Final Year Project

Interim Report

Emotional Wardrobe

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Introduction

Affective Computing, computers that react to your physical state of being, is a rapidly growing area of research, with benefits to everyday computer users. The project being undertaken by myself, and several others, will represent a significant step forward in usability, economy of design, and effectiveness of the work within Imperial College London.

The potential of Affective Computing is limitless, with a diverse range of possible applications. A computer that has feedback from the user can be used to detect important physiological changes, such as a driver falling asleep, or a user's frustration with an application.

At the other end of the spectrum, the technology could be used for fashion purposes. Electroluminescent material can change in colour in response to the user's mood; precisely the goal of this project. The final product will be a scarf, with colour that responds to changes within the wearer. The flow of information is as follows:

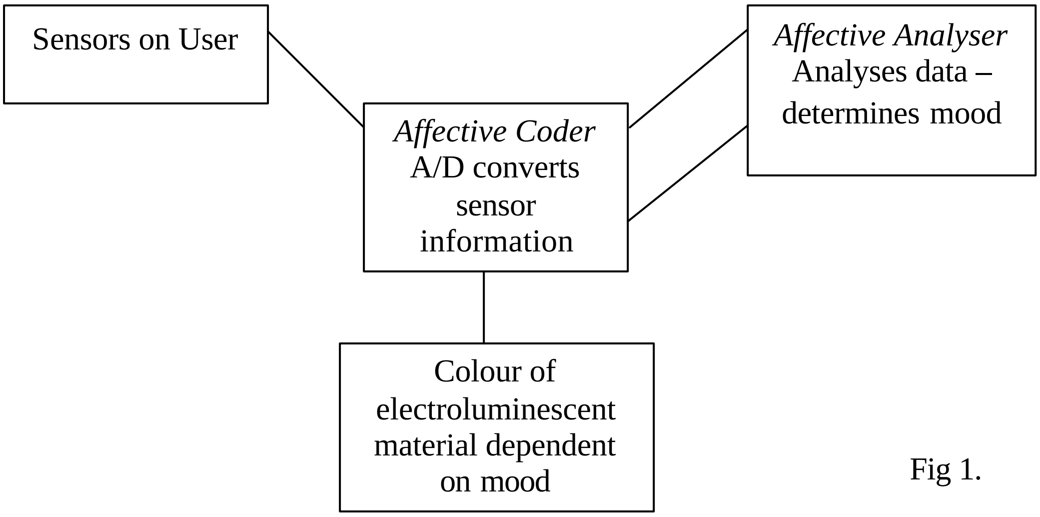


Fig 1.

Much of this project is based on work that was developed by the Interactive and Intelligent Systems group at Imperial College London [1].

My project consists of redeveloping the 'Affective Coder', that is to say the section that receives the biometric data, samples and digitises it, then sends it to the Analyser. As shown above, the results will then be sent back from the Analyser to the Coder, which in turn sends them to the output.

Aims

- To design and implement a product that can convert biometric, analogue information into a digital form suitable for analysis, and to pass analysis results to an output stage
- To implement additional functionality that allows a user to select colours for display, bypassing the Analyser
- To produce a Coder that is as general as possible, with the widest range of potential inputs and outputs
- To design a Coder that is as unobtrusive and flexible as possible
- To create a suitable web site for the project

Design Decisions

There have been many decisions made regarding how data will be transmitted, stored and processed. The following explains the more important decisions:

Digitisation of data

There is a useful precedent here, due to the existence of the previous similar system [1]. The range of the digitisation will be between 0-255, and will be taken at a rate of once per second. The A/D conversion will use dedicated circuitry within the microprocessor, as described below.

Microprocessor

In the previous system, a large 40-pin DIP Microchip PIC 16F877 was used as the central microprocessor. The specific advantages of this chip are:

- On chip 10-bit A/D conversion
- Reduced Instruction Set Computer – therefore easy to program
- On chip timer (usefulness described later)

While the package size is a severe limitation, the same chip is available as a PLCC package which is significantly smaller. However, the Programming Suite available to me does not allow PLCC programming. The cost involved with purchasing an adapter or new Programmer is significant, so therefore I feel it would be more efficient to take advantage of the Serial Programming Capabilities of the microchip. This uses a three pin connection to program the chip, and is easily adaptable from the hardware available.

