First evaluation of enhanced jackets' potential to support first encounters with photo slideshows and emotional displays

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ABSTRACT

We evaluate here the potential and interest of enhanced jackets to support first encounters, based on the automatic generation of photo slideshows, and on emotional displays. Based on social investigations in France and Japan in 2005, we developed a prototype and service that store personal data, process information about context and interlocutors, display photos and comments on the chest and in the back, and evaluate arousal with physiological sensors. Qualitative and quantitative evaluations demonstrate the interest of the system, the impact of first experiences with it on users, and the difficulty to design trusted emotional displays. Finally, we discuss improvements of the system, and propose three guidelines to design social wearables.

Keywords: cyberclothes, design, evaluation, everyday life, human factors, social, wearable.

1. INTRODUCTION

Wearable computers are small computers worn on a user's body; they can be hand-held or embedded in garments, and are therefore well suited to support social interactions and human-human communication. Although potentially benefic and proposed for numerous applications, wearables have failed so far to be adopted by the general public.

There is a consensus on adoption limitations due to costs and current technologies but we believe that another reason is an excessive focus on technical issues at the expense of human ones. Acknowledging the importance of established psychological theories [15] we proposed to focus on human fundamental needs [7], and to create cyberclothes[1] for uses by the general public in everyday life. Our studies in France [5] and Japan [6] demonstrated the interest for wearables that improve well-being. However they indicated a possible rejection of emotional disclosure and of support for social communication [7].

Because wearables that support sociability can improve our quality of life, we decided to identify the roots of these rejections, and to establish design guidelines for enhanced garments, therefore complementing studies on social weight by Toney *et al.* [23]. As a first step we created a prototype and service that support first encounters. This system generates personalized photo slideshows, and displays feedback on the emotional state of the wearer. Our first goal was to identify potential shifts in acceptance due to the use of prototypes. Our second goal was to identify weaknesses in our design, and improve it accordingly. Besides, we aimed to limit negative reactions to emotional disclosure. This increased our understanding of wearables for social applications, and led to the definition of three dedicated guidelines.

We focused on mechanisms and requirements for functional prototypes but did not attempt to create a system that could be used in a real-world setting with current technologies. Emerging technologies (such as embedded fiber optics [1] and OLED [19]) and other research teams [11][14][16][25] promise to solve current technical hurdles, at the exception of long-lasting batteries. Therefore this first evaluation of enhanced jacket's potential to support first encounters lays the foundations for services that can be expected around 2015.

The paper is organized as follows. Part 2 introduces the state-of-the-art in social wearable computing, sensors to evaluate emotions, and technologies to display graphics on garments. Part 3 describes the prototype's hardware and framework, then part 4 presents the functions and data management of the service. After describing the system evaluation in part 5, we discuss results and propose three guidelines in part 6. Finally part 7 concludes and evokes future works.

[1] Cyberclothes are–in a nutshell–garments that satisfy human fundamental needs. They promote well-being, awareness, sociability, have special features for use as social markers and tool, and possess some autonomy.

2. STATE OF THE ART

In this paper we focus on wearable systems that support social interactions. Advanced services are possible thanks to components embedded into fabrics. They can process information [14], acquire physiological data from wearers, and display graphics on garments. So far related devices mainly exist as badges, bracelets, or business suits.

Physiological sensors placed in wearables can be used for medical [11][21], sportive [13], or affective [9][17][18] applications. Contact-less sensors (e.g. for hearbeats [16]) are particularly useful because they can be embedded into wearables and do not require particular manipulations by wearers. Like in our system, some wearables monitor skin conductivity to evaluate wearers' arousal. Picard monitors skin conductivity levels with the *galvactivator* [18] then accordingly modifies an LED's brightness placed on the glove. Similarly Healey devised the *StartleCam* [10], which takes photos of exciting or surprising moments. Other body signals can be used, and Tosa chose heartbeats to provide feedback about couples' feelings [24].

Besides physiological sensors, garments can include screens made of OLED or fiber optics. France Telecom [1] chose this latter solution to design tee-shirts that display smileys and texts. OLED [19] are mainly limited in size and life span whereas fiber optics ones are limited in resolution. Combined with physiological sensors, these general purpose displays can indicate wearers' health status, performance, or emotional state to bystanders or selected acquaintances. Combined with graphics databases, they can also display advertisements, messages, or photos.

Due to past technological limitations, prototypes supporting social interactions and face-to-face communication have mainly used badge-size screens: the *BubbleBadge* [8] displays simple messages, the *Nametags* [3] inform about relationships, and the *Meme Tags* [4] indicate similar points of view. More recent, the *iBand* [12] is placed on the wrist, and displays logos rather than simple texts or color dots. However some social systems do not have public displays. Usually more generic, they integrate more components that must be hidden in garments to remain discreet and socially acceptable. This naturally led to the enhancement of jackets and business suits, such as the *e-SUIT* [23]. Miniaturization and advances in wearable computing regularly allow us to embed smaller components, and to distribute them in different parts of the clothes. This will soon enable usable and powerful enhanced jackets for social applications.

