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Attention Training Game with Aldebaran Robotics NAO and Brain-Computer Interface

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Introduction

«Traditional» Human-computer interaction:

- Speech recognition
- Movements
- Postures and gestures

New method of HCI:

- Brain-computer interface

BCI devices become commercially available in recent years

The new opportunities for researchers and developers to create fundamentally new BCI-based applications

We propose a new application to attention traning for children with ADHD

The main feature of this solution: to use BCI and humanoid robot NAO

Global Software Engineering

Collaborative educational project from 2012 byRitsumeikan University (Kyoto) and TUSUR University (Tomsk)

Lectures by Victor Kryssanov (founder), Tomasz Rutkowski and Evgeny Shandarov via teleconference

Idea: to organize a group of students with different majors to execute the final project

Students with mentors create projects on themes proposed

Different cases

Topics for 2013-2014: BCI and humanoid robot

Attention Dificit Hyperactivity Disorder (ADHD)

ADHD symptoms:

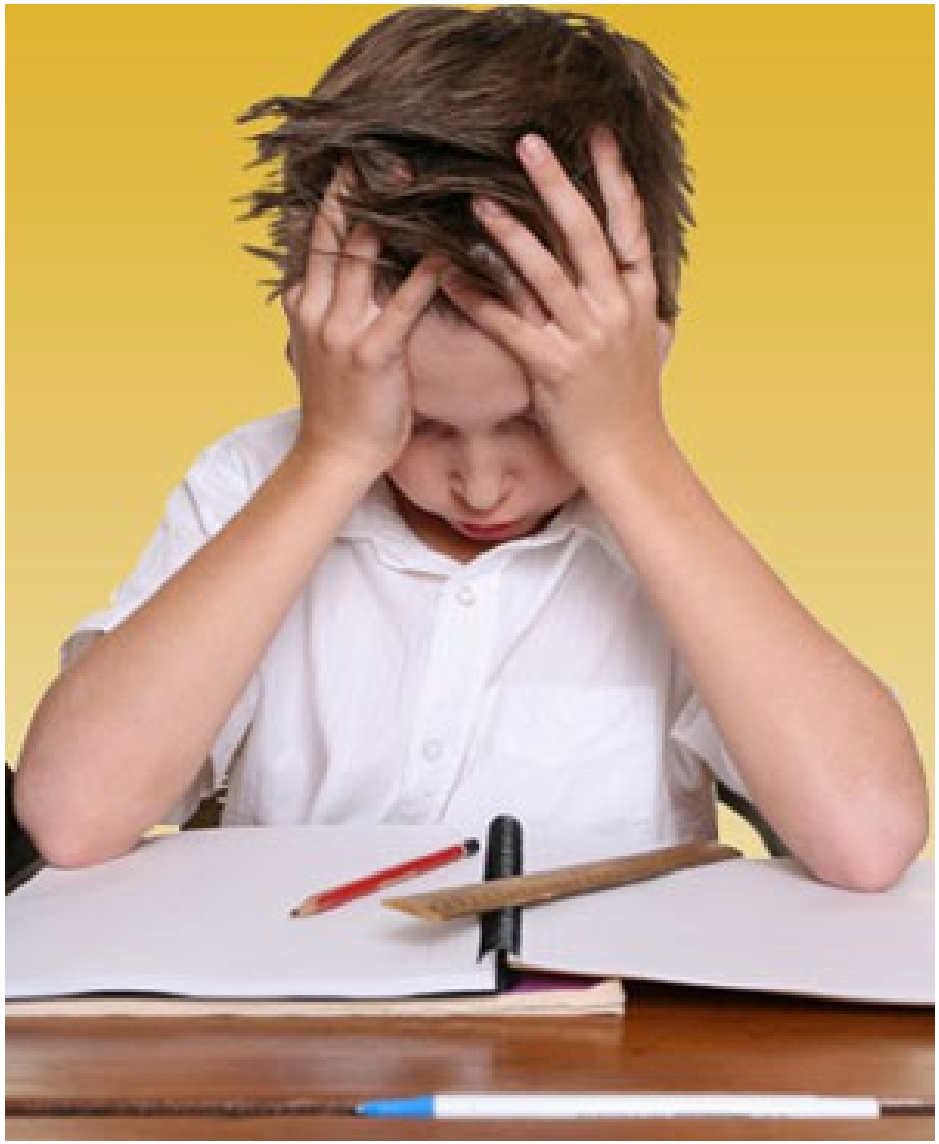
- Inattention, Hyperactivity
- Frequently switch from one activity to another
- Have difficulty maintaining focus on one task

Statistics on ADHD:

- Russia: 4 to 18%; USA: 4-20%; Italy: 3-10%...