Transmission

The Affective Coder sends information to the Analyser, as previously discussed. The following types of transmission were considered:

i.) Direct-Connection
This is impractical, as it would require a wire connecting the scarf to the unit with the Analyser software running on it (practically, this means a PDA). This would cause the product to lose portability.

ii.) Infra-Red
Again, impractical; it would require line-of-sight between the scarf and the PDA.

iii.) WiFi or similar
This connection is more practical. However, the range of such a connection is relatively large, more so than we require. This in turn means the individual units are more expensive than they need to be.

iv.) Bluetooth
The similar system previously mentioned [1] used a Bluetooth connection, and it is also the most appropriate for this purpose. The range is appropriate for the use, and the units are relatively inexpensive. Furthermore, many PDAs already contain the necessary hardware for establishing a connection.

The second decision that had to be made was regarding the manner in which the data would actually be sent. A custom packet has been developed with the following provisional format:

CxxxTxxHxxLxx

Where C is the skin conductivity, T is the temperature, H is the humidity, and L is the light level. The xs represent the digitised information for each statistic. In the future it is anticipated that different statistics will be used, therefore all programs will be designed as generally as possible, to allow changes.

Format of mood information returned
Once the Analyser has analysed the digitised signals, it returns a packet to the Coder in the following format:

0Mxx

In normal operation the first digit will be a '0'. If it is a '1', the entire operation of the unit will change, as discussed later.

M is mood, and xx is the level. It is not known at this stage how many discrete levels there will be, but this does not affect the design.

This value will be passed to the output stage, which will determine which colours to display for each input.

Permanent Colour Settings

In addition to the Affective capabilities of the scarf, a second mode of operation will be created, to fully utilise the potential of the hardware. This second mode will allow the user to select a set of colours to be sent to the scarf, which will store them, and display them in order.

So, for example, if the user decided that they wanted a pure red scarf, this could be set. On the other hand, if they wanted it to cycle between various shades of red, this would also be possible.

At this point in time, the colour will be encoded with the popular RGB colour scheme. This means that the Red, Green and Blue elements are each given a value between 0-255 (00-FF_{16}). So for example, #FFFFFF is equal to pure white, as all elements are fully present. #00FF00 is pure green, as it is the only colour present.

However, this uses three bytes, and allows a greater range of colours than is required; 16.8 million. I propose that the program still determines all colours in a full RGB format, and an additional routine is written to lower the number of colours. This means that if the output stage changes and more colours are possible, only this final routine needs to be altered.

The system will work by having a certain amount of memory dedicated for a series of 'frames' of colour. The scarf will simply cycle through those frames, using the on-chip timer as a simple clock. So, using the previous example, for pure red all frames would contain the same colour information (e.g. #FF0000). For cycling shades, one frame could contain #FF0000, another #990000, etc.

The question of where this memory will be located is an important one. The options available are:

- Stored on the PIC
- A separate traditional memory module
- A separate Flash memory module

The advantage of storing the data on the PIC is that it means no additional hardware is required, therefore satisfying the project's stringent space constraints.

The advantage of a separate module is modularisation of hardware. This allows the memory circuitry to be upgraded easily for future enhancements, without the limitations of the smaller PIC memory. The Flash memory solution has been chosen, as it is possible to setup the memory with very few interconnections, but still retain the modularity.

For the colour information to be entered into memory, the user must input their desired colours. This requires an interface. As the unit is already using a Bluetooth connection, it makes sense for the interface to run on a PC or PDA, and for the colour information to be sent to the unit using Bluetooth.

The language used to implement this interface will be Java for the following reasons:

- The Analyser is written in Java, so this retains consistency within the project
- Java is portable, and so the interface can be run from Unix and Windows

With the current output stage, it is impossible to send colour information, as the electroluminescent material that will be used does not display a full range of colours. Therefore, only the mood level will be sent, and the output stage will translate this mood into available colours.

This means that I cannot send the stored colour information directly. However, I wish to design my project with as general a range of applications as possible. Therefore, I will produce the application as described, and put an additional colour output port on my unit, so *any* output stage can be attached to it. Once the electroluminescent output stage has been completed, work will go into connecting it to this additional output port.

After the user has selected the colour information, it needs to be sent to the microchip. This will be done across the Bluetooth connection. The packet will be as follows:
1CxxxxxxFxxx

The PIC controller will detect the initial digit is a '1', and will therefore know that the packet does not contain mood information, but colour settings. The C stands for colour, and the following xs the RGB value. The F stands for frame, and the xs determine which 'frame' the colour is for.

