Human-Robot Interaction
Team project proposal

Mirjam de Haas, Bas Kooiker, Jan van Acken & Janne Weijkamp

06-05-2014

1 Introduction

Over the years many robots have been developed that can make music. In 1987 a group from the Science and Engineering department at the Waseda University in Japan developed the WABOT-2 [1]. The WABOT-2 is a robot able to play keyboard instruments (see Figure 2, using his eyes to read a score, his hands to play the keys, his legs and feet to play the bass keys and the expression pedal. In 2005 Toyota released several humanoid robots that are able to play the trumpet, drums and tuba. Two years later they released another robot musician that is able to play the violin (see Figure 3). These robots developed by Toyota are envisioned to, in the future, help out with the housework and taking care of people.

Beside robots musicians, robots have been developed that are able to conduct big orchestras. In 2008, ASIMO (the humanoid developed by HONDA) conducted the Detroit Symphony Orchestra, while the orchestra performed "The Impossible Dream" [2]. In 2010 Geuther et al.[3] developed a simple and affordable conducting robot (see Figure 4). These robot conductors use gestures in order to conduct human music players. Beside robot musicians and robot conductors, Morita et al. [4] developed an electronic orchestra that responds to the gestures of a human conductor. The system has several components (see Figure 5. There is a motion-comprehension system for the right hand, a gesture-comprehension system for the left hand and there are the MIDI instrument controllers that play the music. The performance communication system combines all these components to make the MIDI instruments perform under the direction of the human conductor.

2 Project

In this project we are going to follow the line of Morita et al. [4], by developing a robot able to respond to gestures of a human conductor. However, instead of focusing on the very technical aspects of music and conducting, we would like to focus specifically on the human-robot interaction.

2.1 Materials

For this project we need the following materials:

- NXT robot
- Kinect
- Nao
- Laptop

2.2 Method

In this project we are going to let an NXT robot play music, while influenced by a human conductor. The idea is to let the human control tempo and volume with one hand and pitch with the other, which will be sensed by a Kinect. This data is send to a laptop, where a pose tracking system focused on the arms and hands figures out the changes in tempo, volume and pitch. The laptop sends this data to the music-playing NXT robot, which will then adjust its speed, volume and pitch accordingly. Figure 1 provides an overview of the system.

The NXT robot will be a simple robot that has little hammers, which allows the robot to make sound on a xylofoon or just on a drum. With a robot playing with such little hammers the tempo and the volume can easily be controlled. **How can we change the pitch with a drum-playing robot??**

An extra feature we would like to add is Nao as an instructor to the human conductor. In the beginning Nao can show the human which gestures to make to control the tempo, volume and pitch. The NXT robot will also respond to these gestures of Nao, so the human will experience how the gestures can control the NXT robot. Besides that, Nao will also intervene when the human makes an incorrect gesture or encourage the human to continue with playing.

2.2.1 Subtasks

Eventually, we have 4 different subtasks

1. The Nao robot
2. The NXT music robot
3. The Kinect
4. The translation between the Kinect and the NXT music robot

Of course, the amount of work for every task is not equally divided. This will be taken into account during the project.

