

Emotions generation and knowledge organisation in an auto-adaptive system using shape and color recognition

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Abstract: In a continual quest of autonomy, computer science tries to give an accurate perception of the world to computers. Today powerful image recognition exists, but it stills misses emotional interpretation. This paper pioneers image recognition using colors and shape recognition combined with knowledge organization. This project is developed with the Oz/Mozart system using C++ for the color recognition and based on the Camus and Cardon multi-agent system[9]. The Front agent already used in a previous paper[1] has been empowered for this purpose adding the color analyze. Experiments are discussed at the end of the paper. The system is able to understand its environment and to make autonomous decisions based on this environment.

Key-Words: auto-adaptive system, multi-agent system, ontology, knowledge organization, color recognition, Oz/Mozart, C++

1 Introduction

In our society, colors are often used to communicate: danger signals, banners. Colors can give valuable informations about pictures. Many systems are created using the shape recognition and the color recognition, for example to delimit shape in an image(face recognition: mouth delimitation, eyes delimitation); but there is always a data which is forgot by those studies: the emotional aspect of colors. Today, artificial intelligence is renewed by a new concept: artificial life. This concept is exploited by complex systems. In this paper, we pursue our previous work[1] adding a new kind of information from the pictures to the Camus and Cardon auto-adaptive system [9]: the color recognition combined with the shape recognition for an accurate knowledge organization.

2 Problem Formulation

Colors of banners, coloration of pictures, the colors in a picture are a huge source of information for the human. The colors can lead the watcher to the birth of an emotion or a decision according a new interpretation of the image not just based on the shapes contained in the picture. This work follows a previous work [1] adding the perception of the environment to a multi-agent system. Here after the perception of the shape, we add one more module to the recognition: the color

recognition. The purpose of this paper is to see how an auto-adaptive system will integrate the color recognition combined with the basic shapes recognition in its knowledge organization and decision-making.

3 Related work

Several papers have already been published on the subject of color recognition for image recognition processing. The color is often used to determine region in the image like in [2]. In this paper the colors are use to look for the face region and thereafter a neural network is used to analyze the face region. The color is also used by some robots to identify precise objects. As an example the Aibo robot uses colors to identify the objects that users show him. [13]. In fact during the learning process, objects are shown to the robot, which proceed to a conversion of each pixel RGB into a color representation. After treatment, invariant datas corresponding to the objects are enlisted in database. Most of the studies use the colors to give a name to the object. In human perception, the colors have a high influence on the interpretation of images [3]. In our paper we use the colors in a different way, to extract the signification and the emotions coming from the color.

4 An auto-adaptive system

4.1 Multi-agent system

This work uses the auto-adaptive system developed by M. Camus and A. Cardon [5]. This multi-agent system(MAS) is designed to make decisions based on emotions in a non-constant environment. The system contains several agents with different roles. Decision making applied to the environment can be divided into 5 steps:

- **Representation** of the scene including the information coming from the sensors.
- **Attention focused** on elements. This allows operation selection on the data coming from sensors and to increase system treatment.
- **Feelings** based on environmental representation. This level uses morphologic agents to select emotions.
- **Action plan.** Activated agents and emotions create behavior.
- **Reaction to the feedback.** For each action there is feedback, a link between sensors and effectors. This implies an infinite interaction and adaption between the environment and system behavior.

This is a multi-level representation. An entity is not represented by an agent but by several agents. We can recognize a major activation of a role associated to several agents by a high number of messages sent to the linked agents. The system evolves and adapts itself to the environment. This evolution occurs using a systemic loop. The system repeats the same steps in a cycle. As in life, information comes constantly from sensors and are interpreted. Then, actions are made by effectors and taken as inputs by sensors.

In the system, the decision-making level proceeds with parallel information treatment and communication using the same schema that which the human brain uses, as exposed in the Kolb and Whislaw theory [10].

The multi-agent System receives sensor values as input (here, the images). With that information, the system is able to create a scene representation, interpreting the data. Here an image is given as input to the Front agents created for this work in which a neural network generator is embedded. The Front agents are system agents, containing neural networks and so named because they are placed in front of the other system agents. The decisions and the intentional behavior implied by the image recognition is displayed with a tool: the GNUplot visualizer [16] in which the agents are represented.

4.2 Ontology

In this system, the most important part of all the entities is called structuring agents and each represents a specific word. The ontology we use here is distributed, because knowledge is not gathered in one agent, but shared and interpreted at the same time.