Therefore on receipt of a Bluetooth packet the following data flow occurs:

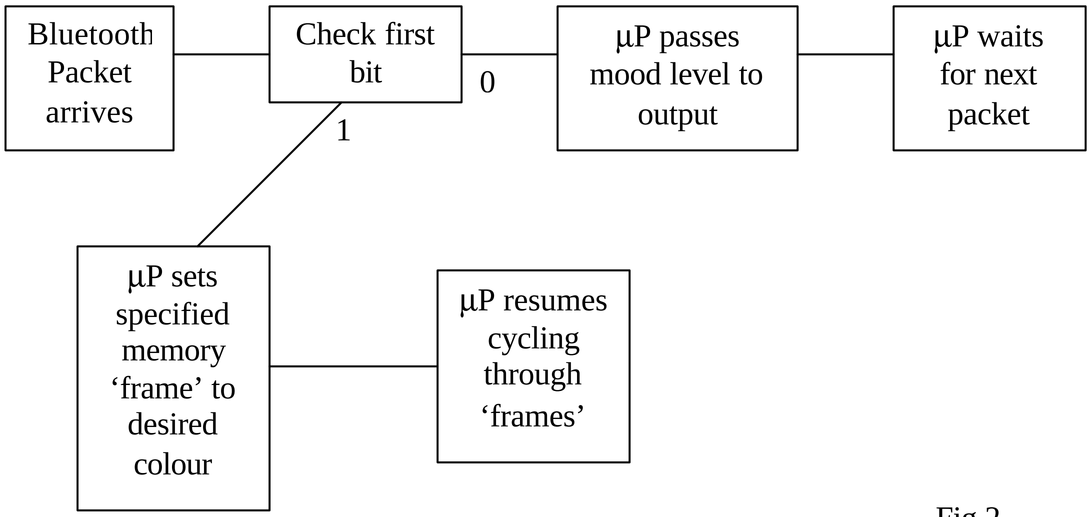


Fig 2.

Web Site

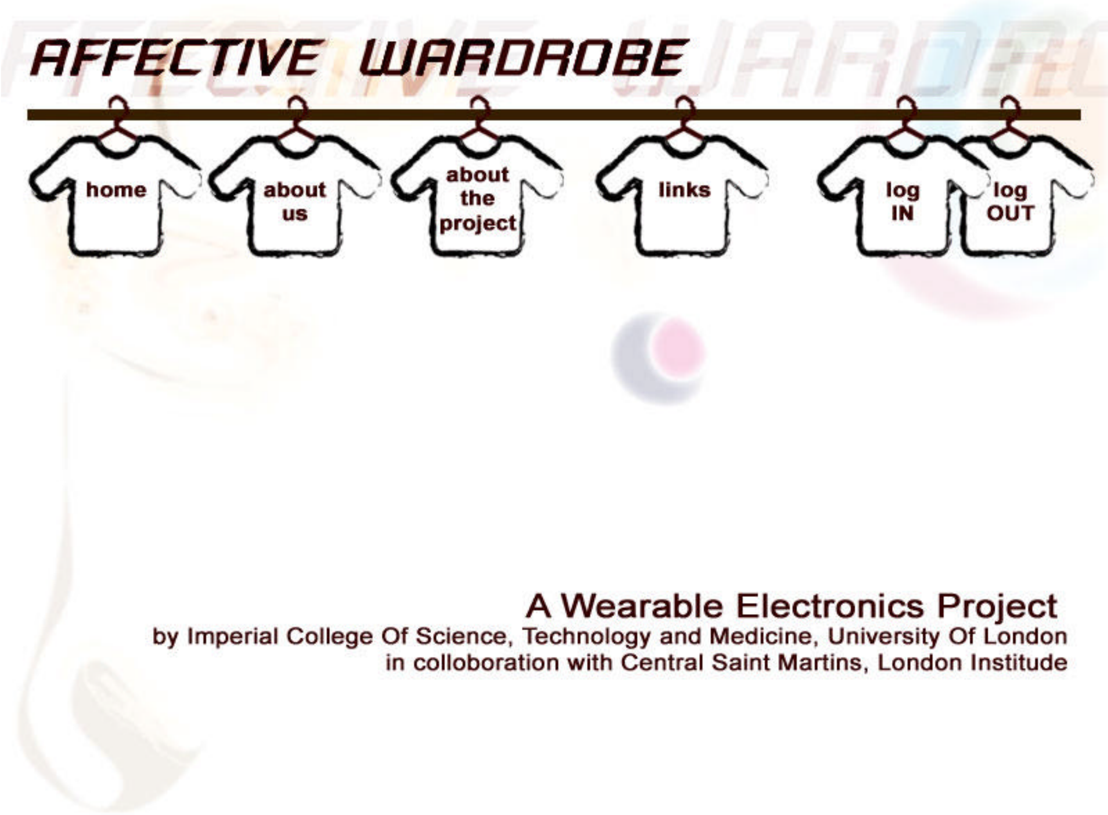
The project will also have an interactive website for both presentation of information, and for team members to share knowledge. The work for this website was split between myself and Stephanie Pau. I wrote the code, and Stephanie did the design and graphics.

