Handbook of Research on Synthetic Emotions and Sociable Robotics:
New Applications in Affective Computing and Artificial Intelligence

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Chapter XXII
Emotional Ambient Media

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ABSTRACT

The "medium is the message": nowadays the medium as such is non-distinguishable from its presentation environment. However, what is the medium in an ambient environment, when the environment is smart, recognizes emotions, and at the same time responsive? Emotions have had an inferior role in philosophy, psychology, art, and nowadays in media technology. In philosophy and psychology many researchers devoted their work to the question what emotions are, and how they can be modelled, ranging from common-sense theories, theories that emotions are simply physiological disturbances, and the many behaviour theories describing emotions providing a much more comprehensive view on emotions (Solomon, 1977). In the age of ambient media, where media technology is embedded seamlessly and hidden into the natural environment of the consumer, the view towards media is changing. The modality how emotions are experienced and the technology to recognize and simulate emotions are changing. To support the theories within the scope of this chapter, a case study – the emotional ambient responsive character – has been performed. The concept was realised as a simple interactive game responding to human emotions. Within this book section, we present a technical oriented view towards recognizing, simulating, and binding emotions in ambient media systems. A case-study for an emotion recognition and response system is presented. The system integrates the content and emotion recognition elements.

BACKGROUND

Within the scope of this book chapter the fields of emotional computation, affective computation, psychology, very slightly the field of philosophy, and ubiquitous- and pervasive computation are touched. The main background relies on the development of ambient media based on media technology coming from ambient intelligence. Current research in the field of emotional computation focuses around these questions:

- What is the relation between emotions and experience?
- How can emotional machines be modelled and implemented?
- What is the meaning of emotions in art and media?
- How can emotions and affects be recognized and generated?
- What are the linguistic and non-linguistic aspects of emotions?
- How can emotion classification based on media be performed?
- Which methods for evaluation of emotional impact,
- How can the affect of emotions be classified, evaluated, and measured?
- What are the linguistic aspects of emotions in text, speech, and media?
- Which models for factors impacting emotions exist (e.g. personality traits)?
- How can emotions be described, generated, parsed, and managed?
- What is the effect on human-computer or human-human interaction?
- How can emotional computation be applied in specific applications (e.g. gaming)
- Which new forms of dialogue systems involving emotion patterns emerge?
- What is the impact of emotions on cognitive robotics and multi-agent systems?

Originally media are delivered via distinguishable entities to the consumer (e.g. video stream, audio stream, image). In the age of ambient media, the entity that is perceived by the consumer is by far more complex to describe. A first definition for ambient media has been made by A. Lugmayr in (Lugmayr, 2007), and the form of ambient media can be described as "particular way in which ambient media assets physically exist or manifest themselves, morph the natural environment entities with the synthetic artificial created world, collaborate with each other, and intelligence of arrangements (composition) and contextualization of media assets and their subcomponents as an artistic or factual genre for the creation of human experience". Thus, the message of the medium is transmitted via any arbitrary signalling information – therefore the message of the ambient media system can be embedded anywhere – as ambient light in a living room, as intelligent car, as a smart phone recognizing the context of the consumer.

Especially media technology developed the need to gain understanding of several different aspects of emotions. Therefore this book section especially matches emotional binding to the media with the latest trends in the development of ambient media technology. It evaluates existing theories coming from philosophy and psychology in emotional research to adopt these with the needs of ambient media systems. From the technical view, a basic model for experience and emotion oriented computation in the field of ambient media is presented. Different existing methods and technologies are evaluated and presented. This includes techniques and methods for the recognition of human emotions. For many years the recognition of human emotions was major research field in artificial intelligence. After the disillusions in the field of AI, in recent decades, many questions where untouched. However, with the emergence of ambient intelligence, the field became a new retouch, and emotional computations gained importance as a major research field.

Another issue this book section is devoting to the evaluation of methods and techniques for the simulation of human emotions with the machine. With the emergence of intelligent computing, we are talking about collaboration with the machine, rather than using machines. Machines will assist in our daily life tasks, hidden in the background. Without any emotional aspect, the machine will rather hardly be able to act human-alike rather than as passive user-interface. Within this book section, a framework for the simulation of human emotions is presented. We evaluate existing techniques and methods to obtain a more coherent view on how simulation of emotions is possible.

In artistic works, emotional binding – thus how to obtain emotional responses from the consumer – is already well developed. In the case of ambient media, it is not clear how emotional binding can be performed, and what the major attraction point for consumer is. Within the scope of this book section, a model for emotional binding is presented.