To conclude, we can already create enhanced garments with physiological sensors to evaluate emotions, and will soon be able to embed good quality screens to display arbitrary data. This provides opportunities for the creation of social wearables that have not been explored yet.

3. WEARABLE SYSTEM

We developed an enhanced jacket to investigate face-to-face first encounters. Although the hardware was selected for short interactions, the framework was designed to allow uses in real-world settings, and extensions to other services (including well-being) for cyberclothes.

3.1 HARDWARE FOR THE ENHANCED JACKET

Taking into account functions and interface issues, we developed an enhanced jacket with processing abilities, access to wireless networks, a multi-button device, two embedded screens, and physiological sensors.

As shown on figure 1, one screen is connected to the video plug, and the other to a USB port via a VGA adapter. Other elements visible on the photo are the harnesses, the battery (top), wireless component (bottom center) and LightStone (bottom left) that acquires biosignals on the second USB port via three sensors.

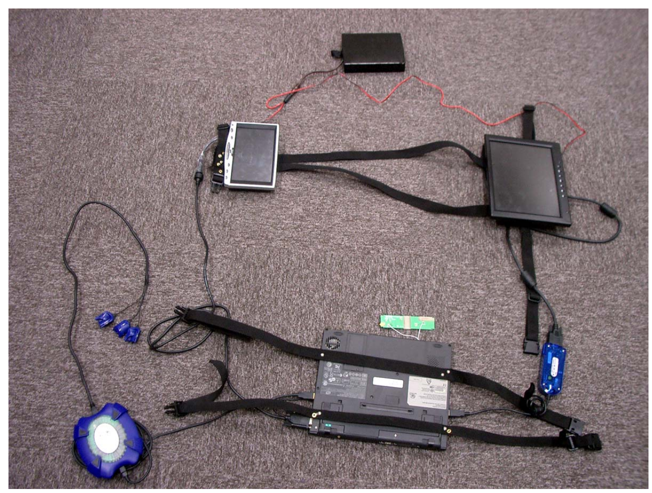

Figure 1: Hardware components of the prototype.

The motherboard was extracted from a Compaq Evo 410. Main components are a processor Intel Pentium III at 1.2GHz, 512 Mb of RAM, and standard wireless (IEEE 802.11). The system runs with Windows XP Service Pack 2 but, with drivers for the physiological sensors, we could also use Linux.

A garment form-factor was selected because it allows uses in everyday life, and maintains the continuity with previous studies on cyberclothes [7]. Offering a good surface/volume to integrate components, jackets could easily conceal the batteries, processing unit, and wires. A first screen was placed on the chest to display content supporting ongoing conversations, and a second one in the back to catch the attention of passersby.

When wearing the system, components are barely visible to interlocutors (figure 2). The motherboard is fixed below the back screen, the battery in the left pocket, and the controller for physiological sensors in the right one. What is visible is the front and back screens, the harness that supports them horizontally, and three sensors that the wearer attaches to her fingers (two for skin conductivity, one for heartbeats).

Figure 2: First prototype with screens and biosensors.

For the screens, we tried several sizes and settled for 18 cm of diagonal for the front screen, and 26 cm for the back one. These dimensions are appropriate to show texts and photos from an usual interpersonal distance. Bigger screens would have been too heavy. With OLED or fiber optics, larger but lighter displays will be available, improving rendering, comfort, and energy consumption.

We focused on visual output because people enjoy showing photos of their family and trips, and also because a study on the selection of photos for face-to-face communication [6] indicated a potential with coworkers and strangers. Besides, we considered input by cameras [20], microphones, tactile devices, and kinetic sensors. Because users feel unease with recording devices, we avoided cameras and microphones. Kinetic sensors will be experimented in a future version of the prototype, in conjunction with a learning algorithm. We tried touch panels but control was more natural with a 3-button device for the functions provided by our service. The control of the system is discreet, which avoids disrupting the natural flow of interactions with interlocutors. However, contact-less physiological sensors would allow wearers to use their right hand more naturally.

The enhanced jacket can therefore be improved, but the current design allows natural face-to-face communication, with the display of photos on the chest for interlocutors and in the back for passersby. Physiological sensors measuring heartbeats and skin conductivity can provide emotional data and a 3-button device allows control of services' functions.

3.2 FRAMEWORK FOR CYBERCLOTHES

The framework that controls the system was developed for cyberclothes, whose scope covers well-being in addition to social support. We present hereafter its main features and the most important classes related to our service for first encounters.

