Immersive Painting

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Abstract. This paper presents a human machine interface, which helps elderly people learn how to become aware of their physical state and how to influence it. One of the biggest requirements for such a system is to provide an intuitive interface which does not overexert an elderly person, while also being easily accepted. Here, the connection of art and computer science offers the ideal outlet for such an interface. In our work, we show an user interface that is pleasant, expressive and does not look like the traditional computer interactions. We use classical biosignals, such as skin temperature or skin conductance, to get the necessary information of the physical state of the user. This information is presented to the user as individual artwork, which is created from the measured biosignals and the position of a cursor. Of course, the traditional scientific graph output is also made available. Another aspect of the system is that its design, allows its smooth integration into a normal home environment, or art studio. All necessary components are off-the-shelf, commercially available products to reduce costs and to allow a quick setup time.

Keywords: Computer Science, Art, Ambient Assisted Living, Elderly People, Human Machine Interface, Biosignals.

1 Introduction

Within the next decades, the continuous improvement of medical care, the increasing standard of living in the world will result in an increase of the anticipated average age [1]. In Germany, for example, the population of people older than 80 years is the fastest growing segment of population. This segment is expected to grow from currently four million people to approximately ten million people in 2050 [2]. This implies a huge challenge to society, government and industry but also for each individual person. It is necessary to address the different kinds of limitations due to for example illnesses, injuries or natural deterioration, that occur or arise with aging. Sustainable solutions need to be created that support elderly people in their everyday activities and to provide assistance

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in case of emergency. Interdisciplinary research is required for the development of solutions that help cope with the upcoming changes in our society.

Especially for systems developed for the focus group of elderly people it is important that such developments are attractive, easy to use and address individual needs. The majority of elderly persons the advantages of a new acquisitions need to be clear. Price, training period and personal benefit are only a few of the important factors, which influence their purchase decision.

In our work, we investigate a new approach, where we combine art, psychology and computer science to develop interfaces for elderly people. We utilize artwork as access to modern communication technology and additionally we want to use it as a means for promoting the collection of clinical relevant data. The aim is to direct the attention, especially of elderly people, to clinically relevant topics, to impart knowledge and to offer screening and diagnostic instruments. In this paper, we show how the combination of art and computer science can help elderly people gain an intuitive and playful access to modern technologies, without the need of complicated instruction manuals. We show that one can develop systems that make it possible to learn how to interpret and manipulate ones physical state while having fun.

2 State of the Art

An example setup that combines artwork and computer science, to arouse interest and to gain the attention of a user was developed by Shugrina et al. [3]. Here the properties of an image, e.g. coloring or style, are changed according to the classified emotion of the user. Features are continuously extracted from a face, which is recorded by a camera. This example shows that the utilization of adaptive art, independent of the actual media, has big advantages. Art as intuitive and attractive interface for the visualization of the acquired data significantly increases usability and joy. Our approach, in comparison, is based on the ideas of classical biofeedback applications, such as described in [4]. In principle, such applications, much like our system, aim at teaching the user how to interpret and manipulate his body signs. There is however a significant difference between traditional biofeedback and our setup. While classical biofeedback approaches perform a predefined action that is influenced by the change of the biosignals, e.g. show a movie of a flower (see Fig. 1) which starts to bloom [5], our system involves the user's creativity, to create unique artwork everytime it is used. The basic idea, to combine artwork with the interpretation of biosignals has also been introduced in the field of biofeedback, e.g. by [9]. But once again there, the user is just able to modify an existing artwork and not to create his own, individual artwork. One advantage of our approach is that it gives a larger freedom of expression to the user and thus keeps the fun factor elevated. One can use it for entertainment or artistic purposes instead of only a means of necessary biosignal data collection. Furthermore, while previous systems could not be integrated in a home environment, our session uses a regular TV screen as a display unit, which is available in nearly every home nowadays.

Fig. 1. The state of the flower depends on biosignals (images from [5])

3 Feature Extraction from Biosignals

As input for the painting device, we need to know, whether a user is currently relaxed or tensed up. To obtain this information, we first of all measure the skin temperature (ST) and the skin conductivity (SC) with the nexus-10 from Mind Media [5]. These signals were chosen from the available signals of the nexus-10, because they are easy to record, compared to other signals, e.g. the electrocardiogram (ECG), but still robust enough to allow for an analysis of the physical state of the user. For the ECG, we would need to place additional electrodes on the body, whereas the recording of ST and SC can be realized by small sensors, shown in Fig. 2, which are attached to the hand. The measured raw values are sent to the computer via Bluetooth, which avoids unnecessary cables and allows the user a higher range of motions.