The reason this is emphasized on this type of agent is that they are the decision-makers. Each sensation and thought is understood thanks to knowledge. Without a way of describing and sensing the environment, there is no way of any thought generation. Then there are no decisions made being that decisions are dependent on thoughts and environment.

Disregarding the differences in the knowledge themes, (naturally leading the words to different classifications), we still always use words to communicate and describe what we feel. Thus the machine can work the same way. Here is a summary of a classification as seen in [12] of those types:

- Capacities: physical capacities of the hardware entity such as sensors or effectors.
- Objects: simple or composed objects. Example: cube, keyboard, a coat, table. An object in general, a thing according to Heidegger in [15].
- Verbs: verbs in general.
- Colors: basic and mixed colors.
- State: the state of the entity: a strong link with the verb for several elements such as “to tire” or “to sleep”.
- People: persons the entity can remember.
- Space: this section establishes where the entity is located or where it is compared to other specific elements in the ontology.
- Simple emotions: basic emotions such as pleasure or pain as well as many others.
- Mixed emotions: emotions using basic emotions such as love which includes pleasure, joy, pain.

4.2.1 Links

“Scene representation” is the amount of information that the system has been able to capture from its environment. In the case of a robot wanting to play with a ball, the “scene representation” occurs this way :

- **external information reception:** the robot can “see” a ball. Sensors will send messages corresponding to the “ball” knowledge.

- **information activation:** The “ball” structuring agent, matching the messages sent by the sensors, will activate itself i.e. send messages corresponding to all agents related to the ball. A ball is shaped as a sphere, and the two dimensional representation of a sphere is a circle. These two agents are strongly connected in the “ball toward circle” direction. So, the ball will send messages to the circle knowledge.
- **information propagation:** The “circle” agent matches the new messages, so “circle” knowledge is activated too. Since the ball-circle connection is strong, this agent will be very excited too.
- **information interpretation:** The system “knows” it is a ball : this agent and its related agents are greatly activated, and no other conflicting knowledge suppresses that thought.

Inversely, seeing something round, the “circle” and “ball” agents will be both activated. But, a circle not always being a ball, the circle-ball connection is less strong (has a smaller value) than its opposite. In this case, we can say that the system will “think” of a ball (whose agent will be less excited than if it had seen it), looking for activation of all its related agents to confirm that idea.

4.2.2 New links

New links can also be created during experiments. In earlier experiments, the system played with a pink ball, and “play” is of course linked with “pleasure“, that is why the words “pink”, “play”, “pleasure” will also be activated.

4.2.3 Negative links

Negative links also exist; they allow suppressing entities of opposite concepts. When the ball hits the system’s sensors, it will activate pain. Pain has a negative link with pleasure, so the system will feel less pleasure and will associate, in proportion to the damage done, pain with ball, and even pain with pleasure. It will remember that a ball can cause pain, and that pain can replace pleasure.

4.3 Emotions

Once the agents are activated, the system has the necessary information to determine the action. But as discovered by Bechara, Damasio H, and Damasio A.R. in [1], emotion plays a role in human decision-making. The same applies for this system as the scene representation does not lead directly to decision. Emotions

are generated too, which will distort the choice in an unpredictable way [5]. In the preceding example, we said that, having once been hit by a ball while playing, the “ball” knowledge is from now on linked with the “fear” knowledge. “Fear” being an agent of the “emotion” type, its action will be different from the classic agents. Whatever the decision, it will be encouraged or discouraged by the positive emotions (euphoria, confidence) or negative emotions (fear, awkwardness).

4.4 Morphology to control

In morphology, geometric shapes represent information and phenomenon. The specific morphology in this paper was discovered by Thom [7]. In this system, the morphology occurs when several agents of a system are activated at the same time. This creates a geometrical form. The Campagne model [8] applied to the system is a synchronous adaptation of Thom’s morphology. The model we use here is an asynchronous one, developed by M.Camus and A.Cardon [9]. Morphology’s goal in the system is to orientate the system to a specific shape in order to match its goals.

In the system, the morphologic agents produce a geometrical shape(histogram) coming from the observation of the communication between the structuring agents during a period. Depending on the situation, the morphology will increase or decrease the prominence of agents. The morphologic agent has a knowledge base with environmental states and there is constant communication between the morphologic agents and the cognition agents. The knowledge contained in the ontology has a shape associated with the structuring agent’s roles. The multi-agent system’s organization will depend on the goal. The structuring agents with the correct corresponding role and shape will be activated to match the shape associated to the goal(s) of the system as described in [9].

5 From picture to knowledge

Recognition with a neural network in an auto-adaptive system.