INTRODUCTION

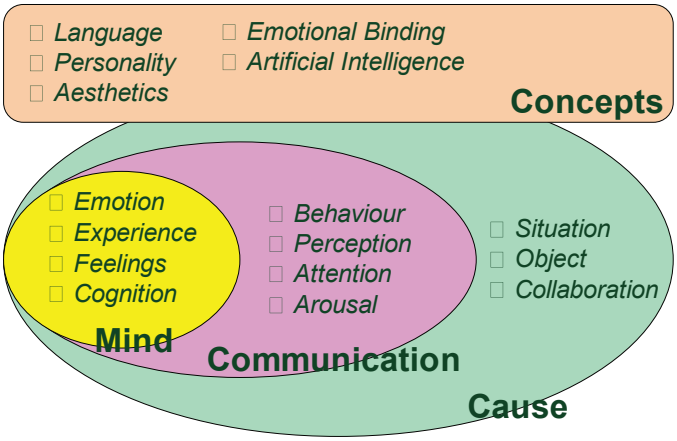
To begin the chapter we have to ask ourselves what actually emotions are. In commonsense knowledge, emotions are a human expression to the current situation in the world. Emotions can be described as human behaviour based on context. While watching a touching romantic movie in cinema, we are getting immersed into the story presented in front of us on the screen. We identify with characters and are touched by the happenings occurring to them. The audience cries if our dies a dramatic death or we feel strong and proud while leaving the cinema when the hero conquers the evil. All these are emotional responses to the presented media. In film these effects are called 'emotional binding'. The director tells his story by using the tools available to him to tell an artificial story universe in space and time. Cinematography, actor's behaviour, and knowledge how to render a story enable him to bind the audience emotionally to his piece. In the medium motion pictures and other artistic domains, such as painting, literature, and music these mechanisms are well known. Without binding the audience to the medium and creating emotional responses, artistic creation is rather poorly possible.

With the emerging available technology coming from pervasive- and ubiquitous computing, the question *what emotional computation means in days of ambient media* – thus in times where the medium is embedded into the natural human environment – gets more and more obvious. Another buzz word in today's media technology is consumer experience. The consumer shall experience media and be bound to emotional designed products to experience it. Both, emotions and experience are very closely related. Emotions trigger experience and without being emotionally bound to an object it is rather poorly possible to create experience. One example is car advertising. The advertisement delivers a message to the consumer. And depending on model and target audience the advertisement suggests a certain driving experience coming with a specific kind of car. To explain what actually the phenomenon 'experience' is, is a more complex theme. However, with the scope of this chapter a first attempt is being made.

To understand the complexity of emotions Figure 1 presents a very loose categorization of most common key-themes related to emotional research. They are categorized according:

- *Mind* describing what happens either physiologically or psychologically in a human brain while experience emotions;
- How emotions are *communicated*, thus perceived or transmitted to third parties;
- *Cause* as trigger for emotions or a contextual situation triggering or consuming emotions; and at last
- *Concepts* describing higher level concepts related to human emotions, as e.g. the de-

Figure 1. Key-themes in emotional research



scribed concept of emotional binding in motion pictures.

This very primitive categorization of emotions shall ease to understand the complexity around the topic emotional research. The human mind is the smart unit for processing emotions and tagging feelings or other high level meanings. Communication of emotions deals with the expression and recognition of emotions in a situation or based on an object. The cause or trigger for emotions is based on the situational environment of a human. However, higher level concepts of emotions deal with the concepts around aesthetics, society, or personality. Without discussing the meaning of all these different themes in further depth, we see the complexity while dealing with the world of human emotions. Figure 1 depicts the different issues around the topic of emotional computation.

CONTENT OF THE BOOK CHAPTER

- **Introduction:** General introduction into the topic, definitions, standards, related works, and questions in the research field;
- **Ambient media systems:** Background of ambient media, content models, sensor networks, context profiles, and creation of media which is relevant for the scope of this book chapter;
- **Models in psychology and philosophy of emotions:** Methods, theories, models, and approaches in philosophy and psychology towards emotional research which are applicable for ambient media systems;
- **Emotional binding in ambient media:** Model for adding emotions into ambient media systems including their characteristics, features, theories;
- **Techniques for recognizing, simulating, and contextualization of emotions:** Theoretical models in ambient media for recognizing, simulating, and binding emotions;
- **Case Study–Ambient emotional responsive character:** Presentation of an implemented case study performed within the NAMU Lab. for researching emotions: the *Animated Ambient Emotional Responsive Dog House*;
- **Discussion:** Discussion of the presented topics, and future research directions;
- **References:** References of the book chapter

EMOTIONAL MODELS IN PSYCHOLOGY

There are wide spread opinion and theories in psychology, philosophy, religion, and law what actually emotions and emotional responses are. The most profound definition for emotions is that emotions are "a strong feeling, such as joy, anger, or sadness [as] instinctive or intuitive feeling as distinguished from reasoning or knowledge" (Oxford, n.d.). Within the scope of this chapter and the follow up sections, we will see, that exactly this definition of emotions is inadequate for the purpose of ambient media systems. However, let's start to explore the most substantial other ones.

General View of Emotions

During history there have been many different viewpoints of emotion – emotions as animal instinct, emotions as defect of the human mind, or emotions as passion. For people further interested in these views, it is referred to the readings of Descartes, Aristotle, or Spinoza. Nevertheless, the most common sense view of emotions is, that emotions "are feelings, distinct experience not unlike physical sensations, something like nausea or anxiety" (Solomon, 1977).

Emotions as Survivor Factor in Evolution

The theory that emotions are a survival factor in Evolution is coming from Charles Darwin. He divided emotions into habit, antithesis, and direct action. Habits are long-term and are learned and occur in familiar situations. Antithesis is a matter of occurring situation, where the human is not familiar with, thus it can be seen as opposite of habits or while the human is in unfamiliar situations. Actions are based on the emotional activities of the nervous systems (Darwin, 1872). This viewpoint towards emotion is interesting, however has rather less influence on the evaluation performed within the scope of this paper, therefore is not discussed in further detail.

