *NeedLevel* is “high” then *Kp* is “high”
If *InterestLevel* is “high” and *NeedLevel* is “high” then *Kp* is “high”

The response of the *RP* not only relies in the *InterestLevel* and *NeedLevel* but in the personality profile as well which is taken in to account in the *Kp* calculation. The Fig 10 shows the overall input-output surface.

4.5 Indicators of ‘Need’

In addition to the controls to define the profile, the indicators to show the cathexis level and the graphs to show the motivation level, there are three indicators to show the battery level associated with the necessity to eat, the performance level associated with the necessity to rest and a counter to show the work undertaken by the robot. In addition, there is a goal indicator that is, how much work the robot needs to do for a given period of time, defined for the indicator labelled as Time Limit.

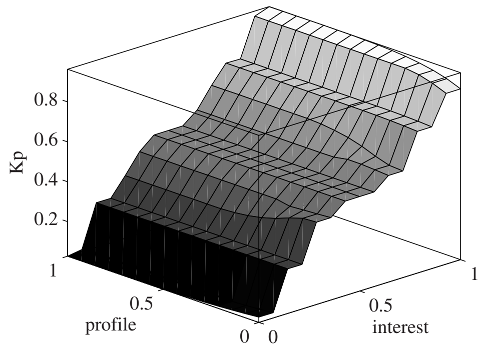


Fig. 10. Overall input-output surface

Fig. 11. Indicators of 'Need'

4.6 Robot Behaviour

In the Figure 12 we show a screenshot of the result of the simulation of a robot with a "high" concern in "work", and "medium" concern in "eat", as a result of this compulsion to "work" the robot die early due starvation.

We can identify this *RP* as a workaholic robot that keeps working without taking sufficient time out for maintenance, and as it keeps working the performance will gradually decrease, the time to achieve the goal will extend and the stress levels to

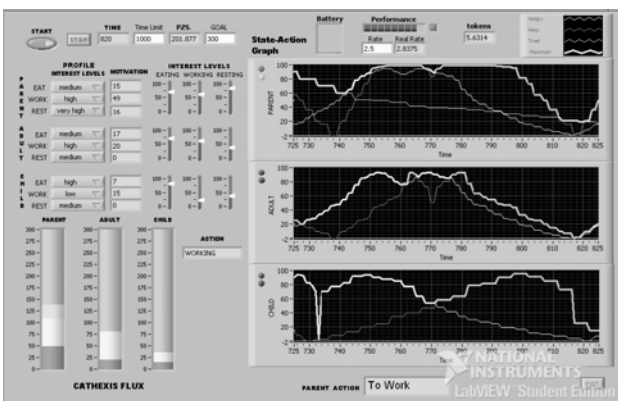


Fig. 12. Screenshot of the simulation of a "workaholic" robot

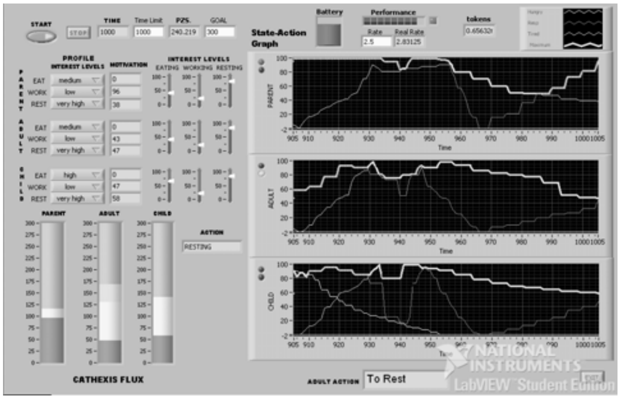


Fig. 13. Screenshot of the simulation of a "workaholic" robot

keep working will remain high. This behaviour will eventually cause the robot to collapse.

In Figure 13 we show a screenshot of the result of the simulation of a robot with a "very high" concern in "rest", and "low" concern in "work", as a result of this the robot only work when the necessity of "eat" or "rest" appear, in consequence the tokens earned at the end of the given period of time is extremely low. We can identify a robot with this *RP* as a lazy robot.

5 Conclusions and Future Work

With the working simulation the aim will be to explore how a psychological pathology as represented in the robot profile, will impact upon its decision making, its ability to achieve the goals set, its responses to critical viability criteria and ultimately its 'existence' as a working, self-sustaining robot and viable system.

In this experiment the psychological profile of the robot as defined by the three ego states described in TA is directly linked to its goal seeking behaviour as a viable system. Looking more broadly at the rationale behind this combination of a cognitive model with a systems model, the intention is to conduct experiments to help understand social phenomena.

Clearly the experiment attempts to simulate a cognate being which can achieve goals and maintain viability. However the model is relatively simple, the robot is only aware of its own needs and is functioning in a very simple environment that has limited perturbations and lacks the complexity of real social systems. The work will look to extend the simulation to gradually increase the complexity and in doing so, gradually improve on our understanding on how the decisions are taken in order to maintain a viable existence.

Conscious of the need to consider 'context' in MAS systems, future work must involve the interaction of robots in a constrained 'world', similar to a small family where individuals at different stages of maturity e.g. father and son whose manifestations of ego states are different. The simulation will require the robots to communicate and in particular must reflect relationships with responsibilities for others and how these interactions lead to changes in ego states and in the decisions that individual robots make relative to others. It will be important to consider the robot both as a viable system in its own right, but recognising the recursive nature of systems, the robot must also be considered as part of a larger family of robots with whom it has dependencies which ensure its emotional or physical well being.

