NAO Project
Social Assistive Robot

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WiTNY COLLABORATIVE PROJECT

RESEARCH MOTIVATION

Goal:

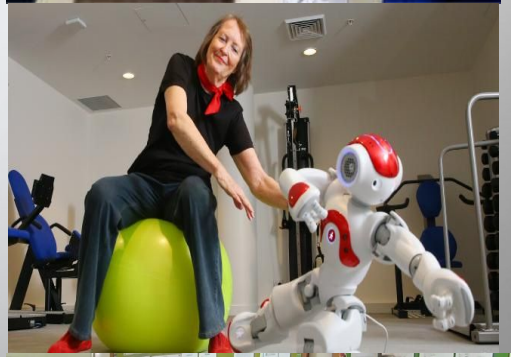
Social Assistive Robot,

Work collaboratively with professionals to provide assistance for:

- People with hearing /speech impairment
- Rehabilitation at home
- Children with cognitive disabilities

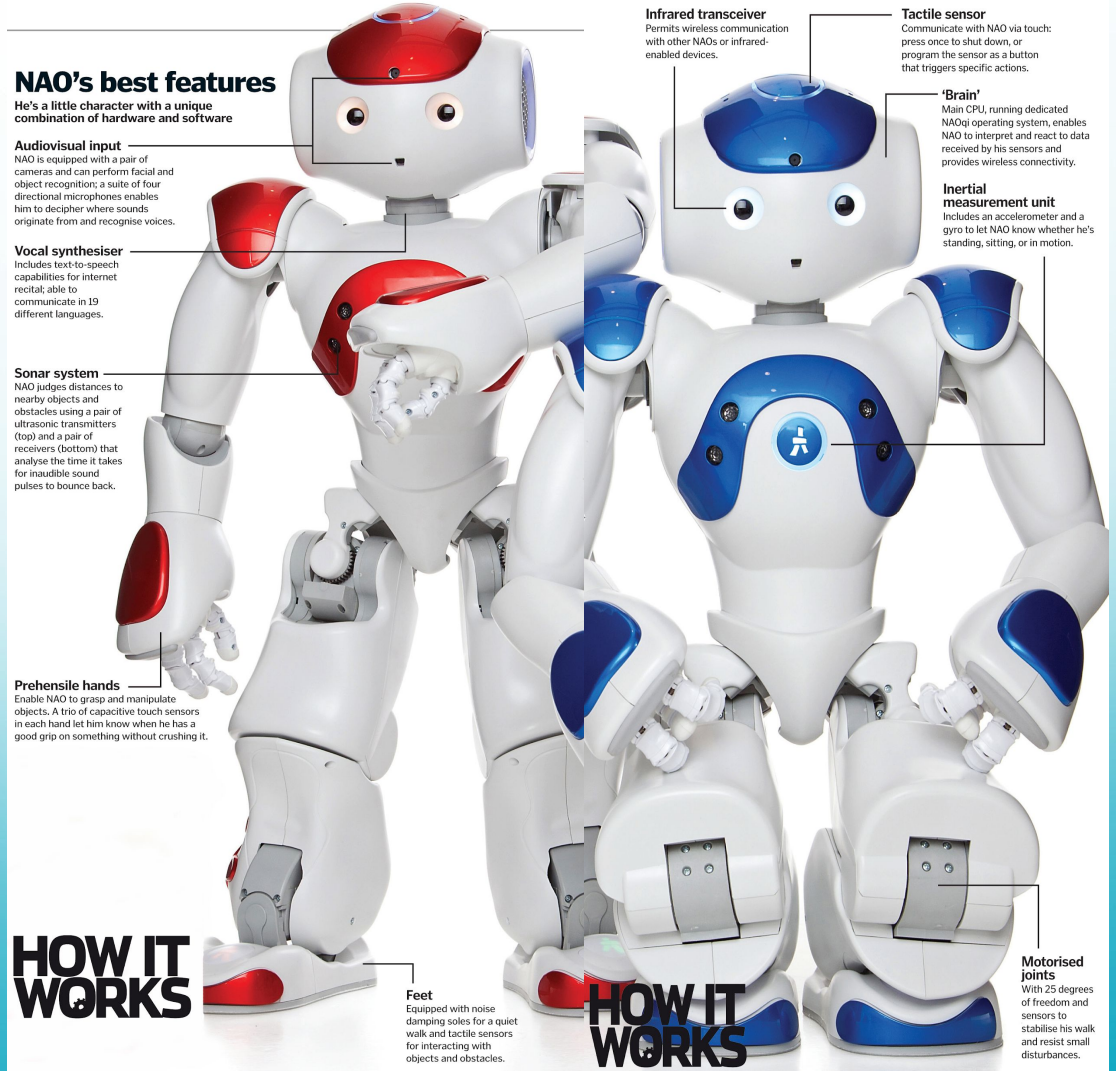
Reason:

Cost-effective and provide emotional support and companion.
Gain confidence
Reinforce memory building through interactive games
Assist the elderly in doing simple tasks efficiently



NAO's best features

He's a little character with a unique combination of hardware and software



Audiovisual input
NAO is equipped with a pair of cameras and can perform facial and object recognition; a suite of four directional microphones enables him to decipher where sounds originate from and recognise voices.