Common Sense View

However, another interesting movement is the common sense or naive psychology (see e.g. Hayes, 1985) view towards artificial intelligence. As far there has been much controversy in research, and if it is a dead end or is leading to a new breakthrough in science. The key idea is that common sense "can be thought as the natural human ability to infer and reason about other people's mental states" (Watt, 1995). Humans perceive humans as a whole rather than objects (Hayes, 1985). Especially the common sense view implicates a re-thinking of emotional computation. The modelling of an emotional machine is an act of modelling the knowledge of our world in a common sense way, rather than explicitly creating complex formalisms and models. Thus to model emotions into our daily world, we have to assume that artificially created objects and human minds are on the same level. Intelligent objects become companions being aware of our mental state and humans of theirs. To follow up with the discussion around naive psychology and common sense thinking, it is referred to (Watt, 1995) where many interesting further references can be found.

Process between Motives, Believes, and Precepts

Another viewpoint towards emotion is viewing emotions as process caused by interactions between motives, beliefs, and precepts (Sloman & Croucher, 1981). Thus the components contributing to emotional computation are *motives, beliefs,* and *precepts*. This theory can be seen as a step towards naive psychology and the common sense way of thinking how an emotional machine can be built. However, for a complete technical solution the theory still requires information technologi-

cal concepts to describe, analyze, and model an emotional system including a computational model of the mind.

Categorization of Emotions

As many theories exist in psychology to describe emotions, as many theories exist to categorize emotions. However, to model an emotional system – independently which psychological model is used – a certain classification of emotions is required to process these with an information processing system. The most significant ones are:

- **Positive/negative classification:** The most simple and obvious classification of emotions is in negative (e.g. hate) and positive (e.g. love) emotions;
- **Basic emotions classification:** The basic classification distinguishes between basic emotions, which are similar to the basic colours. They are the emotions, which are underlying any human emotional concept. There exist many examples for this type of emotions. One is FACTS, which distinguishes between normal, happy, sad, afraid, and angry for facial expressions (Ekman, Friesen, & Hager, n.d.)
- **Primary/secondary classification:** The most common and debated classification of emotions is the division into primary and secondary emotions. Primary emotions are clustered into different sub-categories. This enables higher granularity of different emotion types, and a machine processable format for emotions. One example is the division into eight primary emotions as described in (Plutchik & Kellerman, 1990). This classification leads to a three-dimensional model similar to the HSV colour cone. Emotions can be clustered in optimism, love, submission, awe, disapproval, remorse, contempt, and aggressiveness. Secondary emotions blend between the components of the 3D cube (Fractal.org);
- **Unambiguous, non-redundant classification:** Several classification schemes are very interpretative and depend on the different viewpoints of their inventors. To avoid redundancy and ambiguity, the artificially created language Lojban (1987) classifies emotions according: simplicity, complexity, purity, propositional attributes and complex proposition attributes. Each of these groups has emotion sub-types. E.g. the simple emotion group has the duple gain-loss as one sub-type;
- **Reasoning based classification:** All these models simply focus on the pure classification of emotions, but rather purely rely on dynamic or situation based approaches. In reasoning based classification schemes, the computability of emotions is in the foreground. Thus the emotion classification depends on a sort of reasoning system, capable of processing human emotions according a certain predefined reasoning structure. From the psychological perspective we can eventually also speak of a cognitive model. One example is the OCC model (Ortony, Clore, & Collins, 1988), which allows to categorize emotions in a tree-like structure that includes decision points for machine-readable conditions and a model for reaction to certain causes.

TECHNIQUES IN EMOTIONAL COMPUTATION

Figure 2 depicts a simple workflow for the processing of emotions. The goal of emotional computing can be divided into:

- Capture and recognize emotions via sensors on signal level (e.g. heart rate);
- Interpretation of sensor input on symbolic level (e.g. heart rate x means y);

- Analysis and processing of symbols to obtain emotional patterns (e.g. person x can has positive emotions in situations like y);
- Learning to know the human emotional state of mind on concept level (e.g. behaviour patterns); and
- Provision of smart reactions to human emotional input (e.g. feedback).

In other words, emotional computation is about "getting computers to 'think' like humans, [and] AI's next natural step seems to be getting computers to 'feel' like humans" (Krikke & Alfonsi, 2006). Thus the nowadays all-present information transmission channels shall be extended by an emotional channel, giving emotional feedback.

