Anthropomorphe Interaktionsagenten

„Virtual Human“

An overview
Christian Eckes, Frank Hülsken, Sophie Jörg & Tina Walber

MPI für Biologische Kyberntik, Tübingen
16. Mai 2006
The VirtualHuman Consortium

Director: Prof. Wahlster (DFKI)
Deputy Director: Prof. Encarnação (FhG-IGD)
Project Manager: Dr. Blocher (DFKI)

Funding volume: 7,0 Mio. €, Dr. Reuse (BMBF)
Project duration: 11-2002 – 10-2006
Vision of the VirtualHuman Project

Aim:
Development of virtual, emotional and photorealistic characters

Research Focus:
Multiple Personal dialog partners acting autonomously in real time

Application Areas:
eLearning, Infotainment, Edutainment

Cooperation:
German research groups in the areas
- Language Technology / Multimodal User Interfaces
- Computer Graphics, Character Animation
- Story Telling and Dialog Modeling
Basic architecture of Virtual Human: Who does what?

**Ontology**
- Soccer DB
- Dialog Model
- Games
- Videos
- Astronomy

**Narration**
- Narration Engine
- Story Telling

**Dialog**
- Spoken Input Analysis
- Conversational Dialog Engine
- Gesticon
- Affect Module
- Action Encoder
- Scheduler

**Recognition**
- Speech
- Gesture

**Characters**
- Modeling
- Cloning
- Anim./MoCap

**Studio**
- Models
- Camera

**Display**
- Monitor
- HEyeWall
- Curved Screen
- Mobile Back Projection

**Player**
- (Avalon/OpenSG)
- Skin & Bones
- Virtual hair dresser
- Blood Circulation (blush & blanch)
- IK Engine
- Rendering

**Fraunhofer**
Institut Medienkommunikation – the media innovation factory
Interaction metaphors

monologue

interactive character

simulated conversation

interactive performances

multi-party dialog between virtual & human agents

Fraunhofer Institute for Media Communication – the media innovation factory
Application Scenarios 2002-2004

1st Phase: Astronomy eLearning
Life of a Star

Cebit 2004

2002
Evaluation of 1st application

19 school girls ranging from class 7 to 10 participated and filled out questioner.

Results very positive but:

- speech synthesis needs more emotion
- gestures should be made smoother, larger corpus
- more interaction with teachers wanted
- school boy should be made cooler, e.g. more gel in hair.

.. and the girls had much fun with the application.
Application Scenario 2004-2006

World Cup 2006
Game Show

2004-2006
Cebit 2006

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Twenty-eight million national coaches

Realistic infotainment as an interactive TV Game Show

Round 1: "Kick stop", Interruption of Video Sequences and Prediction of the Final Result (e.g. Goal, Miss)

Round 2: ZAMB - team line up test, selection of players and role assignment

high emotional impact: line-up of the German National Team
The ZAMB Virtual Studio designed by rmh new media

Format VRML 2.0
7387 Vertices, 7685 Triangles,
23 Lightmaps, 5 Spotlights,
1 Pointlight, Raytracing Shadows,
Occlusion Maps
Dimensions:
- Max. Width: 12m
- Max. Depth: 6 m
- Hight: 4,5 m
Background: Allianz-Arena Munich
(with 3D Effects)
First Characters entirely developed in VH for the World Cup 2006 Game Show Scenario

IMK/Charamel: Modeling of body & cloth, head scans, MoCap of gestures
IGD: dynamic hair simulation, eyes' modeling, realistic skin rendering & IK
VirtualHuman ZAMB Scenario:
Multi-Party Dialog between 5 Virtual & Human Agents

Virtual Moderator

Virtual TV Studio

Virtual Experts

2 Human Candidates
multi-party dialog between 5 virtual & human agents

What do you think will happen next in this scene, Mrs. Lebacher?
multi-party dialog between 5 virtual & human agents

Michael Ballack is going to shoot the ball over the goal.
multi-party dialog between 5 virtual & human agents

And what do you think, candidate Two?
multi-party dialog between 5 virtual & human agents

I would like to know what experience Kaiser thinks.
multi-party dialog between 5 virtual & human agents

The goalie will save the ball.
multi-party dialog between 5 virtual & human agents

After all, I think Ballack scores the goal in the upper left corner.
And that's the right answer.
Task of IMK: Building Virtual Humans by

...Creating the visual appearance of an Virtual Human
  > Modeling body & face by cloning from a real human
  > Clothing the Virtual Human

...Animating the Virtual Human
  > Animating body (limbs, hair, gestures, emotions…)
  > Animating face (lips, facial expression, emotions…)
  > Create means to direct and control the Virtual Human

... Giving the Virtual Human senses
  > Ears to enable conversation with real humans
  > Eyes to recognize real humans
The work packages of IMK

WP 1: Application development
  > Development and evaluation of two applications
  > Full-body modeling
  > Motion capturing & animation

WP 7: Personalized Avatar faces
  > 3D reconstruction of faces
  > Generation of a generic 3d-model
  > Facial feature recognition and tracking
  > Collection of a lip/face corpus with face editor

WP 9: Multimodal recognition
  > Robust speech recognition
  > Gesture recognition
Results: Female Character “Kim”: Head

Head scanned from real person and heavily reduced for real-time rendering & animation.
Results: Female Character “Kim” Body

Modeled from a real person based on photos of cloth and body O(10K Poly)
Results: Male character “Marc”

High-quality head scanned from real person O(70K polyg.)

heavily reduced for real-time rendering & animation (3K polyg., low-res texture; skin shader missing)
Results: Male Character “Marc” Twins

• Charamel designed full-body model
• IMK added head & hands & performed rigging and skinning
Workflow: How to create a Virtual Human?