To allow easy maintenance and interoperability, we based our framework on Java 1.5.0, and managed data with the XML format. XML is used to describe services and to store data acquired by sensors. Because wearables can have many features and provide various services, real-world systems require communication between devices and identification of–at least–information required and functions provided by each other. Figure 3 illustrates a service's description:

```
- <Service>
  - <Input>
    - <Resource min="1" max="3">
        <Type>HTML</Type>
        <Description>Requester interests</Description>
      </Resource>
    </Input>
  - <Output>
    - <Resource min="0" max="12">
        <Type>Keyword</Type>
        <Description>Common interest</Description>
      </Resource>
    </Output>
  - <Function>
    - <Display group_fusion="no">
        <Type>Slideshow</Type>
        <Description>Common profile</Description>
      </Display>
    </Function>
  - <Policy>
    - <Privacy>
        <Disclosure>None</Disclosure>
      </Privacy>
    </Policy>
  </Service>
```

Figure 3: Example of a service's description.

The description of a service is in four parts: *Input*, *Output*, *Function*, and *Policy*. *Input* indicates resources requested by the service from the wearable contacted. In the example it requests 1 to 3 HTML files that represent the user's interests (e.g. hobbies). *Output* indicates what information the user's wearable will receive in exchange. In the example it is a list of keywords corresponding to interests shared by the wearers (e.g. hiking, tea ceremony). *Function* describes the actions taken by the service, in this case the display of photos corresponding to common points of the wearers. Finally, *Policy* states the way the data can be used, for example whether it can be exchanged with or sold to third parties. *Output*, *Function* and *Policy* are not enforceable, but they establish a contract between providers and users of the service.

For services to operate efficiently, the framework provides several handlers such as *GarmentHandler*, *WearerHandler*, and *CommunityHandler*. The two first ones are provided by default, whereas the third one is optional. Main framework elements for social services are illustrated on figure 4:

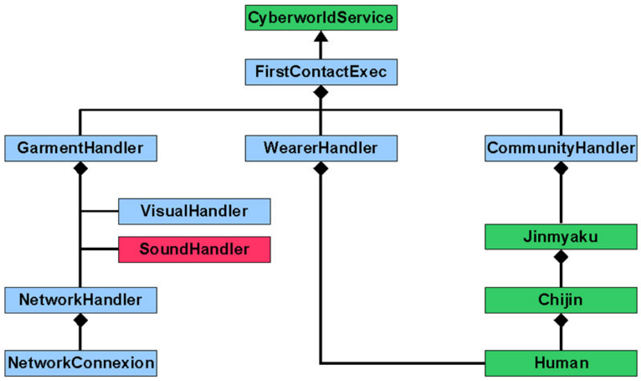

Figure 4: Main framework elements for social services.

GarmentHandler manages the system's inputs and outputs. It keeps track of the nature, location, and number of devices used for inputs and outputs. A module allows the precise control of each device but it can be replaced by intelligent modules that select how services' requests are fulfilled depending on the context. Such a module can for example lower sound levels in theatres and hospitals.

WearerHandler keeps information about the wearer, such as languages spoken, age, gender, or digital signature. This information can be used to adapt services provided by other cyberclothes or intelligent environments.

CommunityHandler can be activated for social services. It keeps a list of acquaintances based on unique identifiers. Depending on information received by the system, it can store practical data such as languages spoken, contact information such as e-mail addresses, and additional data such as hobbies. Extensions are under development to automatically update contact information and to evaluate human networks, allowing recommendations based on known relations between group members. *Jinmyaku*, *Chijin*, and *Human* respectively represent a human network, an acquaintance, and a human being.

Additional handlers envisioned for the framework include a *ScentHandler* to provide relaxing scents to stressed wearers [2][22], a *TactileHandler* to communicate with the blind, and an AirHandler to analyze the air and evaluate pollution for health services.

Currently the framework mainly provides tools to manage a wearable's visual outputs, network connexions, wearers' profile, and information about communities. Although it is limited regarding privacy, security, and internationalization, it suffices to evaluate the potential of social applications dedicated to wearable systems.

4. SERVICE FOR FIRST ENCOUNTERS

The service developed supports first encounters with the enhanced jacket presented previously. It allows prototypes to exchange information, accordingly display personalized photo slideshows, and disclose wearers' arousal. These functions require the management of users' physiological data, and the annotation of a set of selected photos.

4.1 FUNCTIONS

To support first encounters, the system stores personal data about the wearer, processes information about context and interlocutors, displays photos and comments, and evaluates arousal with physiological sensors.

As shown on figure 5, the process involves the recognition and acceptation of the service by a user (or viewer) who sends personal data to the service provider (or displayer). The provider stores the information, processes it to evaluate common interests, sends back the common keywords found, and displays a slideshow based on this result.

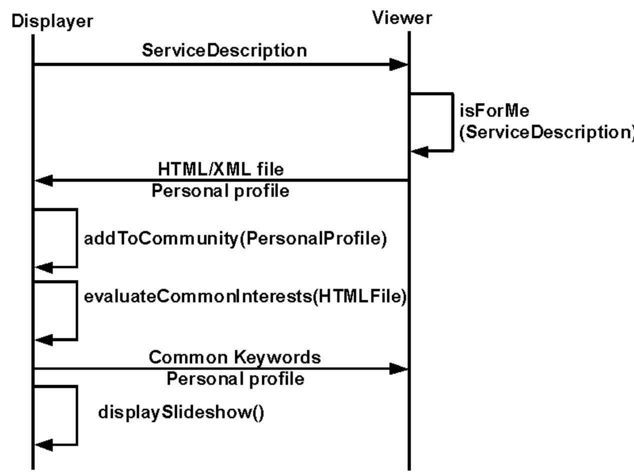

Figure 5: Flow of events for the service with 2 wearers.