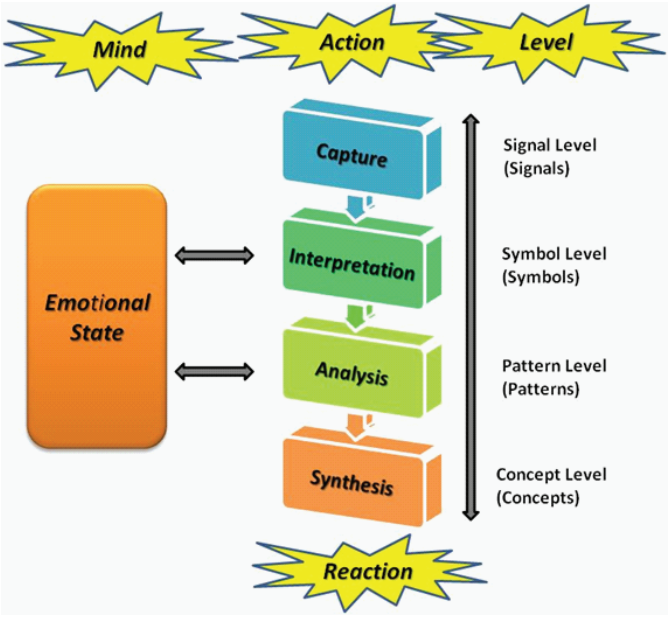
The present technology mostly relies on simple interaction and feedback communication for the communication. However, in ambient media, the emotional channel as additional channel for the exchange of emotional information is gaining of importance to mimic human alike systems. Within the scope of this section we explore the existing technologies in emotional computation.

Making the System Emotion Aware

Emotion Capture

The capture of emotions phase deals with the collection of signalling information relevant as input for the emotional model or for determining the emotional state of a human. These include e.g. facial expressions, sound, or voice. In the case of voice it could e.g. be loudness, spectrum, or harmonics (see also Magnumlanguage). Capture applies on signal level. On this level we simply deal with the communication of emotions on signal level via the human body, thus the capture of human signalling related to emotional expressions. Examples for physiological signalling are lie detectors, skin temperature, heart rate, mouse pressure, or postural movements (see also Krikke & Alfonsi, 2006). A typical result of the capture process is e.g. "Anna's heart rate is high". Capture is a situational process, where signalling related to emotions are captured at one moment in time without any relation to a-priori knowledge such as changes of emotions over time or emotional history.

Figure 2. Tasks and levels in emotional computation



Let's start with the discussion which human signals can be used to capture human emotions. Many forms of human signalling can be used to recognize emotions:

- **Perceptible emotions as explicit communication channel:** Facial expression, voice, gestures from hand and body, posture, eye movements (e.g. pupils);
- **Non apparent emotions as implicit communication channel:** Brain waves, respiration, muscle actions, physiological signalling, skin temperature, blood pressure;

A good example project for the use of physiological in emotional computation is the Autogenic-Feedback System-2 (AFS-2). The system is in use for a physiological monitoring system for space travel. Nowadays it is used for monitoring health, but with the miniaturization of sensor data and in the future its application for obtaining emotional responses might be possible (NASA, n.d.). A more 'down to earth' example is the real-time smile detector. The detector is capable of measuring valence via a camera through eyebrow and head move detectors (Sharon, n.d.). However, the capture of emotions only deals with the capture of signalling, thus the interpretation of smiles belongs to the interpretation and analysis part of the emotive computational system.

Interpretation and Analysis of Emotions

The interpretation of emotions turns signal information into symbolic and thus process-able values. Both, interpretation and analysis are closely related, however, in emotion analysis we speak of emotional patterns, as a-priory knowledge and a wider view on emotion is present. We also can speak of learning mechanisms and more intelligent systems capable of interpreting emotions. Nevertheless, we can distinguish between different forms:

- **Discrete emotion capture:** Capture of emotions as discrete values (e.g. happy, sad);
- **Continuous emotion capture:** Capture of emotions as continuum (e.g. intensity of emotions over time or arousal/valence over time);
- **Pattern based emotion capture:** Capture of emotional patters as higher level concept (e.g. based on a-priory knowledge);

Synthesis and Communication of Emotions

The previous system described the process how to make the system emotion aware. Within the scope of this section, it is explained how systems can communicate emotions to the consumer. This channel can be text, audio, visual, language, or higher level language (e.g. film language) based. Thus the goal in synthesis of emotions is to create an emotional channel between the system and the human. Due to the wide ranging field of ambient media, emotion synthesis is a rather huge field and involves many different perspectives. This includes product design, media objects, utilized communication channels, etc. To help categorizing different synthesis possibilities, we can distinguish different levels of synthesizing of emotions:

- **Media object level:** Synthesis of emotions as part of the media object perceptible by the consumer (e.g. colours used in a piece of film);
- **Context level:** Synthesis of emotions on the basis of sensor data capturing the current context of the consumer (e.g. consumer is angry at a bus stop);
- **Product level:** Creation of emotional experience as part of the device (e.g. Philips iCat);
- **Design level:** Modelling of emotions as part of the product experience design process (e.g.)

- **Emotion channel level:** Communication channels for communicating emotions or emotional user interfaces (e.g. emotion support in human communication systems); and
- **Experience level:** Ungraspable experience designed as pattern of arousal of emotions (e.g. products with 'appeal').

There exist many examples for synthesis of emotions. One good example is the 38cm tall iCat from Philips (n.d.). The toy can be plugged to the USB bus of a PC, and acts as mediator of emotions between human and computer. It is capable of expressing of emotions such as happy, surprised, angry, or sad. It has various sensor systems such as microphones, proximate, webcam, etc. to capture its surrounding. It can be seen as a very good example for a system expressing emotions on product level and context level.

Another system is the SenToy, which belongs to the category of emotional user-interfaces. The system lets the consumer influence the emotions of a computer character by gestures or movements (Paiva, Costa, Chaves, Piedade, Mourão, Sobral, et al., 2003). A doll is the input device. Depending on the gestures of the consumer, the animated character performs actions on the input.