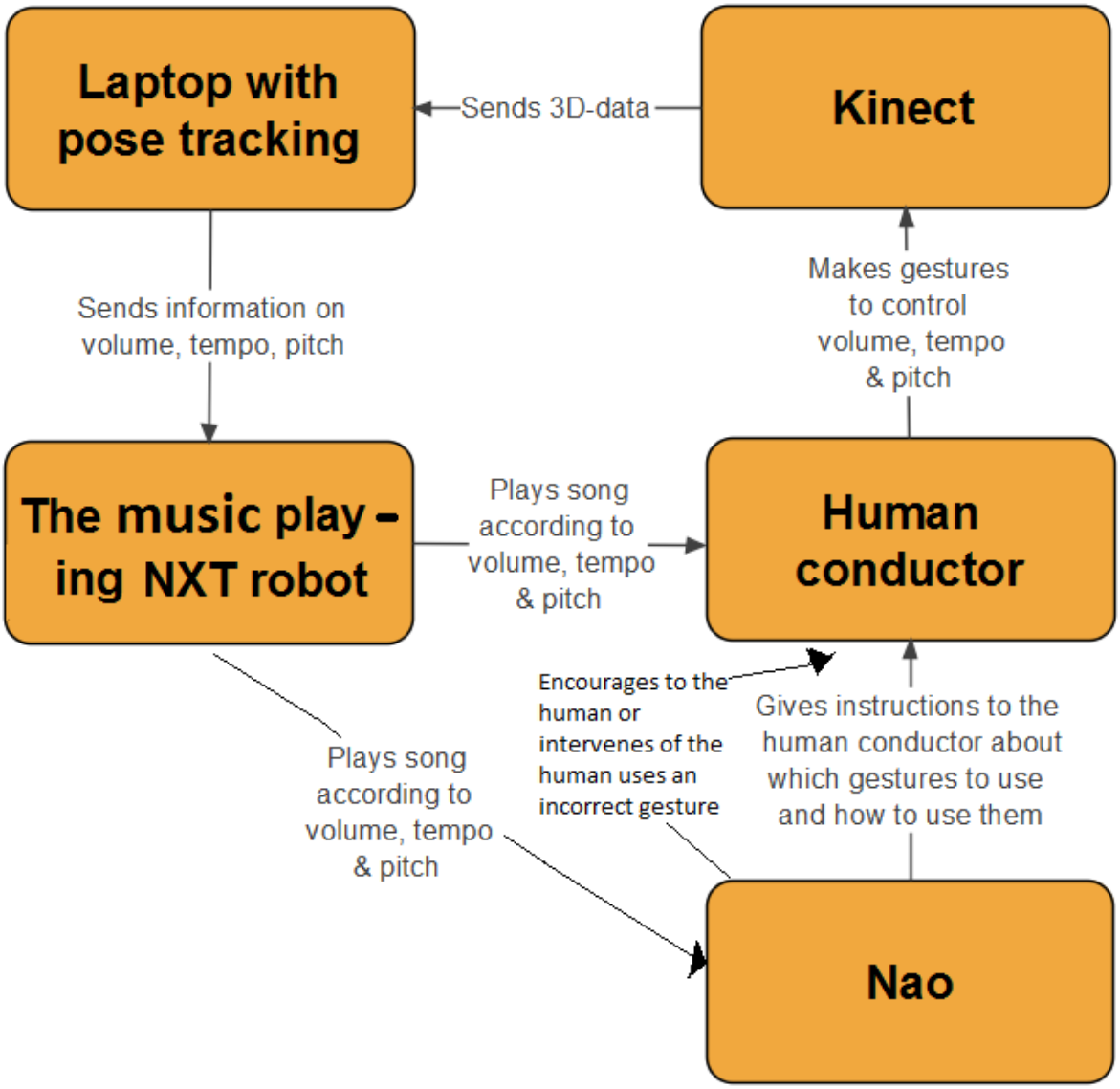

Figure 1: Overview of the project described in this paper.