- 3D-scan
- photo sessions
- artist
- geometry
- texture
Cloning human heads: Our 3D-Photo studio

Make photo session with high-quality digital camera
- with flash projecting a fine grid onto the face and
- without grid flash but special polarization filter

Structural light approach to 3D reconstruction

input to 3D-reconstruction

diffuse texture @ 1280x1024 res.

Structural light approach to 3D reconstruction
Cloning human heads: first step in pipeline

grid recognition

3D-reconstruction

calibration
Cloning human heads: 3D-reconstruction

Grid recognition (errors marked white)

Shape reconstruction for single patches

Registration by Iterated Closed Point (ICP)
Cloning human heads: Scan of Visemes

Scan of 10 visemes based on 4 patches and neutral head
Cloning human heads: Texturing

Texturing
- Generate UV-mapping in Maya
- Align texture images with geometry
- Use diffuse texture images

UV-Mapping
Cloning human heads: UV-texture

Due to geometry alignment in multi-patch registration texture correspondences become fuzzy -> texture blurr

Topic of further research
Cloning heads: What is needed for realistic skin?

Investigate real-time skin shading to prepare input for realistic rendering of skin

Approach

- sub-surface scattering needed
- bidirectional surface scattering distribution function (BSSRDF) (e.g. Tomson, SigGraph ’03) needs diffuse texture (epidermis layer)
- use polarization filter, align with scans and deliver to the consortium
Controlling Faces: Face editor

Face editor as a plugin for Maya (WP 7.6)
Face animation based on blend-shapes

18 blend-shapes + neural face were generated and integrated in T-48
Talking head by blend-shape animation

- text-to-speech system
- phoneme durations
- phoneme-viseme mapping

So this funny …

weights for visemes

Aschenberner & Weiss
IKP, University Bonn

Aschenberner & Weiss
IKP, University Bonn
Research focus in facial animation

Linear superposition of blend shapes results in unnatural motion

Use model of human muscles to constrain animation

face muscles

phoneme duration

weights

Diploma thesis Martin Stöcker
Motion Capturing

Task

> Record motion data for dialog-supporting gestures by capturing synchronized hand- and full-body motion
> Enable high-quality visual feedback by using iCone display system to achieve optimal performance
> Plotting motion onto virtual humans
Motion Capturing: Cooperation with Metricminds

High-Quality Motion Capture

> IMK collaborated with motion capture studio „Metricminds“
  > Vicon8 RT system with 18 VICON-M cameras (1000x1000 Pixel @120 Hz) with 320 qm (7x4x3m capture volume)
  > Real actor included
> Hand motion is still manual: IMK provided 2 CyberGloves and operator
> IMK performed two sessions with male and female actor and plotted onto VH-characters “Kim” and “Marc”
Motion Capturing Results: Animate Characters

despair

plane
Motion Capturing Results: Animate Characters

complicated „mental“ gesture in detail

actor rig in blue

offset-animation: character rig needs offsets to match different skeleton sizes
Motion Capturing Results: Animate Characters

complicated „fingerring“ gesture

data requires still time-consuming optimization of hand motion due to unstable CyberGlove calibration
Motion Capturing Results: Animate Characters

complicated „finger-ring“ gesture

actor tracker

CyberGlove motion
Motion capturing leads to avatars with various gestures

**Emblems (26)**
- anticipation
- attention
- block
- chide
- clap
- concession
- despair
- dismiss
- doubt_shrug
- fingerring
- fold
- interrupt
- mental
- more_or_less
- nod
- number1
- number2
- number3
- number_1_to_5
- refuse
- shake
- so_what
- sphere
- strong
- walls
- wave
- wipe

**Metaphorics (5)**
- bridge_back
- bridge
- cup
- progress
- regress

**Beats (1)**

**Idle (9)**
- idle_exite
- idle_exite2
- idle_hands
- idle_hands_back
- idle_normal_whole
- idle_side_left
- idle_side_right
- idle_side_to_side
- idle_stand2

**Gaze (n)**
- look_<target>

**Iconics (3)**
- big
- plane
- small

**Deictics (n)**
- point_<target>

**MoCap:**
- roughly 40 basic gestures in 1-3 variations and 9 idle moves partly with emotional aspect per actor
- **Total:** Over 100 gestures
Further activities in Motion Capturing