A very important initiative for the communication of emotions is the W3C Emotion Incubator group (2006). W3C aims at the development of a emotional language based on XML for representing emotions. This ranges from the state of mind, simulation of emotions by a user interface, or the communication of emotional information.

There are many other aspects for simulating emotions, and more and more projects focus on this issue. To mention just a few more: IBM's BlueEye projects aims at making computers to know what you feel (IBM, n.d.), and the humaine project focuses on several aspects of affective computation (n.d.).

EMOTIONAL BINDING IN AMBIENT MEDIA

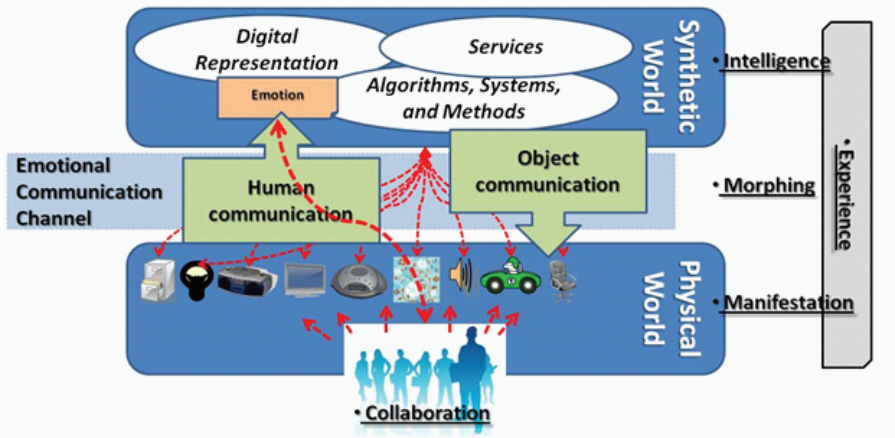
Considering the different presented viewpoints in psychology concerning emotions, the most relevant ideas for ambient media come from the common sense viewpoints, and seeing emotions as processes between motives, believes, and precepts. To be able to define emotional binding, and concepts around emotions in the field of ambient media, let's enumerate a few characteristics of ambient media:

- **Embedding:** The digital media environment is embedded in the natural environment;
- **Diversity:** Wide variety of life situations, locations, living spaces, and motivations;
- **Miscellany:** Convergence of a wide variety of media forms to one new form;
- **Genre unspecific:** Genres are single artistic expressions, rather ambient media as a total;
- **Concept driven:** Concepts are defined by content, devices, human, and converging services;
- **Ambient asset driven:** Service space and experience orientation, rather than single entities;
- **Ambient aesthetics:** Provision of a new digital aesthetics throughout the living space;

The Principles of Ambient Media

The 5 principles of ambient media are: intelligence, morphing, manifestation, collaboration, and experience. Intelligence deals with the system intelligence. Each ambient system can be seen as a physical world overlaid by a synthetic world. The physical world is the daily world we are living in, where a synthetic world is mapped on top of it. Ambient media are therefore entities that are exchanged between these worlds (Lugmayr, 2007; Lugymayr, 2006; Lugymayr, 2008a; Lugymayr,

Figure 3. Animation flow chart



2008b; Lugymayr, Pohl, Mühlhäuser, Negru, Kallenbach, & Köbler et al, 2006; Lugmayr, Pohl, Mühlhäuser, Kallenbach, & Chorianopoulos, 2007; Lugmayr, in press). Figure 3 presents this idea.

As far, media objects where distinguishable digital objects – as e.g. a video stream, TV show, and newspaper. In the case of ambient media the human is part of a digital service space that is linking the real physical world to the synthetic world overlay. This requires a certain mapping or linking of both worlds. This principle is called morphing – it defines the actual connectivity between worlds. In the case of emotions, it is an emotional channel between the human and the digital world, for example a system responding to human emotions. A simple example is the visualization of geographic information via GPS onto a digital map. The physical world is the actual place the human is, and the geographical information links the digital world overly to it. One example for this principle in the case of emotions is the Philips iCat (n.d.).. The Philips iCat is a toy, which can generate emotional responses – it smiles, looks angry, or is sad. The cat creates emotional channel relaying emotional information of the system to the consumer.

Another important principle is intelligence. The media is aggregated by the system, rather by a human editor. The aggregation of media objects is part of a complex system contextualizing the content to human situation, environment, emotional state of mind, preferences, and relevancy. Media need to be rendered in a certain form for the human being. Thus media objects need to manifest themselves in a certain form. Thus the synthetic overlay needs to be turned to human graspable information. One example for this principle is electronic wallpaper, which adjusts to the emotional state of a human. The electronic wallpaper becomes the way how the technical system responds or renders its output.

The paradigm of user-interface design or human computer interaction in ambient media is a matter of collaboration. Machine-machine collaboration, human-machine collaboration, and human-human collaboration are major concern. Collaboration, rather than complex user-interfaces are of consideration. As far technical system needed to be 'learned' – in the case of ambient media, the system collaborates with the consumer and adapts smartly to his needs. This is also relevant for human-human mediated cooperation, where the system shall support the communication. Especially emotional computation is one communication channel, and emotional binding of the human to the ambient media system underlines this important fact.