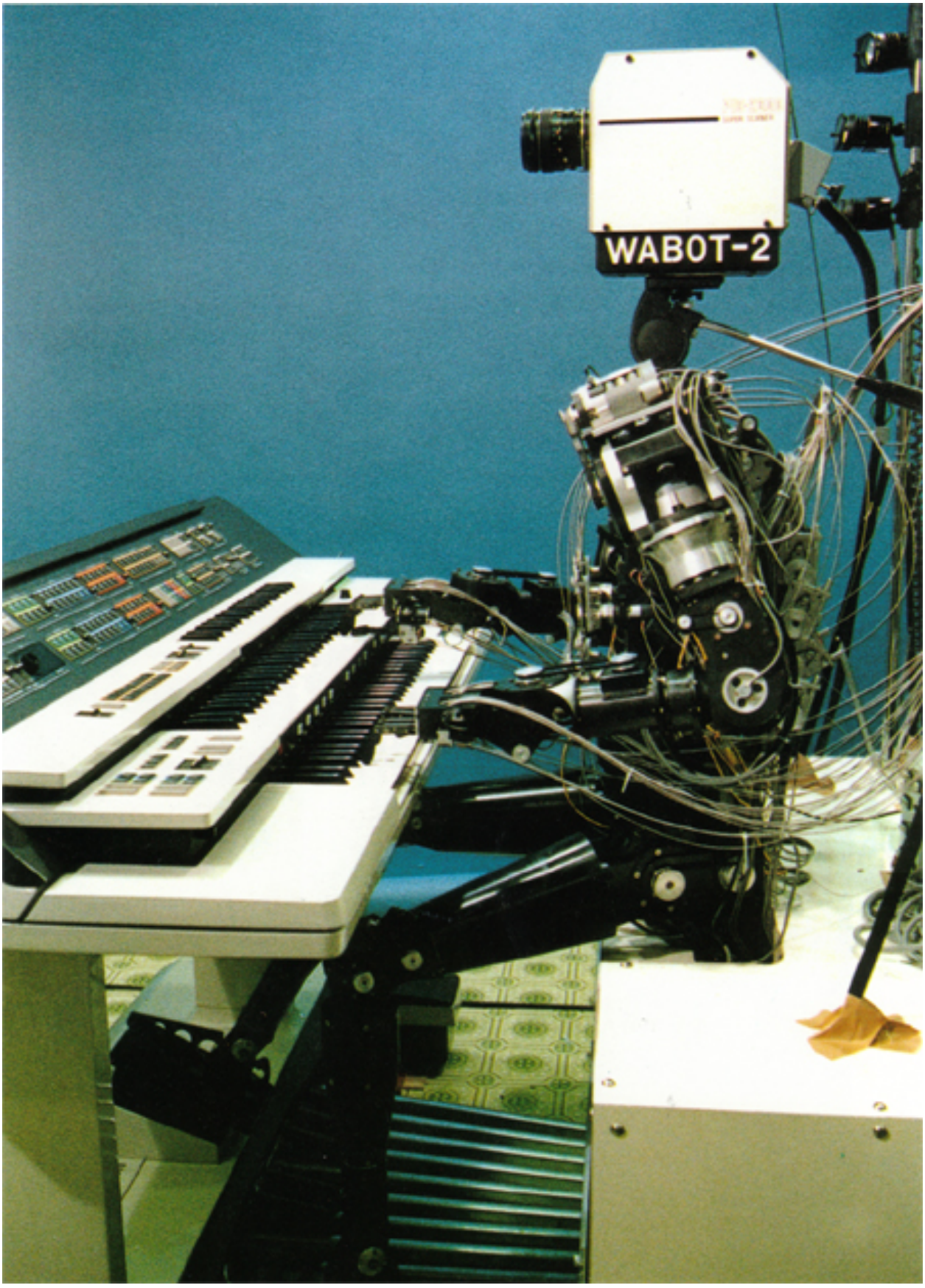

Figure 2: WABOT-2 playing keyboard using his hands, feet, and camera.

