Agent-based Recognition of Facial Expressions

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ABSTRACT
Description of a system to detect facial expressions using an agent-based approach is presented. The system utilizes interaction between Matlab-based image filters and a JADE-based agent implementation. The system is demonstrated using a feature recognition example. The system however has a much wider applicability, especially as Matlab is used extensively in other scientific/numerical computing applications.

Categories and Subject Descriptors
I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence – *Multiagent systems*.

General Terms
Algorithms, Design, Experimentation.

Keywords
Face expression recognition, Distributed computer vision, Multi-agent systems.

1. INTRODUCTION
Facial expression recognition is likely to become an important part of human-machine interface technologies, since the face is a rich source of information about human behavior. An extensive literature already exists on this topic, using techniques such as optic flow [1] or model [2] based approaches. To improve such systems and allow better recognition capability, the work described here considers the implementation of a facial expression recognition scheme based on intelligent agents.

Our system consists of two key concepts:

1. Mechanisms for connecting agents developed with the JADE toolkit with Matlab. The approach we use can allow application-based JADE agents to launch commands on one or more Matlab agents (running locally or remotely). Each Matlab agent is responsible for receiving a remote query, and processing it on one or more machines. We believe such an approach may be useful for a diverse community interested in numerical computing or image analysis.
2. Filters implemented in Matlab that are able to process images maintained at a remote site, and output its results to an application-based agent. Multiple Matlab agents may be used to process the same image. The results of these filters can then be aggregated using a domain specific ontology to analyze the contents of the image. Often it is necessary to pass the same image through a series of filters before any deduction can be made. This therefore involves the application agent planning how a set of filters can be applied in some sequence to obtain some meaningful analysis of the image.

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2. FACIAL EXPRESSION RECOGNITION WITH AGENTS: MAIN FEATURES
Our system is generic in its scope, and may be applied to a number of application areas. However, to provide a more concrete example, the demonstration focuses on the use of the system for recognizing expressions. Using the Facial Action Coding System (FACS, see [3]), we are able to determine particular muscle movements, and investigate which of these correspond to which action unit (every expression is a combination of action units). Wrinkles can help us to detect some of these muscle movements, for instance, that can be related to particular action units. The key motivation for this example is to demonstrate how an agent based approach may be used to analyze facial images and automatically classify these into particular types of expressions. There are therefore two key aspects being considered here: (1) mechanisms to detect particular facial features, and (2) associating these features with an ontology describing expressions. In this case, (1) is achieved through the use of one or more Matlab agents trained to analyze images for particular features, and (2) is achieved by one or more application agents aggregating the response from Matlab agents to make a deduction.

Matlab filters to detect wrinkles on a face were used in the experiments discussed. More filters will be added to the system in future, so that it can be used to automatically recognize facial expressions. The aim of the filters used in our experiment are to detect horizontal wrinkles in the upper part of the face (on the forehead), vertical wrinkles on the lower part of the face (on the cheeks), and diagonal wrinkles on the lower part of the face. The first will be explained, since the other two work in a similar

way. To detect horizontal wrinkles related to muscle movements, we need two images: the one we are analyzing (final image) and another one where we can see the same person with a neutral expression. We will need eye positions for both images, as well. They will be used to align both images. They must also be scaled to have the same size. Figure 1 shows an example of using this filter.

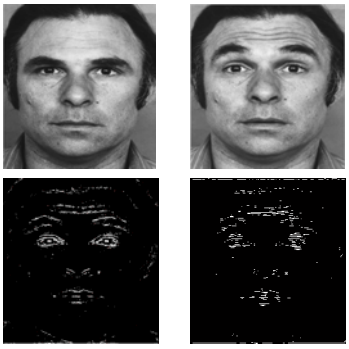

Figure 1. Horizontal wrinkles detection (upper face).

3. SYSTEM OVERVIEW

3.1 Architecture

The architecture of the current system is described in Figure 2.

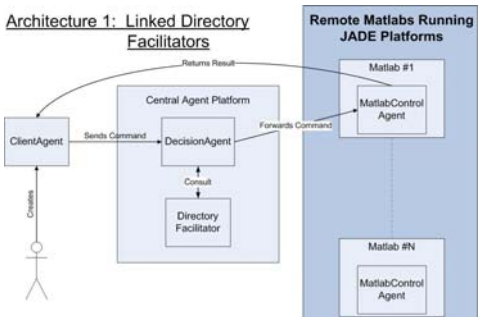

Figure 2. System Architecture.

This system works as follows:

1. User creates a new `ClientAgent` with a specified command to execute in their platform.
2. The `ClientAgent` then send its request to the `DecisionAgent`.
3. The `DecisionAgent` consults the local Directory Facilitator to find a free `MatlabControlAgent` and passes the command on, instructing the `MatlabControlAgent` to reply to the `ClientAgent`.
4. The `MatlabControlAgent` passes the command to the local Matlab instance for execution and generates the `Result` object.
5. Finally the `MatlabControlAgent` passes the result to the `ClientAgent` in the form of an `Inform ACLMessage`.

3.2 Infrastructure requirements

A laptop computer with network access is needed to undertake this demonstration. An image bank at Cardiff will be used for the demonstration.

3.3 Advantages and drawbacks

Although in recent years a number of so-called vision agent-based systems have been completed, only a few actually behave using standard agent paradigms and, when they do so, most systems are not much different to the non-agent approaches. Consequently, the introduction of agents in vision systems must result in some kind of advantage that a standard method is not able to provide. Thus, the most significant advantages of our approach are:

1. The system could recognize facial expressions correctly in case some of the filters were temporally unavailable. The classification agents could adapt to incomplete input information.
2. There can be more than one facial expression classification agent within the system, resulting in different classifications for the same input. We could train different classification agents related to the use of facial expression in different cultures, so that the system could adapt to variations in expressions across different cultures.

As a drawback, we must note that network latency can make our system run slower than other standard facial expression recognition systems.

4. FUTURE AND RELATED WORK

Despite the fact that using intelligent agents in vision systems is not a novelty (see [4], for instance), in the case of facial expression recognition we are not aware of the use of agent-based techniques. The most evident improvement to our system consists in adding more facial expression recognition filters and introduction of specialist classification agents that are able to classify expressions. From the architectural point of view, some possible improvements are:

1. Support Network Address Translation (NAT) natively, some plug-ins can help agents to send messages using the HTTP protocol, such as **FIPA MailBox** (http://agents.cs.bath.ac.uk/agents/software/fipamailbox/).
2. An ontology for the domain of our problem must be created.

5. REFERENCES

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