The viewer accepts or rejects a proposed service based on the service description it receives, and on its configuration. An example of service description was provided in figure 3 and commented as part of the framework. Once the service has been accepted, the viewer provides a subset of her profile. It should contain her unique identifier for later transactions, and information such as language spoken to adapt the service accordingly. If the viewer wants to remain anonymous, she can send a void profile, and the service will work with default values: English for the language, etc.

The service can process files in HTML or XML formats. This choice was motivated on one hand by a concern for interoperability, and on the other hand by the possibility to reuse existing materials available on home pages, Blogs and wikis. HTML is a limited language, and the annotation of photos is only possible using the *alt* field. XML is a good complement because it is a standard, easy to process and update, and can be inserted in HTML files without negative side effects.

When two users get into contact, their wearables display a welcome message in the languages that are appropriate to the context (e.g. Japanese in Japan), and in the language of both users. Once common interests are calculated, photos corresponding to the associated keywords are extracted based on URLs indicated in the HTML/XML files. Then the system displays photos one by one, the user going forward or backward with the right and left buttons of the interface. Each photo is displayed with meta-data indicating why the photo was selected (usually common keywords).

The example on figure 6 illustrates a possible display for displayers and viewers who share a common interest in Japanese tea ceremony. The meta-data is either the relevant keywords extracted from the alt field of the HTML file, or data selected in XML. Only three meta-data are presented simultaneously to avoid overwhelming viewers: the display hints at a common interest but does not replace discussion.

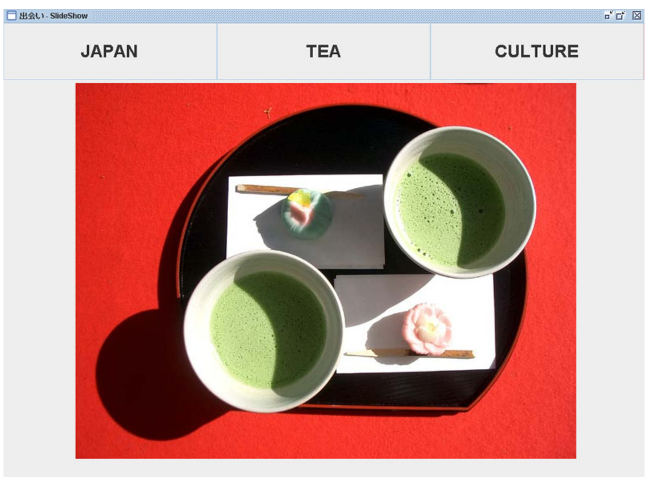

Figure 6: Example reflecting common interests in *tea*.

When there are no common keywords, or interlocutors do not possess a wearable, a slideshow is generated based on the wearer's schedule or other contextual information. For example, if the schedule indicates that at the current time the wearer should be at a conference on computer science, the service will display a slideshow based on the words “conference” and “computer science”.

While the slideshow is going on, wearers can concurrently activate their emotional mirror by clicking on the middle button of their device. Data streams from the physiological sensors are then processed in real-time to reflect the arousal of the wearer. When the skin conductivity level is low, the wearer is considered calm, and when it is high the wearer is considered excited. In the current version of the service, the background color is modified along a linear gradient, from blue for calm to red for excited.

For emotional mirrors, we considered the use of smileys, colors, and texts. A color gradient was preferred because it does not take visual spaces (just fills unused spaces), can reflect skin conductivity values more flexibly than text, and is potentially less misleading than smileys. If we had better algorithms to evaluate emotions such as “Anger”, “Fear”, and “Happiness” [17], smileys might be more appropriate. However, color gradients are not silver bullets: colors have different meanings depending on cultures. Following the use of cold/warm colors, we display from blue (for calm) to red (for excited). This choice is appropriate in most Western countries but not in China, where red represents happiness. Misunderstandings can therefore arise because in our system red is used when the user is very happy or angry. This issue should be investigated in more depth.

4.2 DATA MANAGEMENT

The generation of a photo slideshow reflecting common interests, and the display of arousal require the management of photo and physiological data. As a consequence photos must be annotated (preferably automatically), and wearers' physiological profile must be stored and updated.