The big advantage of choosing sensors that are easy to use is, that our system can be used without a complicated preparation, which in turn would lead to a loss of acceptance. There are already systems under development, where the biosignals can be collected via a glove [6], a vest [7] or a T-shirt [8] in a comfortable way. Such devices can also be integrated in our system in the future so as to obtain additional signals, like the ECG, or the respiratory frequency in a comfortable way. Our system is flexible enough to allow the possibility to process additional signals besides skin temperature and skin conductivity. As

(a) Nexus-10 (b) Temperature sensor (c) Skin conductance sensor

Fig. 2. Sensors for acquiring skin temperature and skin conductivity (images from [5])

soon as these devices become commercially available and can be comfortably and intuitively used by elderly persons, it will be investigated, if these devices can be integrated in future versions of our painting device.

To ensure that the measured signals have the consistent influence on the painting process, whether the user tends to relax or tends to tense-up, the nexus-10 is calibrated and the received raw values are normalized. The normalized signal values $s(n)$ of each sensor n are multiplied by a sign factor $f(n)$, which guaranties that an increase of the values implies a tendency for tension and a decrease of the values indicates relaxation. Afterward they are summed up to a total sum S, which is the sum over all corrected signals received from the number of available sensors N.

$$S = \sum_{n=1}^{N} f(n) \cdot s(n) \quad (1)$$

The sum S in Eq. 1 is calculated for each time frame t. In the next step the sum of the current frame is compared to the average A sum of the last five frames. If the current sum is larger than this average, this indicates that the user has become more tense. If the sum of the current frame is smaller than the average, then this is an indication that the user is more relaxed. With this information one part of the necessary information that is needed as input for the painting device is available. The workflow of the device is shown in figure 3.

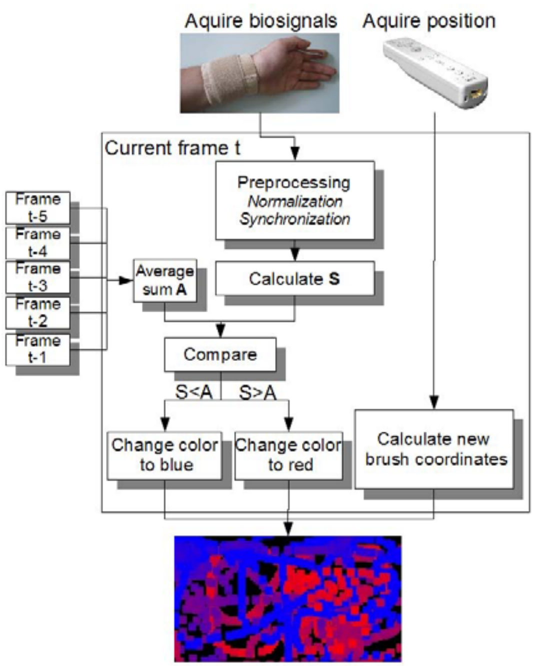

Fig. 3. Workflow of the painting device

4 The Painting Device

To finally setup the Painter, the position of a paint brush and its color need to be defined. To realize the paint brush, we currently use a Wii Mote™[10], which is used as pointing device. The user just needs to point to the direction of the desired spot with this device to define the position of the paint brush. For people, who are used to a computer, it is also possible to use a standard mouse device to define the current position of the brush.

The color of the paint brush is defined according to the sensed psychological state as described in Section 3. The information of the state of the user, relaxed or tensed up, is used to shift the current color between two colors for each frame. To avoid the case where a single wrong measurement in one frame could result in a large change of the color, the color only changes gradually from frame to frame. In the images shown in Fig. 4, the colors are set to vary between blue and red. As long as the user relaxes, the color of the paint brush continuously shifts from red to blue over time. If the user is tensed, the color changes from blue to red. The user is always able to interrupt the painting, just by pushing a button on the Wii Mote or on the computer mouse. This enables the user to precisely position the brush before the point is colored. When the user is pointing to a position, which is already colored, the mean of the old and the current color is set. If the painting is finished, the user can stop the painting, the image is saved and one can then either start with the next one or quit the software.