Low-cost MoCap @ IMK in iCone:

> 9 A.R.T. cameras (AR-Track GmbH, Munich, Germany) commonly used in VR but not yet for professional MoCap
> 2 CyberGlove data gloves (Immersion, U.S.A.)
> software for plotting/offset animation (Alias MotionBuilder & Maya)
> 11 6-DoF Targets attached to human body
> Promising research field (e.g. Hornung, Sar-Dessai and Kobbelt, IEEE VR 2005)

Advantage: Direct immersion of user in VR possible since ART supports smaller distance to user
Further activities in Motion Capturing

The plan:


iCone with 9 A.R.T. cameras

Suit with up to 14 6 DoF bodies
Further activities in Motion Capturing

The plan:


iCone with 9 A.R.T. cameras

Suit with up to 14 6 DoF bodies
Speech recognition

Task

> Realize real time speech recognition based on ISIP (Mississippi State University) for German & English
> Training of acoustic models on Verbmobil corpus (cross-word triphone)
> Generation of grammars
> Define protocol and implement client-server system

After all, I think Ballack scores the goal in the upper left corner.
Gesture recognition

Task:
> Recognize user gestures

Approach:
> Use of 3D-Camera „Swissranger“ by CSEM Zürich able to measure depth by in-pixel phase measure (Time-Of-Flight)
> 160x124 16Bit depth ~ 0-7.5m @ 30Hz

Status:
> Environment for corpus recording finalized, 5 persons already in database, optimization
> Recognition of hand gestures was investigated in diploma thetis
AP 9.5 Automatic Erkennung von dialogerelevanten Gesten: Erste Ergebnisse

Task: Recognize pointing gestures in real-time

Method:

> Localization by depth keying and Connected-Component-Analyse
> Head detection by rectangular filter (convex filter)
> Hand localization with rectangle/Haar filterbank
Localization of Human Head & Hand

Depth keying

Head/hand loc.
Research in hand gesture recognition

„Virtual CyberGlove“: Reconstruct human hand and recognize actions (motivated by Prof. Klein/F. Kahlesz @ Uni Bonn)

Approach:

> Calibration, depth keying, 3D-point cloud base

PCA & registration with articulated hand model

point cloud roughly aligned with model

Diploma topic Pia Breuer

Fraunhofer IMK

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How to control virtual humans?

Real-time control of a virtual character

- Autonomous: idles
- Navigation/walking
- Point gestures
- Body motion
- Mimic
- Facial motion
- Autonomous: blink, jitter

Game pad optimal for unskilled user

E.g. museum guide

Diploma thesis Sophie Jörg
How to give avatar autonomy?

Simulate memory and human-like perception to produce autonomous behavior of VHs

Details:
- add a memory of virtual environment (where & what)
- model visual perception (fovea)
- implement learning & forgetting with LoD
- let VH act by simulating perception and dynamic memory

Knowledge of object localization vanish over time

Study of Marion Langer
Current Work @ IMK

> Optimizing head reconstruction pipeline, replacement of cloned character “Marc” by 3rd character “Nick” [Frank Hülsken & Roland Kuck]

> Optimizing ART-based MoCap system in iCone, investigate facial MoCap [Sophie Jörg & Frank Hülsken]

> Gesture recognition with 3D-Kamera [Christian Eckes]

> Cooperation with IKP (Prof. Hess, Uni Bonn) in Speech/Lip animation and psychophysics experiments (Frank Hülsken)

> Two Diploma projects still ongoing:
  > Development of a „Virtual News caster“ (Tobias Killian, Prof. Müller, Uni Koblenz)
  > Head reconstruction from Video/Projector system (Tina Walber, Uni Koblenz, Prof. Paulus, Uni Koblenz)
Publications & Diploma Thesis  VH@IMK

Diploma thesis
> Jörg Unterberg, „Development of a real-time skin shader“, TU Ilmenau, Prof. Brandenburg, Dec. 2004
> Martin Stöcker, „Muscle model generates dynamic constrains in blend-shape animation“, University Koblenz, Prof. Müller, June 2005
> Sophie Jörg, „Real-time controlling of a virtual character“, Hochschule für Angewandte Wissenschaften Hamburg, Prof. Witt, Nov 2005

Other
> Marion Langer, “Graphical methods for supporting perception of autonomous virtual characters”, Studienarbeit, University Koblenz, Prof. Müller, Jan. 2005
> Johannes Strassner, Marion Langer & Stefan Müller, “The mental continuum – Control methods for virtual humans in real-world situations”, Workshop KI, Koblenz, 2005
Thank you

Thank you for your attention!

VH@IMK

Frank Hülsken, Sophie Jörg, Tina Walber, Tobias Kilian, Raimund Cürthen, Florian Hühnermann, Simon Schüller, Konstantin Biatov, Christian Eckes, Joachim Köhler and Martin Reiser

and former members of the team

Jörg Unterberg, Kai Hüttemann, Marion Langer, Martin Stöcker, Pia Breuer & Johannes Strassner