



# Embodied Audition for Robots

## Introduction & Overview

**Heiner Löllmann, Christine Evers, and Radu Horaud**

**EARS Tutorial**

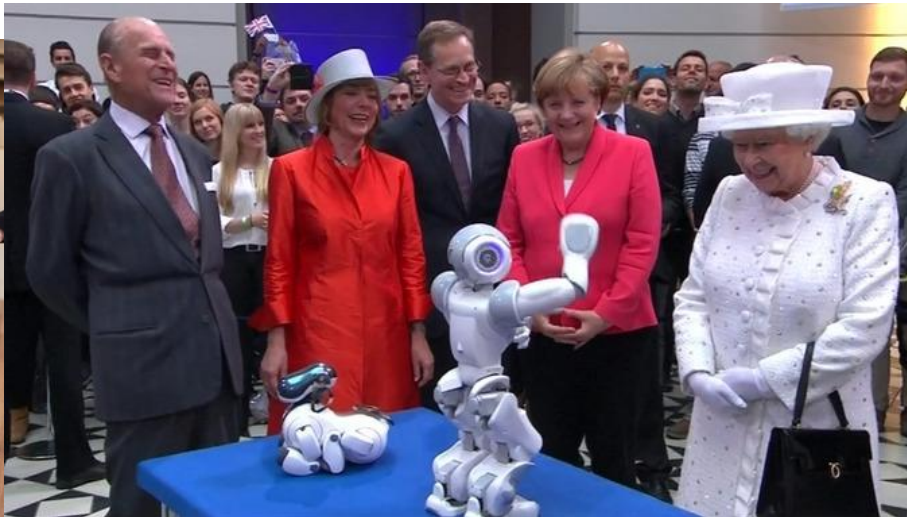
Paris, November 26, 2015

# Motivation

- ▶ **Humanoid robots, which can interact with persons like human beings, attract and fascinate people likewise**
- ▶ **Potential applications are**
  - support of elderly people
  - reception of customers, e.g., in hotels or shops
  - healthcare assistant in hospitals
  - greeting the Queen



Source: Aldebaran Robotics



Source: RTV



Source: SoftBank/Aldebaran Robotics

# Motivation

- ▶ **Speech is the most natural and effective way for humans to communicate with a humanoid robot (as with humans)**
- ▶ **For a natural human-robot interaction (HRI), the robot should**
  - look to the person it is talking to
    - source detection, localization and tracking
  - understand the content of the conversation
    - automatic speech recognition (ASR)
  - respond in a reasonable manner
    - speech-dialog systems
  - show human-like gestures
    - robot gesturing



Source: Polly Braden

- ▶ **What are the specific challenges for robot audition?**
- ▶ **Which concepts are promising to tackle these challenges?**

# Challenges in Robot Audition

- ▶ **Distorted recordings**
  - background and interfering noise
- ▶ **Room reverberation**
  - no close distance between robot and person
- ▶ **Robot ego-noise**
  - caused by motors (actuators) and cooling fan
- ▶ **Acoustic feedback for a speaking robot**
  - loudspeakers at close distant and nonlinear transmission characteristic
- ▶ **Robot (head) and/or person are moving**
  - speaker localization and tracking
- ▶ **Microphone and/or camera signals possibly unsynchronized**



# The EARS Project

---

## ▶ Embodied Audition for RobotS (EARS)

- **Main focus:** Developing the fundamentals for a natural dialogue between humans and robots in *adverse acoustical environments*.
- **Runtime:** 3 years (Jan. 2014 – Dec. 2016)
- **6 Partners:**
  - FAU Erlangen-Nuremberg (Project Coordinator)
  - Imperial College London
  - Ben-Gurion University of the Negev, Beer Sheva
  - Humboldt University Berlin
  - INRIA Grenoble
  - Aldebaran Robotics SA, Paris



# Tutorial Overview

---

This tutorial should provide an overview and details some of the challenges, concepts, and state of the art developments in embodied audition for robots.

10:00 **Embodied Audition for Robots: Introduction & Overview**

10:15 **Acoustic Signal Enhancement for Robot Audition**

Heiner Löllmann

10:45 **Coffee Break**

11:00 **Acoustic Scene Mapping**

Christine Evers

11:30 **Audio-Visual Analysis for Human-Robot Interaction**

Radu Horaud

12:00 **Lunch break**