The most significant principle of ambient media is experience. Consumer experience is nowadays a hot topic and widely discussed. Experience deals with the "observational knowledge of the world [...] what one has come to know [...] by direct observation [...] without inference" (Oxford, n.d.). The observations of the world can be seen as a stream of subjectively observed happenings, which "makes up the conscious life of the possessor [...] being a separation between mind and the world" (Oxford, n.d.). Thus experience is subjective knowledge. Nowadays we deal with information processing, however, in the case of ambient media we are dealing with knowledge processing, rather than processing pieces of data. Emotions and experiences are rather tightly related, as "arousal is essential to the experience of emotion [...] as the experience of specific emotions results from the perception of specific and unique patterns of [...] arousal" (Barrett, Mesquita, Ochsner, & Gross, 2007).. Thus emotional binding between human and object can be described by patterns of arousal.

Def. Experience (in the context of ambient media): stream of subjective observed happenings manifesting throughout the natural environment processed as knowledge rather than as information and emotionally perceived by patterns of arousal. Emotional binding is the actual media experience perceived as pattern of arousal.

Ambient Media and Emotion Concepts

To find a suitable definition for emotional computation is a rather huge tasks. Ambient media are part of many aspects of our daily lives: e.g. in artistic theatre plays, smart fridges, intelligent living rooms, travelling situations, and mobile services. Each of these aspects could provide a unique definition and a set of rules. However, to come to an abstract definition, le'ts introduces the idea of emotional concepts. Emotional concepts are a set of techniques, parameters, and languages that apply for a specific ambient situation. In the case of a mobile digital TV film, distributed to a mobile phone, the concept relates to the art and craft how a video has to be created to bind the watcher. Thus, emotional rules such as colour theory, the language of the edit, or the cinematographic expression are applied. However, the concept also includes other parameters, such as personal preferences for certain movie genres, in which situation the consumer is currently (e.g. in the office, in a bus), and techniques applied to process emotional information.

Levels of Emotional Concepts

We can distinguish between different levels of emotional concepts, relevant for the specific situation or application. To illustrate the idea, we consider a video portal available on mobile phones containing travelling videos for different locations:

- **Primary concepts** relate to the major ambient asset or goal. In the video travelling portal, the main video about a city or location is the major ambient asset. The primary concepts are film techniques, cinematography, or the language of the edit.
- **Secondary concepts** are assets supporting the major ambient asset directly to create experience. Secondary concepts are not directly related to the primary concept, but have a significant contribution to make the major ambient asset to a consumer experience. It could be a personalization engine including its algorithms on the mobile device adapting the presented content to the current GPS location and preferences of the consumer.
- **Tertiary concepts** are indirect concepts supporting either secondary ambient assets or the major ambient asset in some way. These concepts are not directly related to the primary concept, but support either primary

or secondary concept in a certain form. It could for example be a health application knowing the diet of the consumer and recommending certain restaurants fitting to the food preferences of the consumer.

Definition of Emotional Ambient Media

With the background knowledge developed as far, we can firstly define emotional ambient media as follows:

Def. Emotional Ambient Media: Emotional ambient media create an experience to the consumer and are a complex process and interaction between mind, communication, cause, and concepts. Concepts are higher level techniques, parameters, and languages contributing to trigger bi-directional emotional communication channels in specific locations or situations throughout the natural human environment. Emotional ambient media are emotionally binding the consumer to ambient media assets, and its sub-components. Emotional binding is created as interaction between a set of ambient assets.

Requirements in Emotional Ambient Media Design

The requirements in emotional ambient media design highly depend on the used primary, secondary, or tertiary concepts. Nevertheless, we have to keep the major assumption from naive psychology in mind. To create a model for emotional computation in ambient media, the main assumption will be the one from naive psychology – artificially created objects and human minds are on the same level: intelligent objects are companions being aware of our mental state and humans of the intelligent object. However, on very abstract level we can define the following system components as part of an emotional ambient media system:

- Descriptive language for describing emotions, the state of mind, emotional channels, emotional concepts, and causes;
- Models providing a common sense view towards emotion processing, thus turning information into knowledge;
- Efficient methods and techniques for capturing, recognizing, interpreting, analysis, and synthesis of emotions;
- Collaboration between human and machine, as artificially created objects and human mind are on the same level being companions being aware of each other mental state;
- Creation of an emotional channel between daily objects, humans, and in human-human mediated communication as morphing principle between synthetic world and physical world;
- Technology and devices for the manifestation of emotions in the physical world acting as communicator for emotions;
- Development of new collaboration techniques based on additional emotional channels.

CASE STUDY: AMBIENT EMOTIONAL RESPONSIVE CHARACTER

The key-idea was to develop a system responding to human emotions and approach it from both, the artistic and the technical perspective. The idea was to model a character which responds to emotional input parameters (see Dorsch, 2008). The implementation aimed at the development of an interactive ambient installation, where the consumer can communicate with an intelligent virtual character. The means of communication is human emotion, and the character responding to human emotion. Via an emotion tacking system, human emotions can help the character to support him in his well-being. The virtual character

himself resides in a computer graphic generated virtual world, supporting him in his well-being. The installation combines animation, mimics, music, and interactivity in an ambient way and is structure as an ambient computer game. The implementation involves a motion tracking system, computer graphics modelling, animation, virtual character development, and smart algorithms for emotional response tracking.