Therapy:

- Psychotherapy; Educational and neuropsychological correction
- In 2012 Lim et al. using BCI for training children



Robot Hardware

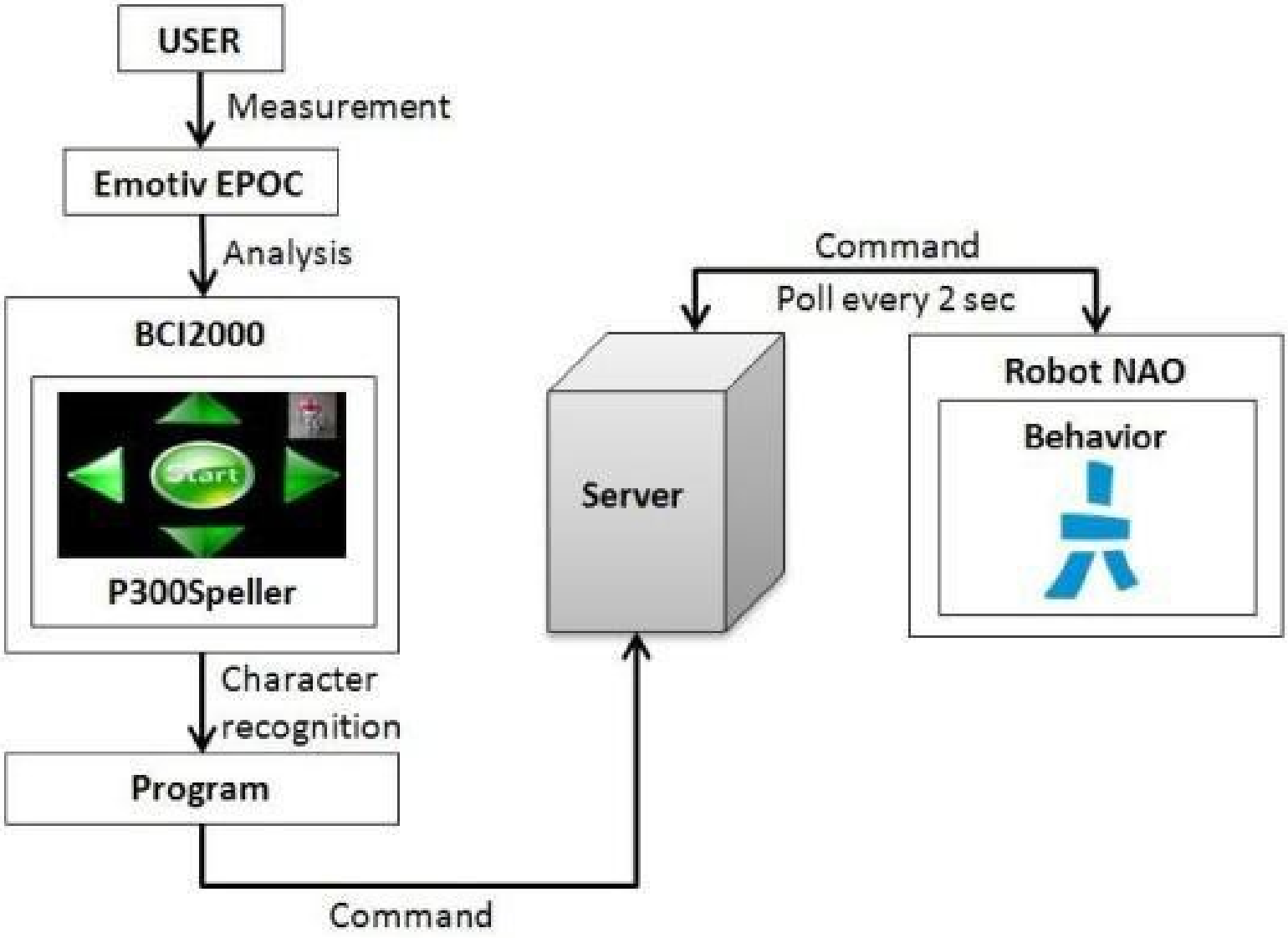
- Aldebaran Robotics NAO
  - Height: 58 cm
  - 25 DOF
  - Sensors and actuators: 2 speakers; 4 microphones; 2 cameras; Gyroscope + accelerometer; Range sensors
  - Very friendly robot
  - Choreographe software
  - Very useful for social robotics
  - Speech synthesys; voice recognition
  - Computer vision
  - NAOqi framework

