Dialogue Systems Research at Ulm University – Adaptive Speech Interfaces for Technical Companions

Wolfgang Minker, Maxim Sidorov and Stefan Ultes
Human-Computer-Interaction – State-of-the-Art

- Explicit functional requirements
- Explicit system responses
Human-Computer-Interaction – Beyond State-of-the-Art

- Explicit functional requirements
- Explicit system responses

- Implicit functional requirements

Technical system

Environment

User

Mental status
Spoken Dialogue Systems – Towards Companions

- **User centered functionality and assistance**
  - Explicit functional requirements
  - Explicit system responses

- **User oriented Human-Computer dialog**
  - Implicit functional requirements
  - Implicit system responses

- **Capture and interpretation of the situation**

- **Mental model**

- **Environmental parameter**

  - Emotional parameter

- **Knowledge model**

- **Companion system**

- **User centered functionality and assistance**

  - Explicit functional requirements
  - Explicit system responses

- **User oriented Human-Computer dialog**

  - Implicit functional requirements
  - Implicit system responses

- **Capture and interpretation of the situation**
**Companion Systems**

- Contain beyond state-of-the-art technical systems that are able to
  - autonomously perceive their environment
  - plan actions and pursue aims
  - carry out natural and unconstrained dialogues with users

→ Properties close to human interaction partners:
  - assistiveness
  - adaptiveness
  - proactiveness
  - individuality
  - availability
  - cooperativeness
  - Trustworthiness

- Adaptive and TRusted Ambient eCOlogies (2008-11) (EU-FP7)
Spoken Dialogue Systems – Towards Companions

• Assistiveness, adaptiveness and proactiveness

→ Enhance the linguistic analysis and dialogue management components
## Current and Past PhD Theses

### Speech Analysis

#### Classification and Optimization:
- Automatic Categorization of Human-Human and Human-Machine Conversation based on Hierarchical Classification
- Interaction Quality Modelling for Human-Human Conversations
- Evolutionary Algorithms for Automated Classifier Design in Spoken Dialogue Systems
- Automatic Estimation of Verbal Intelligence

#### Emotion Recognition:
- Speech-Emotion Recognition in Adaptive Dialogue Systems
- Emotion Recognition for Adaptive Spoken Dialogue Systems
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### Speech Analysis

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**Emotion Recognition:**
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### Dialogue Management

**Assistiveness:**
- User- and situation-adaptive explanations in dialogue systems
- Domain-Level Reasoning for Dialogue Systems

**Adaptiveness:**
- Statistical Modeling for Online Monitoring of Adaptive Spoken Dialog Systems
- User-Adaptive Spoken Dialogue Management
- Situation- and User-Adaptive Dialogue Management
- Model-Driven Adaptation for Spoken Dialogues in Intelligent Environments

**Adaptive Multimodality:**
- Interactive Anthropomorphic Interface Assistants
- Intuitive Speech Interface Technology for Information Exchange Tasks
- Adapting Multimodal Interactive Systems to User Behaviour

**Proactiveness:**
- Proactive Spoken Dialogue Interaction in Multi-Party Environments
User-Adaptive Spoken Dialogue Management (Stefan Ultes)

- Provide **appropriate system behavior** based on perceived user state
User-Adaptive Spoken Dialogue Management

- Provide appropriate system behavior based on perceived user state

Automatic user state recognition:
- idea: usage of statistical classifiers to recognize:
  - intoxication
  - emotions
  - user Satisfaction
  - perceived coherence
- focus on Interaction Quality (IQ)
  - objective form of user satisfaction
  - analysis of multiple statistical modeling approaches
    - static models (SVM...)
    - sequence models (HMM...)
  - evaluation of IQ in dialogues
User-Adaptive Spoken Dialogue Management

Adaptive Dialogue Management (DM)
- change system behavior / dialogue strategy based on Interaction Quality
- explicitly
  - rule-based system
    - adapt:
      - grounding
      - initiative
      - prompt design
- implicitly
  - automatically learn best strategy
    - statistical DM (POMDP)
    - reinforcement learning
  - IQ part of dialogue state
  - IQ part of reward function

Experiments and results at my poster
Emotion Recognition for Adaptive SDS (Maxim Sidorov)

- Emotion Recognition is used to change a dialogue strategy or to redirect an end user to a human-assistant

Multimodal automatic emotion recognition:
- machine learning algorithms for modelling
  - ANN
  - SVM
  - KNN
- usage of multimodal features
  - audio
  - visual
  - text
- types of fusion
  - feature-based or early fusion
  - decision-based fusion (weighted sum, product, meta-modelling algorithm)
  - model-based
Enhancement of Emotion Recognition

- Emotion Recognition is used to change a dialogue strategy or to redirect an end user to a human-assistant

- gender- or speaker-adaptive emotion models
  - system A: Independent models for each speaker and gender
  - system B: Incorporating speaker or gender hypotheses directly into feature vector

- multi-objective genetic algorithm-based feature selection
  - to maximize emotion recognition performance and minimize number of features simultaneously

Experiments and results at my poster
Conclusions

Enhanced spoken dialogue interaction plays a key role in advanced technical systems.

• How to optimally adapt spoken language dialogue systems to user status and context of use? (Adaptiveness)
  – relevant context information captured and interpreted
  – information integrated into a user-oriented human-computer dialogue
  – adaptive dialogue modeling strategies

• How to reduce the cognitive burden of the user? (Assistiveness and Proactiveness)
  – more powerful back-end and dialogue strategies
  – multi-user interaction
  – dialogue history management