Currently the implementation is more of a type of interactive installation from the technical emotion recognition part. However, the technical side for the capturing of emotions will be continuously extended. From the artistic perspective, the conceptual model for the character design is well developed and emotional responses can be given. The system will be extended in the future by far more advanced emotion filters and trackers. But the idea of the system will be clearer within the scope of this section. See Figure 4 for an illustration.

In relation to the presented theories in the previous sections of this book, the following are applied within the scope of this case-study:

- Common sense (naive psychology) view on emotions, where humans deal with the perception of assets as a whole rather than a technical product;
- Development of emotional binding via
- Morphing of emotional responses generated in the synthetic world to the real world via a responsive animation;
- Animation as concept for manifestation of emotions in the natural environment;

Emotional Concept Perspective

The primary concept of this installation related to the modelling and setup of the animated responsive character. Thus, how the virtual dog can be designed to create an emotional channel for the viewer. The involved emotional concepts are based on *colour theory, animation language,* and *facial animation.* Dependent on the human interactions, the animated dog is angry, happy, or sad. The animation flowcharts, thus the reaction on different human inputs are presented in Figure 5.

Technical Implementation

From the technical viewpoint, thus the secondary emotional concept of this installation is the

Figure 4. Implementation overview

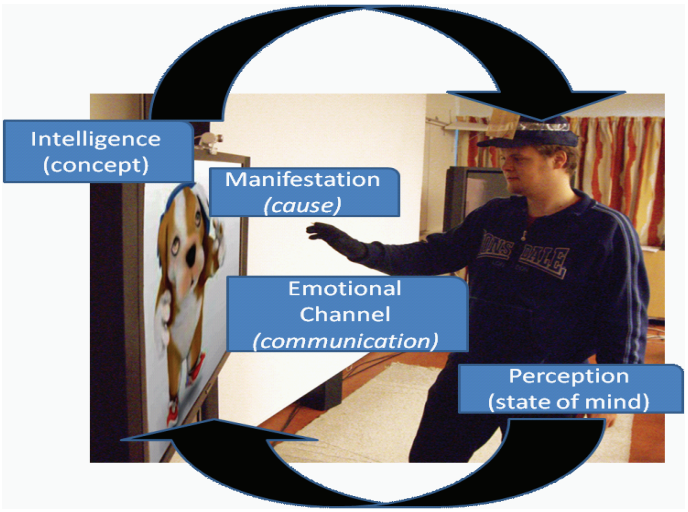
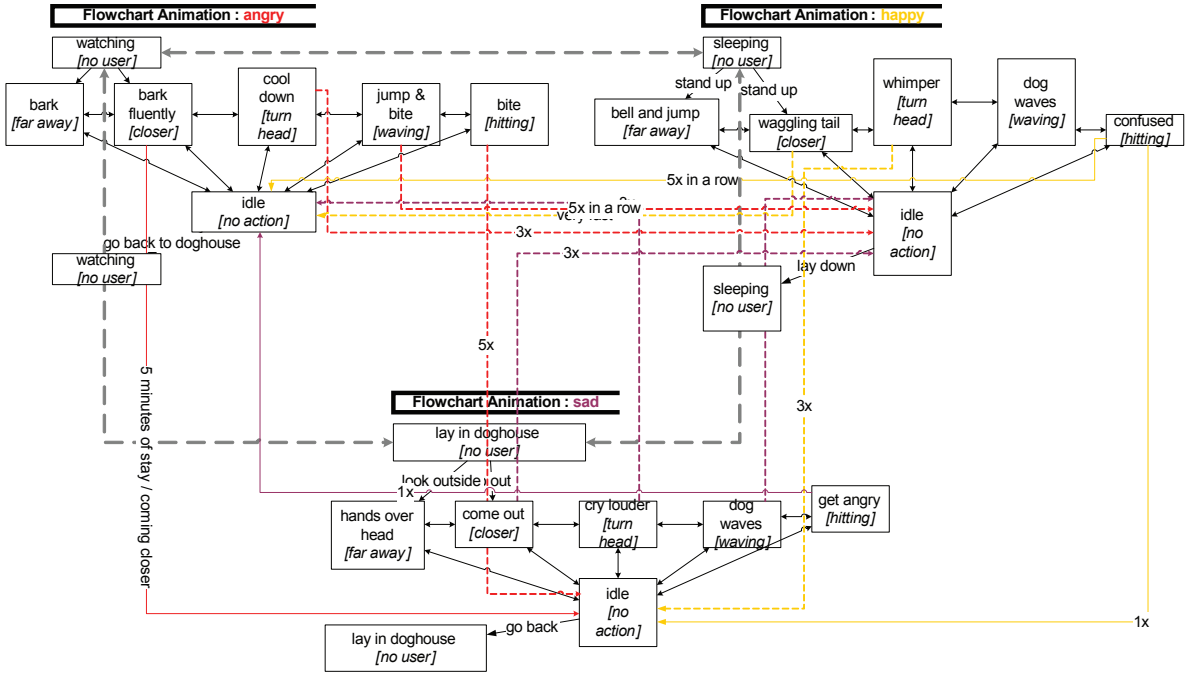


Figure 5. Animation flow chart



recognition of the emotional parameters of the human. The technical concept was realized with motion tracking of human body gestures. The input parameters are used to animate the facial expressions of the dog. Figure 6 illustrates the facial animation for angry, happy, and sad.