Emotive EPOC

- Device implementing BCI functions
- Helmet with electrodes for reading user EEG
- Emotive EPOC:
  - 14 sensors + 2
  - Gyroscope
  - WiFi connection and USB interface

BCI200 and P300Speller software are used for signal analysis and collect data

General architecture



Interaction scenario

BCI Emotive EPOC is used by user

1. Robot explains the rules of the game by voice
2. Robot demonstrates a sequence of four activities: (Go forward; Go backward; Turn left; Turn right)
3. Robot asks user to «repeat» sequence by «thinking» commands (commands are formed by BCI)
4. Robot executes commands one by one if the command is correct, and if not, robot asks to try again
5. In the end robot congratulates a user

Mini-game with robot and BCI for attention training

The main goal is to train child to hold attention

Cycle of the game will completed successfully when sequence will fully performed by robot

Implementation

Emotive EPOC used as BCI device

BCI2000 software with P300Speller used for command recognition

Program communicate with server via HTTP

Custom command protocol using to form command for robot:

- HTTP GET method
- http://<server addr>/set_command.php?<cmd>
- Commands: F (forward), B (backward), R (turn right), L (turn left)

Robot polls server every 2 second for the commands

Experiments

January 2014

BCI part was in Kyoto

Robot and server parts was in Tomsk

Skype was used for visual contact

Communication between components via HTTP over public networks

Results:

- Period of experiments: 2 hours
- Five sequences of motions for the robot was created
- Four complete cycles of the game have been successfully run
- Time interval between command formation and execution by robot: 15-20 seconds
- The main reason for delay: reading, analyzing and recognition commands from BCI (12-18 seconds)

Conclusions

As a result of this work the team has proposed the system concept for training attention, implemented a prototype game and performed tests of the system via the public Internet networks.

The main problem was the long delay between commands.

Given the success of the experiments of Lim et al., this scenario may be used in further experiments with people suffering from ADHD.

Thank you for attention!

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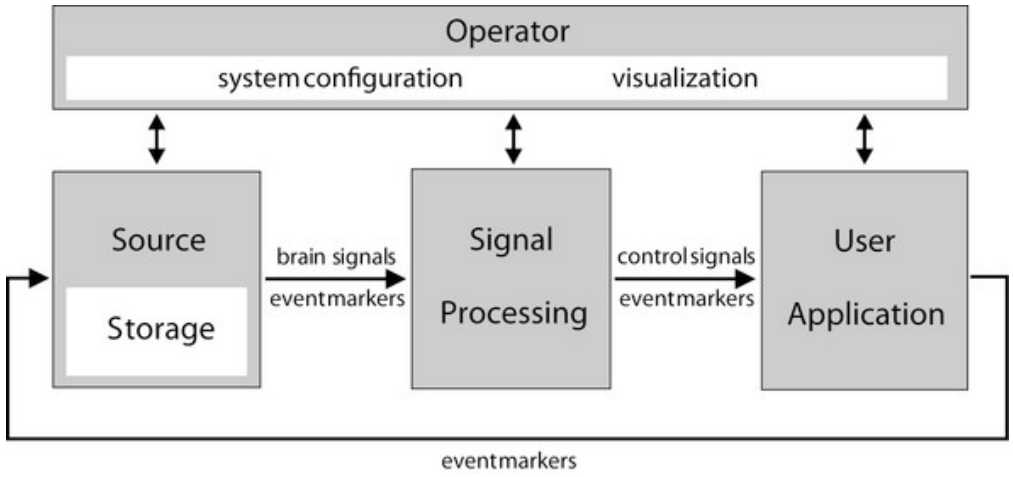
BCI2000


Operator
system configuration
visualization
Source
Storage
brain signals
eventmarkers
Signal
Processing
control signals
eventmarkers
User
Application
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