5.1 General Features

The Front Agent already used in [1] has been empowered with a color recognition system. With the color recognition, the Front agent is able to determine the various colors contained in the image. They receive the information(an image) from the sensors and they send words(representing colors) to the structuring agents. If the words sent are part of the ontology,

the structuring agents use the acquaintances to activate the related words. The ontology is populated with precise and various colors. However in a contextual ontology, those colors can be associated to specific objects and feelings. The analyze of pictures only using the shapes is incomplete. For example in the road ontology, a red banner has not the same meaning than a blue banner although they have the same shape. An association of simple shapes and colors can represent any compound object. For example, in another ontology, a triangle on the top of a square is a house. Depending on the ontology, a red square emphasizes a danger signalization, otherwise a green square can just show the exit in a room. Here we use really the color recognition with the simple neural networks we already used in our previous paper. The simple shape recognition combined with the color recognition with a powerful ontology enables accurate results.

5.2 Achievements

5.2.1 Programming language

The Oz/Mozart [11] is designed for parallel programming, having a very simple syntax for thread creation. It also provides a very interesting paradigm : the "Message passing" which allows sending information from one thread to another. So is the entire MAS coded in Oz/Mozart which is also used to connect the color analysing library to the MAS.

But the library analysing the colors is implemented in c++. It actually analyse each pixel of images. Therefore a particularly speed language is needed here and we choose the c++, well-known language.

5.2.2 Front agents

This specific type of agent contains Neural Network and color module. They are placed at the beginning of the systemic loop (figure 1). The information interpretation is proceed in several steps. The proceeding of the shape recognition having already been detailed on our previous paper [1] we will focus on the color recognition:

Library treatment:

- We use a C++ Library which gives the color components of the pictures.
- The color module analyzes output of library to give as results words representing the main colors of the pictures.

Information transmission:

- The Front agents receive picture, and send it to the color module.

- NN is activated on the reception of the message sent by an object of type Neural Constructor.
- The Front agent send the words results to activate knowledge.
- Those knowledge are combined with the knowledges obtained with the shape recognition sent too by the front agents

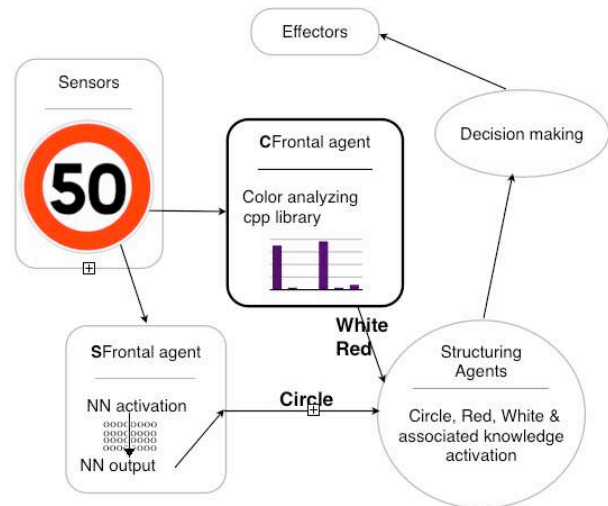


Figure 1: Front Agents' functioning. In black the newest part

5.2.3 Color analysing library

The color analysing library (figure 2) is an executable program in c++ which computes the proportion of the different colors. It is executed in Oz/Mozart by the front agent, which also retrieves the results of the analyse. The figuring is an histogram calculation. For each pixel of the picture, one is added to the bar of the chart which corresponds to its color. But there is a very high number of colors and we need much less to distinguish different objects. That is why we only use twenty colors here, each having a specific domain. Once the whole picture is analysed, predominant colors are selected and sent back to the front agent using a simple system of writing/reading on the standard output and input.

6 Experiment

6.1 First scenario

Features of the scenario:

- knowledge of the environment

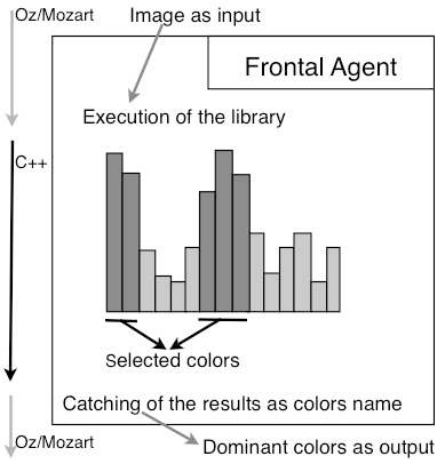


Figure 2: Process and languages used for the Color Analysing library.