For the service to be efficient, photos have to be annotated to reflect contexts and interests. Partial automation of this process is possible: cameras can mark time and location, the user's schedule can identify events, and video-processing can identify faces of acquaintances. The user then just needs to correct mistakes and manually add complementary keywords. This needs not be time-consuming if users only annotate the photos they want to use with the service. Guided by a dedicated software, users easily produce XML annotations similar to those on figure 7:


```
- <Resource id="2005_05_28_0084">
    <Type>Photo</Type>
    <Location gen="GPS">Tokyo</Location>
    <Event gen="schedule">Banquet</Event>
    <People gen="manual">Megumi</People>
    <People gen="manual">Paul</People>
    <People gen="recog_algo">Ryozuke</People>
    <Keyword gen="manual">Conference</Keyword>
    <Keyword gen="schedule">Party</Keyword>
    <Keyword gen="manual">Virtual Reality</Keyword>
    <Comment gen="manual">Great talks and sushis</Comment>
    <Copyright>...</Copyright>
  </Resource>
```


Figure 7: Example of photo annotation.

To allow our service to efficiently compare the annotations of two users, common terms must be agreed on. Shared ontologies are a first solution, with the possibility to combine a generic one with a specialist one, allowing better match for specialists. Another solution is to compare terms with a thesaurus. The main problem is the comparison of annotations prepared in different languages. A pivot language would allow the comparison of Japanese and French term, but ambiguous terms may generate surprising results.

Once annotations are processed, sets of keywords are compared. The intersection indicates common interests of the users. To provide more pertinent material, information from the schedule's current event are used for an additional intersection, as shown on figure 8:

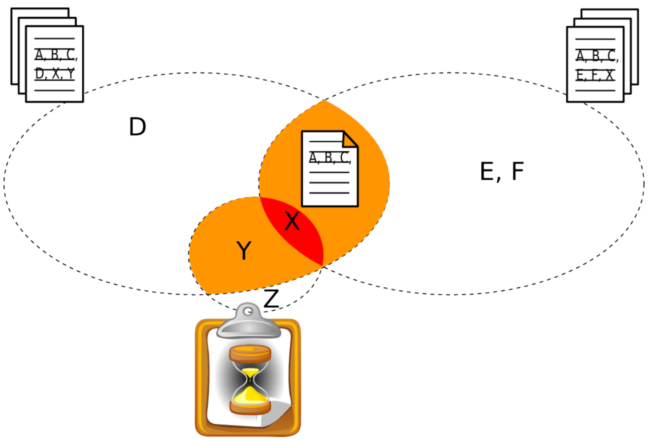

Figure 8: Matchmaking from two wearers' documents.

The system displays in priority the photos associated to the strongest (red) intersection, which corresponds to common interests related to the current event. Then the system shows photos associated to the weakest (orange) intersections, which are either related to common interests or to the event. This algorithm only works for a pair of wearers; a possible improvement is therefore to manage groups.

Globally the system involves more than the HTML/XML files discussed above. There are four main databases: context repositories, personal resources, physiological data, and community data. Their role is illustrated on figure 9:

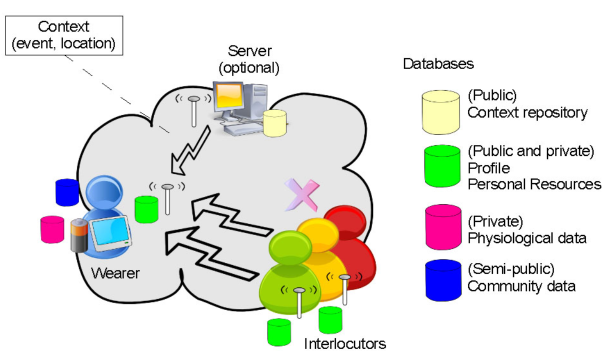

Figure 9: Databases in the system.

Context repositories are public but optional; they provide information related to the context. At a conference site or in the street, they can be accessed through a server that broadcast information about ongoing events. Profile and personal resources gather information about the wearer, including shared HTML/XML files. This database is necessary for all service users; on figure 9 the third (red) interlocutor does not possess and cannot therefore influence the generation of the slideshow. The physiological database stores usual values for heartbeats, skin conductivity levels, and can be used for medical, sportive, or affective services; it is therefore strictly private. Finally, the community database stores information willingly released by and about people met, indexed by unique identifiers. It includes digital business cards, descriptions of first encounters, common interests, etc.

As a conclusion, the service reveals common interests of a pair of wearers from HTML/XML files that contain photo annotations. The algorithm prioritizes the slideshow using the internal schedule and optionally context information provided by external servers. The four databases that store the data are public, semi-public, or private depending on their role and on wearers' decisions regarding specific services. The main limitations of the system are related to the process of photo annotation, to internationalization, and to the generation of slideshows for groups. These issues are important for uses in everyday life but do not prevent first evaluations of the system.

5. SYSTEM EVALUATION

The system was evaluated with quantitative and qualitative data. The goals were to verify the interest of the system, improve our design, check shifts in acceptance of social wearables after uses, and clarify the rejection of emotional disclosure.

The system was evaluated with twelve French, German, and Japanese. The age range was 26-32 (M=29, SD=2.5), with a single female. The experiments consisted of 10-minutes discussions between a wearer and two interlocutors. Each user had prepared 30 annotated photos. The simulated situation was meeting at a professional event: conference, seminar, etc.