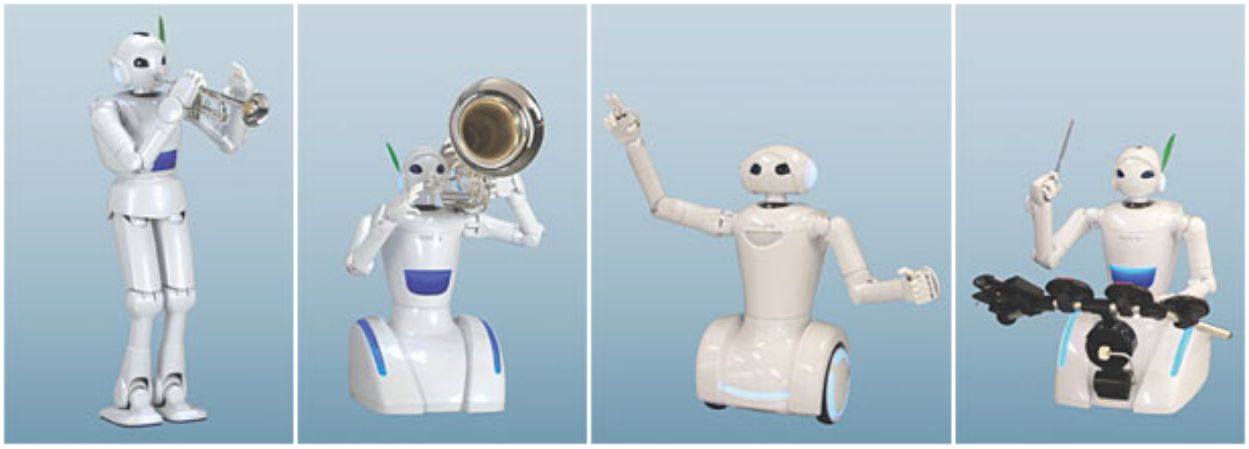

Figure 3: The robots developed by Toyota able to play musical instruments.

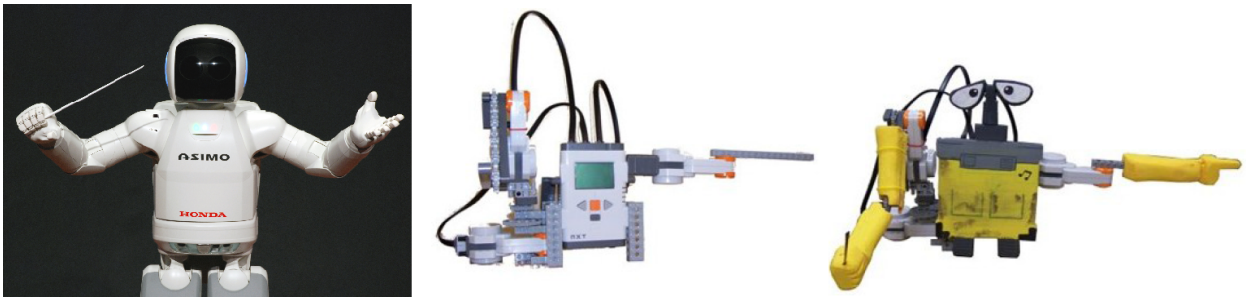

Figure 4: Robot conductors. On the left: ASIMO developed by HONDA. On the right: the Lego Mindstorm NXT robot developed by Geuther et al.