In large social systems, which encompass the population of cities like Tijuana for example, social science researchers need tools to help them find or identify the mechanisms which drive and underpin social problems. While TA can help social researchers understand behaviour from a psychological perspective, the VSM and its more systemic paradigm, helps put individuals and their decision-making behaviour into a context with clearly recognisable characteristics that can be identified and analysed. This powerful combination of the cognitive with the systemic and structural should help represent social entities both at the level of the individual and at an organisational or social level - effectively a more natural simulation of a social system. Given the complexity of large urban populations like Tijuana we need an approach which can take an account of the context of an individual in a social system and at the same time take account of social interaction recognising that the two are part of the same communication phenomena.

Acknowledgement. The authors would like to thank CONACYT and UABC for the financial support given to this project. The students (Carelia Gaxiola and Dora-Luz Flores) were supported by a scholarship from CONACYT.

References

1. André, E., Klesen, M., Gebhard, P., Allen, A., Rist, T.: Exploiting Models of Personality and Emotions to Control the Behavior of Animated Interface Agents. In: Proceedings of the Workshop on Achieving Human-Like Behavior in Interactive Animated Agent in conjunction with the Fourth International Conference on Autonomous Agents, Barcelona, pp. 3–7 (2000)
2. André, E., Klesen, M., Gebhard, P., Allen, A., Rist, T.: Integrating Models of Personality and Emotions into Lifelike Characters. In: Proceedings of the Workshop on Affect in Interactions Towards a new Generation of Interfaces in conjunction with the 3rd i3 Annual Conference, Siena, Italy, pp. 136–149 (1999)
3. Beer, S.: Diagnosing the System for Organizations. John Wiley & Sons, London (1985)
4. Berne, E.: Principles of group treatment. Oxford University Press, New York (1964)
5. Boeree, C.G.: Teorias de la Personalidad (2001), `http://www.ship.edu/~cgboeree/introduccion.html`
6. Cheng, Z., Capretz, A.M., Osano, M.: A model for negotiation among agents based on the transaction analysis theory. In: Proceedings of Second International Symposium on Autonomous Decentralized Systems, ISADS 1995, April 25-27, pp. 427–433 (1995)
7. Cheng, Z., Capretz, A.M., Osano, M.: A Model for Negotiation among Agents based on the Transaction Analysis Theory. In: Proceedings of the Seventh International Workshop on Computer-Aided Software Engineering, Washington, p. 427 (1995)

8. Gmytrasiewicz, P.J., Lisetti, C.: Emotions and Personality in Agent Design and Modeling. In: Bauer, M., Gmytrasiewicz, P.J., Vassileva, J. (eds.) UM 2001. LNCS (LNAI), vol. 2109, p. 237. Springer, Heidelberg (2001)
9. Jones, S.J., Rodriguez-Diaz, A., Hall, L., Castanon-Puga, M., Flores-Gutierrez, D.L., Gaxiola-Pacheco, C.: A cybernetic approach to multi-agent system simulation in Tijuana-San Diego using the Viable Systems Model. In: IEEE International Conference on Systems, Man and Cybernetics, ISIC 2007, October 7-10, pp. 1648–1652 (2007)
10. Kopecek, I.: Personality and Emotions - Finite State Modeling by Dialogue Automata. In: Proceedings of UM 2001 Workshop on Attitudes, pp. 1–6. University of Bari (2001)
11. Nitta, T., Tanaka, T., Nishida, K., Inayoshi, H.: Modeling Human Mind. Systems, Man, and Cybernetics. In: 1999 IEEE International Conference on IEEE SMC 1999 Conference Proceedings, October 12-15, vol. 2, pp. 342–347 (1999)
12. Ovum Report Intelligent agents: the new revolution in software (1994)
13. Rodríguez-Díaz, A., Cristóbal-Salas, A., Castanón-Puga, M., Jáuregui, C., González, C.: Personality and Behaviour Modelling Based on Cathexis Flux. In: Proceedings of the Joint Symposium on Virtual Social Agents AISB 2005: Social Intelligence and Interaction in Animals, Robots and Agents, ED. AISB The Society for the Study of Artificial Intelligence and the Simulation of Behaviour UH, pp. 130–136. The University of Hertfordshire (2005)
14. Sargent, P.: Back to school for a brand new ABC, in The Guardian, p. 28 (1992)
15. Slogan, A.: What Sort of Control System is able to have a Personality. In: Proceedings Workshop on Designing Personalities for Synthetic Actors, Vienna (1995)
16. Velasquez, J.D., Maes, P.: Cathexis: A Computational Model of Emotions. In: Proceedings of the First International Conference on Autonomous Agents, pp. 518–519 (1997)
17. Virtual Person Project, Virtual Persons, Virtual Worlds, Sponsored by The PT-Project at Illinois State University (2003), `http://www.ptproject.ilstu.edu/vp/welcome.htm`
18. Transactional Analysis Journal Internet, Science and TA, `http://www.tajnet.org/articles/boyd-science-and-ta.html`