Before the experiment, testers filled a questionnaire about enhanced garments, using a 5-point Likert scale: 1–strongly disagree, 2–disagree, 3–neither agree nor disagree, 4–agree, and 5–strongly agree. After the experiment, they filled the same questionnaire, and replied to additional questions related to the system they had experienced. In addition, interlocutors had to list the interesting elements they had learnt about the wearer during the discussion.

Pilot groups tested the system in automatic mode (photos changed every 30 seconds) without manual control. The multi-button was provided at their demand, which increased greatly usability.

Direct observation and feedback from participants indicated that usability and efficiency were good. Figure 10 shows feedback based on the Likert scale. Testers think that the system improves both the wearer's (4.2) and interlocutors' (3.8) ability to communicate. According to oral feedback, the system is a good icebreaker because it provides starting points for the discussion, and new topics when required. Participants also think the system helped them learn more things (4.3) and more interesting things (3.8) which is positive from quantitative and qualitative points of view. Both wearers and interlocutors wonder (2.7) whether the system improves long-term relationships or not. Considering that the service was designed for short interactions, this result does not contradict the interest of the system. This evaluation might be improved by the explicit management of long-term data, and transfer of a digital business card at the end of the discussion.

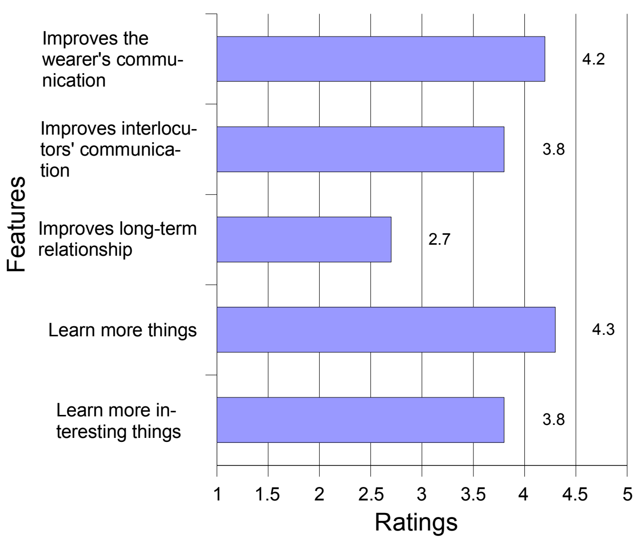

Figure 10: Efficiency of the system.

Besides, quantitative comparisons with a control group indicate that the system is indeed efficient: interlocutors list 25% more items about a speaker when he uses the system than without it.

A comparison of answers to the questionnaire before and after the experiment indicates a shift in acceptance of several features of cyberclothes (figure 11). The results are significant for the acceptance to display graphics on garments, for the disclosure of one's profile to her own community, and for the use of emotional displays. Besides, the acceptance of the service is very significant after the experiment.

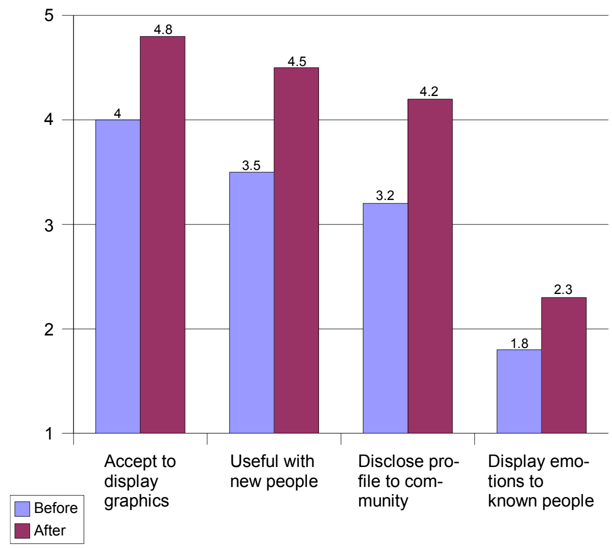

Figure 11: Shifts in acceptance due to the experiment.

Besides, results clarify the rejection of emotional displays noted in [7]. Figure 12 shows that emotional displays are considered useless, and potentially harmful. This perception depends on the social distance with viewers of the display. Perceived usefulness is inversely proportional to social distance. Perceived danger follows a more complex pattern.

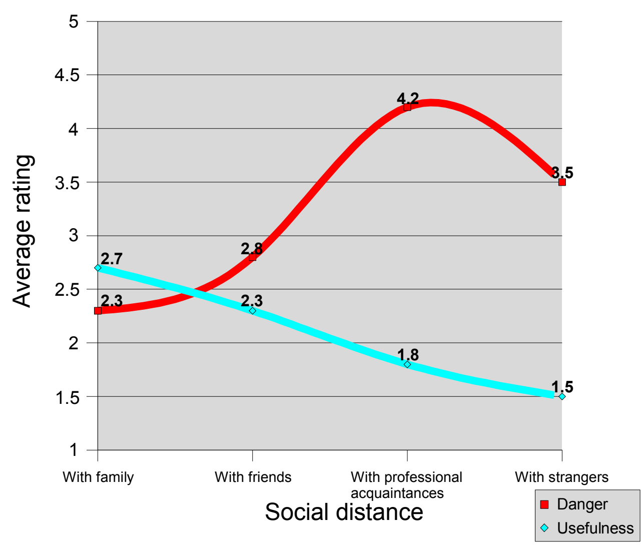

Figure 12: Perception of emotional displays

Perceived danger is the lowest with family and friends. It is high with strangers, and the highest with professional acquaintances. Based on the comments of participants, we speculate that it is because one usually tries to hide personal feelings to professional contacts and strangers. Emotional displays are seen as less harmful with strangers because strangers are easy to ignore if things go wrong, whereas it is difficult with co-workers that belong to our everyday life.