The implementation was based on a virtual reality device capable of tracking and interpretation of human gestures. Different gestures imply different emotional human expressions, upon which the character (the dog) is reacting. From the software architectural side, the implementation was a full interactive system, based on the Quest3D real-time rendering software (www.quest3d.com). The software interface was capable of interpreting emotional responses from the consumer. To track gestures, a gesture recognition software has been developed. The software received a video stream and recognised infrared LEDs on markers of the human. The states: going far, going near, nodding, shaking, looking away, waving, and tapping are interpreted as responses to the actions of the dog.

Figure 8 illustrates the software architecture of the full system, consisting of several modules.

CONCLUSION AND EMERGING TRENDS

The interactive implementation shall present a first step towards the implementation of a more emotional responsive system. Currently some might argue it's more of the type of an interactive installation. However, in the future we will integrate more emotion filters to be capable of detecting more complex emotions with various different techniques. The case-study shall underline the different concepts in ambient media and discuss their relationships. Figure 9 shows briefly the different concepts that have been considered.

Emotional computation and especially a common sense view of psychology and the exploration of possibilities to realize these theories in technical systems is a major future step. However, in artificial intelligence first attempts have been made,

Figure 6. Facial animation for angry, happy, and sad

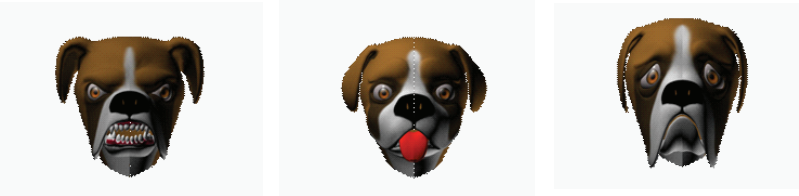


Figure 7. Snapshots of the utilized hardware

Figure 8. Software architecture

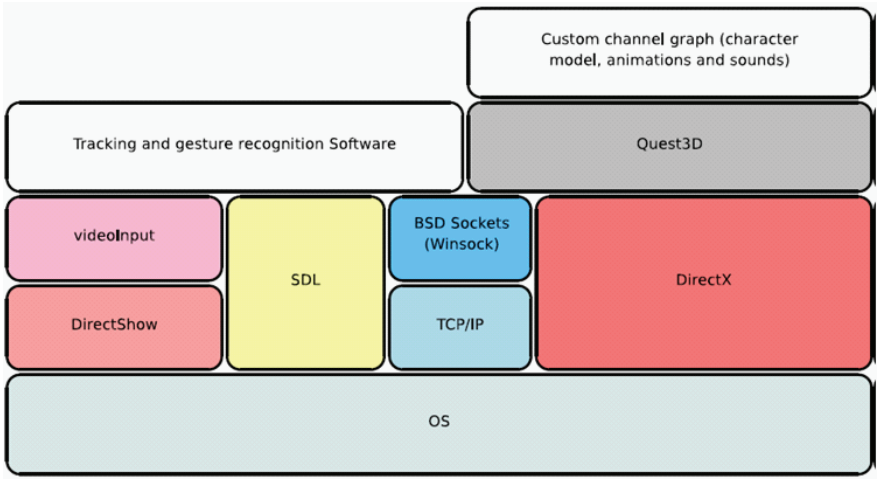
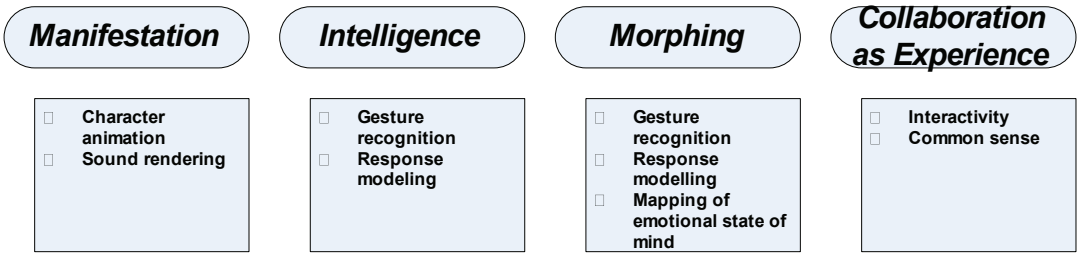


Figure 9. Relating different concepts of ambient media



but we are simply at the beginning. Emotional computation and smart environments deal with the long-ongoing discussion, if machines will be intelligence – or if machines will be able to have emotions. Currently we are only exploring the basic foundations of possibilities. To conclude this chapter, we refer to the excellent reading of Sloman & Croucher (2007), entitled "Why robots will have emotions". This article explores the philosophy and has a few excellent thoughts around this topic.

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KEY TERMS

Ambient Media

Emotion Concepts

Emotion Framework

Emotion Recognition

Emotional Binding

Emotional Computation

Pervasive Computation

Ubiquitous Computation