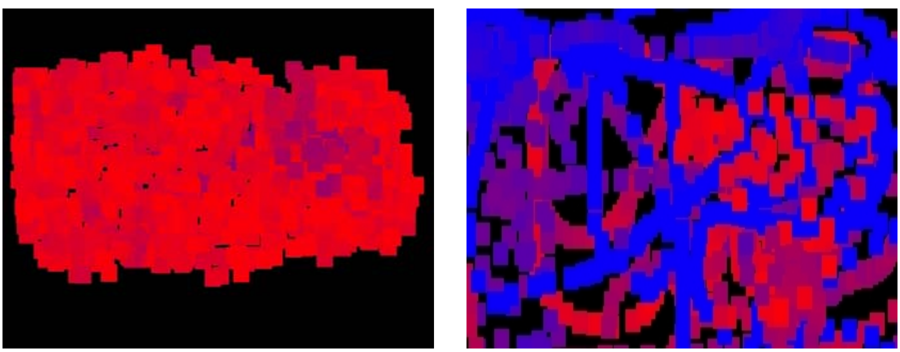

Fig. 4. Individual artwork created with the painter

5 Conclusion and Future Work

With our approach we show one possible way to combine artwork and computer science to build attractive and intuitive applications that motivate usage and direct the interest to clinical relevant data at the same time. People, who use this application, playfully learn, how to interpret and manipulate their psychological state. Additionally, we are able to integrate our system into a home environment. This is important, as future work will focus on two main applications.

We want to use the different biosignals from the available sensors to enhance the existing painter. These different signals could be utilized to control the input to the artwork. For example, one signal could be used to choose the color, another signal could be used to choose the type of the paint brush. Additionally, the time the brush is at the same spot in the image could determine the thickness of the brush. We also plan to have artists use our prototype and guide us in the next version of our immersive painting method.

Furthermore, we want to provide a continuous training, which can be utilized as a screening instrument. It will be investigated, if our system can be used as platform to build a screening instrument to support the early diagnostic of dementia. Therefore, a set of pictures of known persons or events of the past will be shown to an elderly person on the TV screen. As reference, also pictures with neural content will be in this selection. For each picture, known or neutral, an artwork from our painting device is created, but in contrast to the described painting device, the artwork will be created in the background. After each session these artworks can be used to compare the session with previous ones. Although, the spatial resolution of the artwork and the delay in the change of the biosignals will probably not be sufficient to give a detailed prediction, which detail in the picture had the most influence, we expect the user to show different reactions, between known and unknown pictures. With the additional information, which picture shows known persons or events to the user, we will examine, if a system can be set up, which automatically detects, whether a picture is known or unknown to the elderly person with the help of the created artwork. The aim of this enhancement is to gain continuous information if the memory of an elderly person acts according to the age.

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References

1. Commision of the European Communities, Green Paper - Confronting demographic change: a new solidarity between the generations, COM(2005), 94 final (2005)
2. Eisenmenger, M., et al.: Bevölkerung Deutschlands bis 2050. 11. koordinierte Bevölkerungsvorausberechnung. Statistisches Bundesamt, Wiesbaden (2006)
3. Shugrina, M., Betke, M., Collomosse, J.: Empathic painting: interactive stylization through observed emotional state. In: NPAR 2006: Proceedings of the 4th international symposium on Non-photorealistic animation and rendering, Annecy, France, pp. 87–96 (2006)

[1] Bayerische Forschungsstiftung.
[2] www.fit4age.org

4. Horowitz, S.: Biofeedback Applications: A Survey of Clinical Research. Alternative and Complementary Therapies 12(6), 275–281 (2006)
5. http://www.mindmedia.nl/english/index.php (06.07.2009)
6. Peter, C., Ebert, E., Beikirch, H.: A Wearable Multi-sensor System for Mobile Acquisition of Emotion-Related Physiological Data. In: Affective Computing and Intelligent Interaction, pp. 691–698. Springer, Heidelberg (2005)
7. Paradiso, R., Loriga, G., Taccini, N.: A wearable health care system based on knitted integrated sensors. IEEE Transactions on Information Technology in Biomedicine 9(3), 337–344 (2005)
8. Pola, T., Vanhala, J.: Textile electrodes in ECG measurement. In: ISSNIP 2007 Third International Conference of Intelligent Sensors, Sensor Networks an Information Processing, Melbourne, Australia (2007)
9. Tirel, T., Hahne, S., Garancs, J., Muller, N.: BIOS - Bidirectional Input/Output System. In: VISION - image and perception, Budapest, Hungary (2002)
10. http://www.nintendo.com (06.07.2009)