- a tiny “road” ontology
- Speed limit road sign picture
- gnuplot visualizer
- a Stuttgart Neural Network Simulator (SNNS) [14] build network graph for the shape recognition.
- a color analysing library for the color recognition.

The picture is given as input to the Front agents. The figure 3 shows the activation of the “Red” and “Circle” roles which are linked to “Forbidden”. The “Red” role is also linked to the “Alarmed” emotion, which will modify the decision, increasing the activation of the “Pay attention” role as shown in figure 4. Those activations lead to the decision “slow down”.

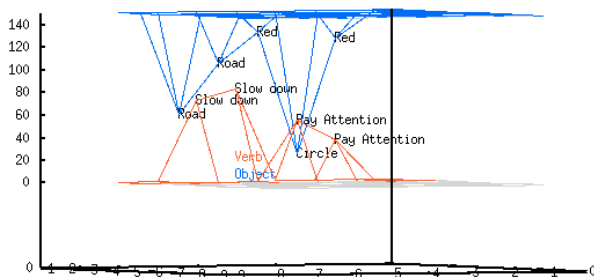


Figure 3: Knowledge representation for “Red” experiment.

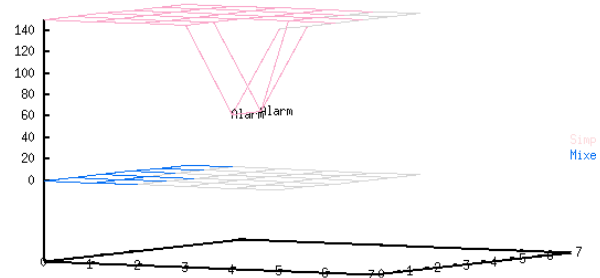


Figure 4: Emotion representation for “Red” experiment.

6.2 Second scenario

Features of the scenario:

- knowledge of the environment
- a tiny “road” ontology
- Obligation to go straight road sign picture
- gnuplot visualizer
- an SNNS [14] build network graph for the shape recognition.
- a color analysing library for the color recognition.

The picture is given as input to the Front agents. The figure 5 shows the activation of the “Blue” and “Circle” roles which are linked to “Obligation”. The “Blue” role is also linked to the “Calm” emotion as shown in the picture 6, which will not modify the decision. This emotion increases no other activation, leads to concentration, so do not bother the decision. Those activations lead to the decision “go”.

7 Conclusion

Today, a high number of studies has been made separately on the two topics: Object recognition and Complex Systems. However the papers developing both subjects are rare. In this paper we pursue our work and added the color recognition to the front agents of the Camus and Cardon System: the Front agents. Using a neural network and color recognition, Front Agents are in charge of recognition. They also have to exchange messages within the system. Interpretation is therefore possible.

We succeed in this task, letting the system understand the basic meaning of road signs (danger, obligation or interdiction) with shape and color recognition and the

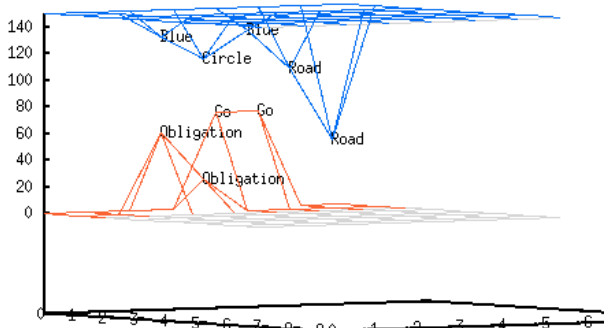


Figure 5: Knowledge representation for “Blue” experiment.

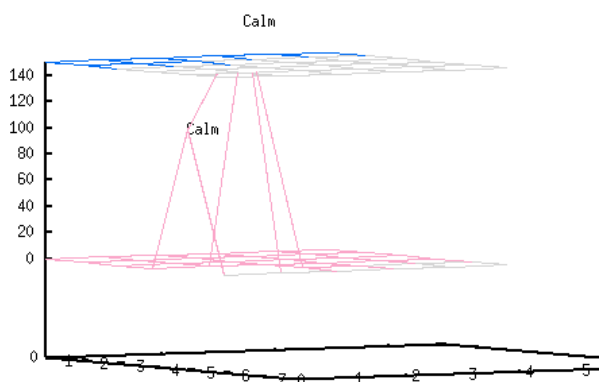


Figure 6: Emotion representation for “Blue” experiment.

knowledge organization of an auto-adaptive system. The addition of the color recognition allows for example to distinguish between road signalizations with the same shape but not the same meaning due to their different colors. For further development, we will include more elaborated ontologies in the system to improve its abilities.

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