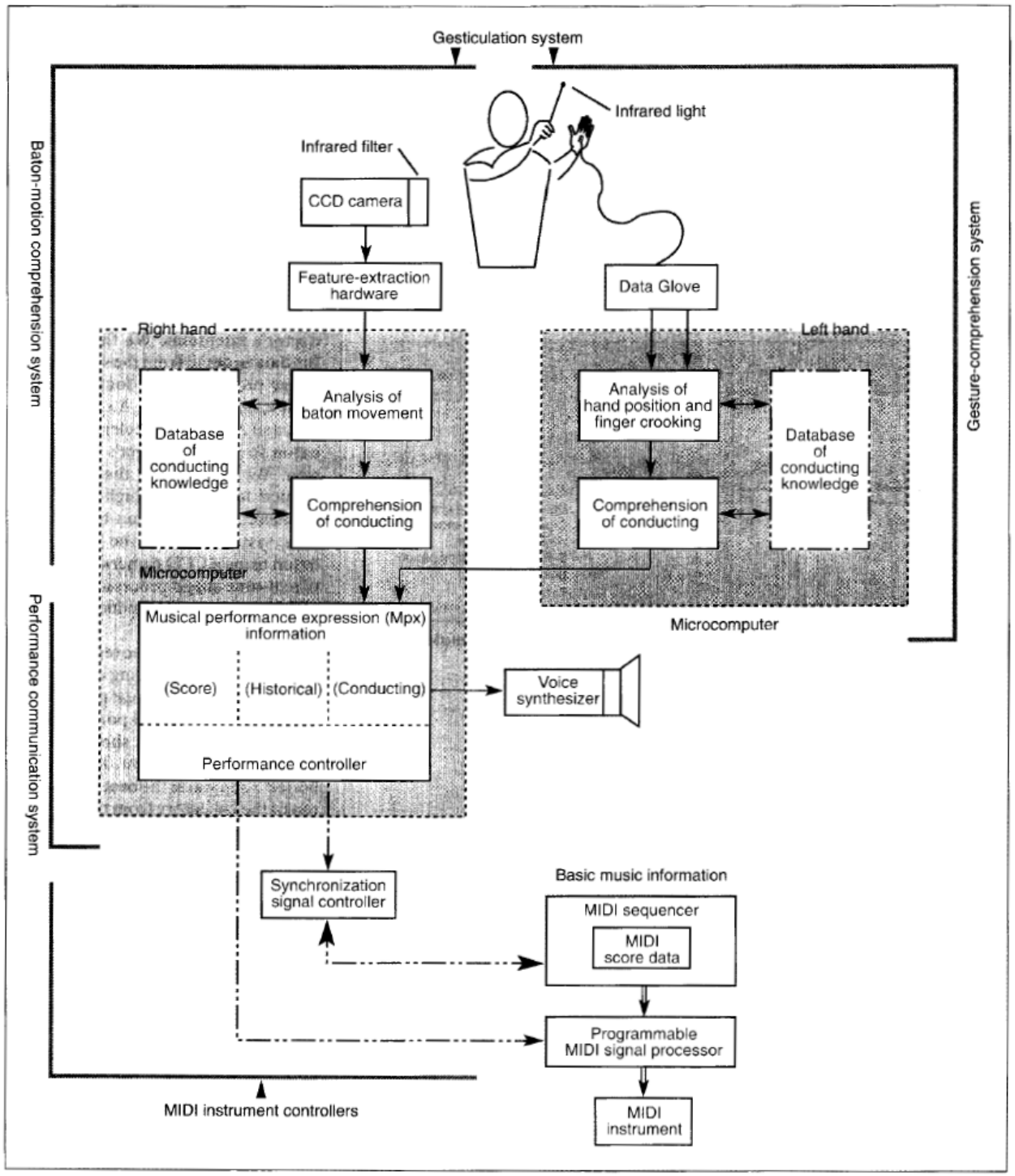

Figure 5: Overview of the system that can play music under the direction of a human conductor, developed by Morita et al. [4].

References

[1] I. Kato, S. Ohteru, K. Shirai, T. Matsushima, S. Narita, S. Sugano, T. Kobayashi, and E. Fujisawa, "The robot musician 'wabot-2'(waseda robot-2)," *Robotics*, vol. 3, no. 2, pp. 143–155, 1987.

[2] "Honda ASIMO Robot conducting the Detroit Symphony Orchestra." `http://world.honda.com/news/2008/c080423ASIMO/`, `http://www.youtube.com/watch?v=Cf5szwz6Qzc`.

[3] B. Geuther, A. Breese, and Y. Wang, "A study on musical conducting robots and their users," in *Humanoid Robots (Humanoids), 2010 10th IEEE-RAS International Conference on*, pp. 124–129, IEEE, 2010.

[4] H. Morita, S. Hashimoto, and S. Ohteru, "A computer music system that follows a human conductor," *Computer*, vol. 24, no. 7, pp. 44–53, 1991.