The website has two main modes of use: the first being what the general public see, and the second being what team members can access. This means that a login system had to be implemented. The information that can be accessed is:

- Information about the individual parts of the project; content needs to be decided by the student responsible.
- Related Links; a logged in user can add links.
- Personal Data of Team Members; logged in users will have more complete information.
- All project reports

An important decision from a design point of view was choosing the appropriate language. For the more complex elements, such as the login system, a server-side language is essential. I have experience with various languages, but feel that a PHP/MySQL combination is the most effective in this case. It is simple and applications can be built rapidly.

Shown below is the design:



Anticipated Challenges

As the Affective Coder will be linked to both input and output stages, it is a logical position to house the power supply for all three stages on the scarf. Both input and output will require a 5V DC supply.

I believe this may present a challenge, as the finished product has to be lightweight and the electronics unobtrusive. The power supply needs to have sufficient battery life to be useful, without being bulky. When the various projects are in a position to allow battery life testing, this will become a priority.

The electro-luminescent material that is being used for the output runs at a high AC voltage, and could cause electro-magnetic interference. At this stage I feel that, while this possibility should be kept in mind, work should continue regardless. The unit will be built with the possibility of attaching any output, so alternatives are possible.

Finally, there are severe physical limitations on the Affective Coder; if it is to be worn on the body it must be both robust and unobtrusive. Therefore significant thought must go into the physical dimensions and placing of the unit, at all levels of design.

Achievements to Date

The foundations of the web site are already in place, as is necessary for the continuous sharing of information to take place. Most of the code has been written, and a design is being applied. A prototype is available at http://www.nedlowe.co.uk/fyp/

Extensive work has gone into understanding the project which this is based upon, and understanding design decisions previously made. For example, I felt that it may be better to send packets between the Coder and the Analyser in XML. However, this had already been looked at previously, and it was found the overhead of running XML tools on the PIC was too great.

All the previously described design decisions have required research and collaboration between other students working on the larger project.

Project Plan

Term 1

	October	November	December
Choosing Project			
Reading available material			
Familiarising myself with previous work			
Learning Java and JBuilder			

Term 2

	Weeks										
	1	2	3	4	5	6	7	8	9	10	11
Writing interim report											
Find replacement microchip											
Developing web site											
Order equipment and recreate existing functionality											
Simulate Analyser information being returned to Coder – Bluetooth connection											
Add new inputs - simulation											
Add permanent colour functionality											
Implementing Java interface for permanent colours											

Term 3

	After Summer Exams
Interconnection of Coder, Analyser, inputs and outputs	
Writing Final Report	
Making necessary changes to system	

Conclusion

Biometric data can be used to influence electronic equipment, and this project proposes to use the data to change the colour of a fashion item. Success will be determined by the 'Affective Coder' being able to successfully sample inputs, pass them to an Analysing unit, and return the results to an output stage. This document aims to show the feasibility of the project, its successes to date, and a timetable of future work.

References

[1] AffectiveWare Project Final Report
June 2003 – Quan Sim

Imperial College London AffectiveWare
http://www.iis.ee.ic.ac.uk/~p.goulev/AffectiveWare/index.htm

Microchip PIC 16F877 Data Sheet:
http://www.microchip.com/download/lit/pline/picmicro/families/16f87x/30292c.pdf

MIT Affective Computing Media Laboratory
http://affect.media.mit.edu/

Bluetooth Demystified
Nathan J. Muller
McGraw-Hill Telecom S.

PHP and MySQL Web Development
Luke Welling and Laura Thomson
Sams Publishing