When asked which elements should be improved in priority, testers mainly asked for an additional private display for the wearer so that she can easily check was she is displaying, and eventually skip photos before they are visible to interlocutors. Testers also asked from better wearability and aesthetics of the prototype.

As a conclusion, quantitative and qualitative evaluations show that the system is usable and efficient. An additional private display, better wearability, and aesthetics would greatly improve the system but it is already a good proof of concept for the enhanced jacket and support of first encounters. The higher acceptance of related features after experiments is an additional hint of cyberclothes' interest. Finally using concrete prototypes increases the acceptance of emotional displays but perceived uselessness and danger still prevent its adoption.

6. DISCUSSION AND GUIDELINES

The system developed is very novel. The hardware and service are still limited, but the initial reactions to, and evaluations of, the system are very positive. It provides information that can be generalized to cyberclothes, and leads to the definition of guidelines that can be applied to social wearables.

One limitation of the evaluation is the size of the sample used. On the negative side, it prevents a gender and cultural comparison. However it was enough for first improvements. Another limitation of the evaluation is the number of photos prepared by users and the quality of the annotations.

A possible improvement of the system would be to add kinetic sensors to allow the system to predict actions of wearers based on their movements. This might reduce the need for manual controls. Another improvement would be to use OLED [19] or fiber optics displays. Such screens could cover a larger surface, would be lighter, require less energy, and would allow a better aesthetics. Therefore they would remove negative comments of the testers. Besides they could be used more easily in public spaces, allowing tests of the system in more natural contexts.

Another improvement suggested by our results concerns the control of emotional displays. As shown on figure 13, the addition of an on/off button for the emotional display would satisfy completely 50% of testers. The possibility to choose emotions displayed is not a satisfactory solution: it makes people more indecisive about the system. The reason is that choosing the emotion displayed removes the perceived danger, but at the same time removes the utility of the system... Several other implementations will be tested in next versions, like the possibility to fix thresholds so that only intense emotions are really rendered, other ones remaining neutral, providing information only in special situations. Another solution would be to display a mood of the day, averaging the whole day instead of rendering in real time the current emotion.

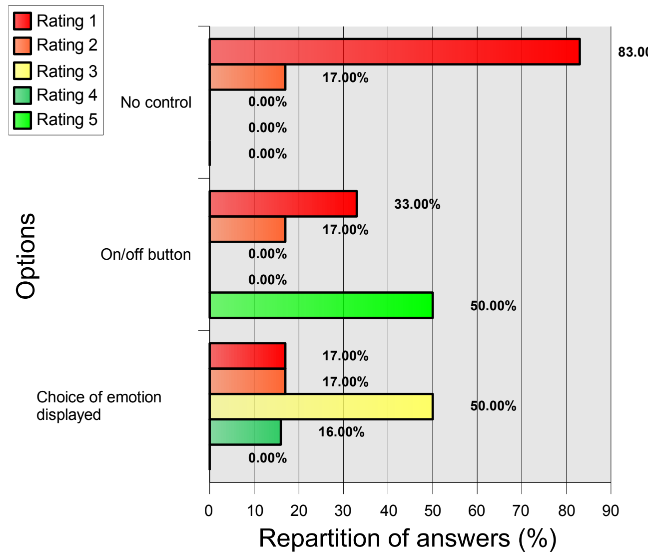

Figure 13: Improvements of emotional displays

The system proved to be very usable, and much more comfortable of use for testers since the addition of a simple manual control. The multi-button device improved the quality of interactions, limiting intempestive interruptions of ongoing discussions when a photo was automatically changed by the system.

Besides an additional display is often requested for wearers (figure 14) because they keep on breaking eye contact to make see what is displayed on their chest. Testers indicate that it is necessary: the “no additional screen” is rejected very strongly (1.2!). The preference of testers goes to semi-transparent glasses then to a small screen at the tip of the sleeve. Both solutions have advantages and drawbacks. Dataglasses allow the visualization of data without changes in gaze direction, however previous studies showed problems related to the perception of the real activities of the wearer, and also to eye contact due because glasses appear as obstacles. One advantage of dataglasses is that the wearer can watch private data and therefore also control options without interfering with what interlocutors see. Having a screen at the tip of a sleeve is convenient, and does not require to wear an additional accessory. Besides bystanders can trust that wearers are not having concurrent activities like reading their e-mails on dataglasses while conversing with them.

These two solutions are technically feasible, and we plan to evaluate both settings in parallel. We acknowledge that both types of displays have potentials that can be tapped differently depending on users and other services embedded in prototypes.

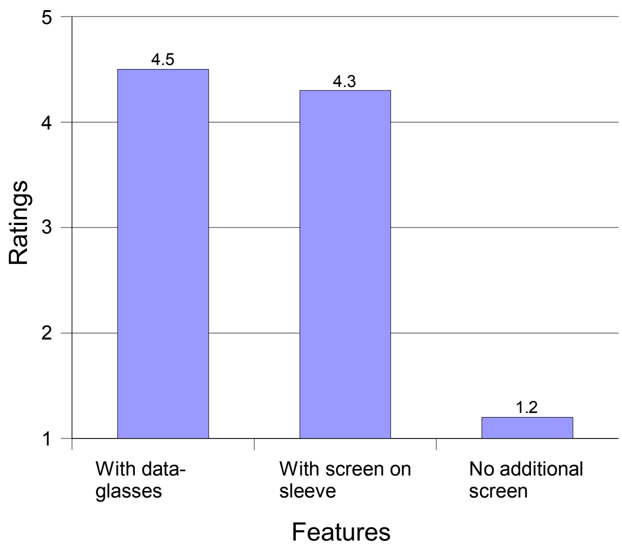

Figure 14: Requests for additional screens.

Based on these results, we propose the three following guidelines for the design of social wearables, which complement the general guidelines we proposed previously for cyberclothes [7]:

1. Emotional disclosure based on physiological data should be avoided, especially for non-anonymous public displays.
2. Wearers should receive feedback about the activities of their wearable.
3. Surrounding persons should receive feedback about the activities of wearables when they are concerned.

The first guideline corresponds to the current reaction of the general public to emotional displays. It is backed by previous social studies [6][7], and by the experiments presented in this paper. Because the reaction arises from a feeling of uselessness and of danger, it might be discarded if pertinent applications introduce the technology to the general public, letting users get used to it and feel safer about implemented safeguards. Considering that these negative perceptions increase with social distance, it would be sensitive to first introduce the technology in family and friends settings. Professional applications would be the most risky, and may only be appropriate for very special cases, like when undergoing psychological treatments or marital counselling which are both situations when disclosing one's emotions is helpful for the task at hand.

The second guideline indicates that a wearer should be aware of the activities of her wearable. This is particularly true for social wearables, which provide information (sending files, displaying photos, etc.) to interlocutors. If the wearer does not have this awareness, she may not understand what interlocutors evoke in their speech. The wearer can be informed in many ways but visual feedback appears the most accessible because it is easiest to understand, and information can be understood quickly (as opposed to voice messages) and without special training (as opposed to vibrating devices) for complex messages.

The third guideline indicates that bystanders and interlocutors should be aware of the activities of the wearables that deal with them. The idea is not to make public the whole activities of the system, but only those that acquire data from bystanders with cameras or microphones. This reflects a good practice applied in some commercial products: video camcorders indicate that they record via a small light, and Japanese cell-phones always make a sound when used for photos. Two difficulties are location and interpretation. If vision is used, where should the light or symbol be placed? It must be visible by persons concerned but not be too distracting once acknowledged. If several devices are simultaneously used (video recording, sound recording, etc.), what should be done? The second difficulty is interpretation. Wearables can have many function so using an LED can have various meanings; there is no direct mental mapping yet. Does a small light mean that video or sound is being recorded? Or something else?

To conclude, we have demonstrated the potential of enhanced jackets to support first encounters with photo slideshows and emotional displays. Although our prototype can not yet be used in everyday life, coming technologies will soon enable more functional and more attractive versions. We have also shown that the design can be improvement with an additional screen to provide feedback to the user. Emotional displays currently suffer from a lack of acceptance, and are therefore not recommend. However we propose some design hints (e.g. on/off button) for services that would still use them. In any case, we recommend more investigations on emotional displays.

7. FUTURE WORKS

This work is done in the frame of our research on cyberclothes. The creation and evaluation of our enhanced jacket showed the interest and acceptance of services that support first encounters, and identified the roots of the rejection of emotional displays (perceived uselessness and danger). Although our prototype is very modest, the interest of testers for the service motivates us to improve our system, identify good design practices and improve our algorithms to improve the quality of interactions. First steps will be to improve matchmaking, integrate auto-detection of wearables, and improve wearability with emerging technologies (notably flexible displays). Then we will improve group management, and add more tools for long-term relationships.

Besides, we think that emotional displays can be useful and we will therefore investigate their use in more depth. On one side we plan to improve the sensors, acquire the body temperature, and free the fingers because the current setting is handicapping to carry out other activities. Also, to improve acceptance and introduce the technology to the general public, we will investigate services for the family. Finally, this work can have an impact on the design of all social ubiquitous systems, and on the development of affective systems embedded in robots or simple computers.

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