Vocal synthesiser
Includes text-to-speech capabilities for internet recital; able to communicate in 19 different languages.

Sonar system
NAO judges distances to nearby objects and obstacles using a pair of ultrasonic transmitters (top) and a pair of receivers (bottom) that analyse the time it takes for inaudible sound pulses to bounce back.

Prehensile hands
Enable NAO to grasp and manipulate objects. A trio of capacitive touch sensors in each hand let him know when he has a good grip on something without crushing it.

Feet
Equipped with noise damping soles for a quiet walk and tactile sensors for interacting with objects and obstacles.

Infrared transceiver
Permits wireless communication with other NAOs or infrared-enabled devices.

Tactile sensor
Communicate with NAO via touch: press once to shut down, or program the sensor as a button that triggers specific actions.

'Brain'
Main CPU, running dedicated NAOqi operating system, enables NAO to interpret and react to data received by his sensors and provides wireless connectivity.

Inertial measurement unit
Includes an accelerometer and a gyro to let NAO know whether he's standing, sitting, or in motion.

Motorised joints
With 25 degrees of freedom and sensors to stabilise his walk and resist small disturbances.

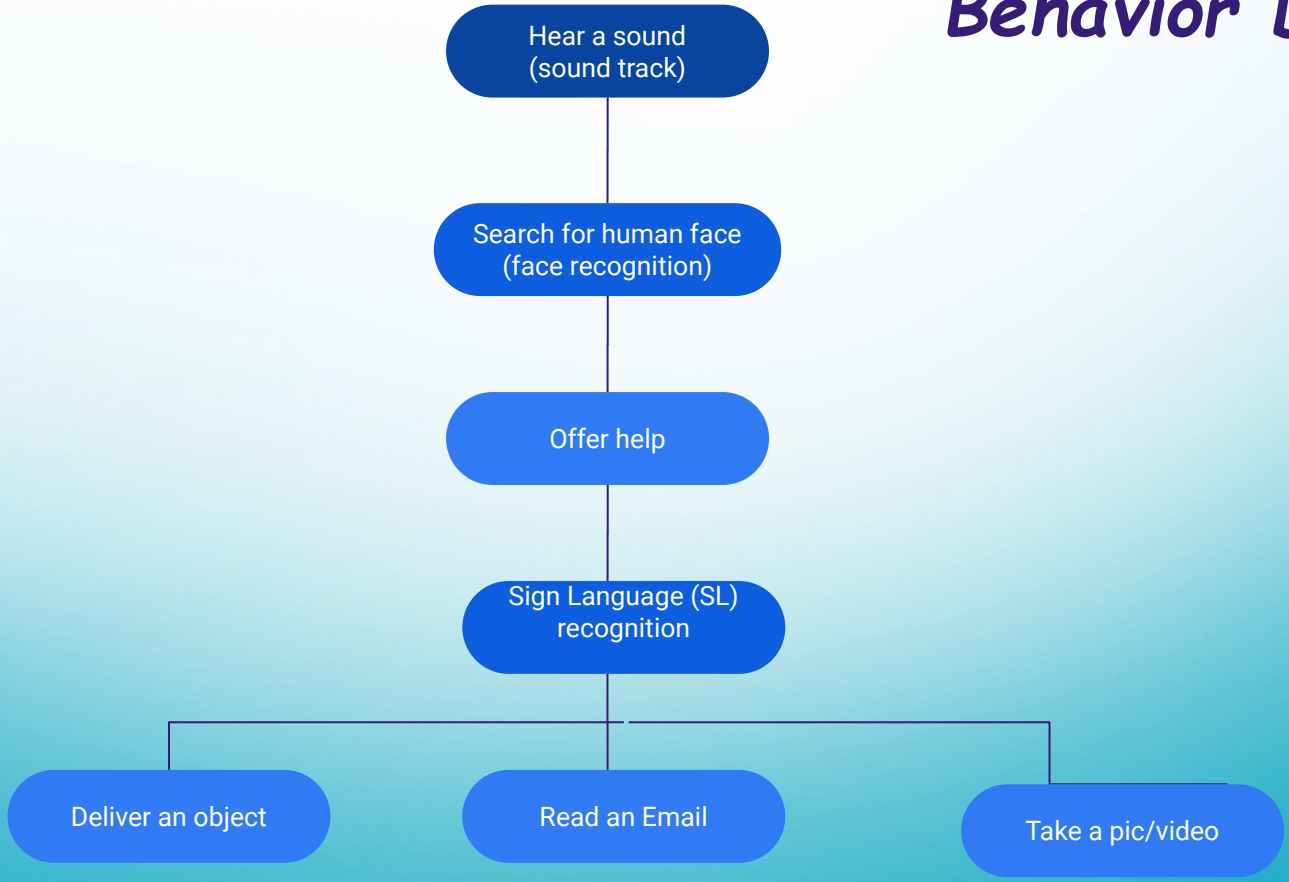
HOW IT WORKS

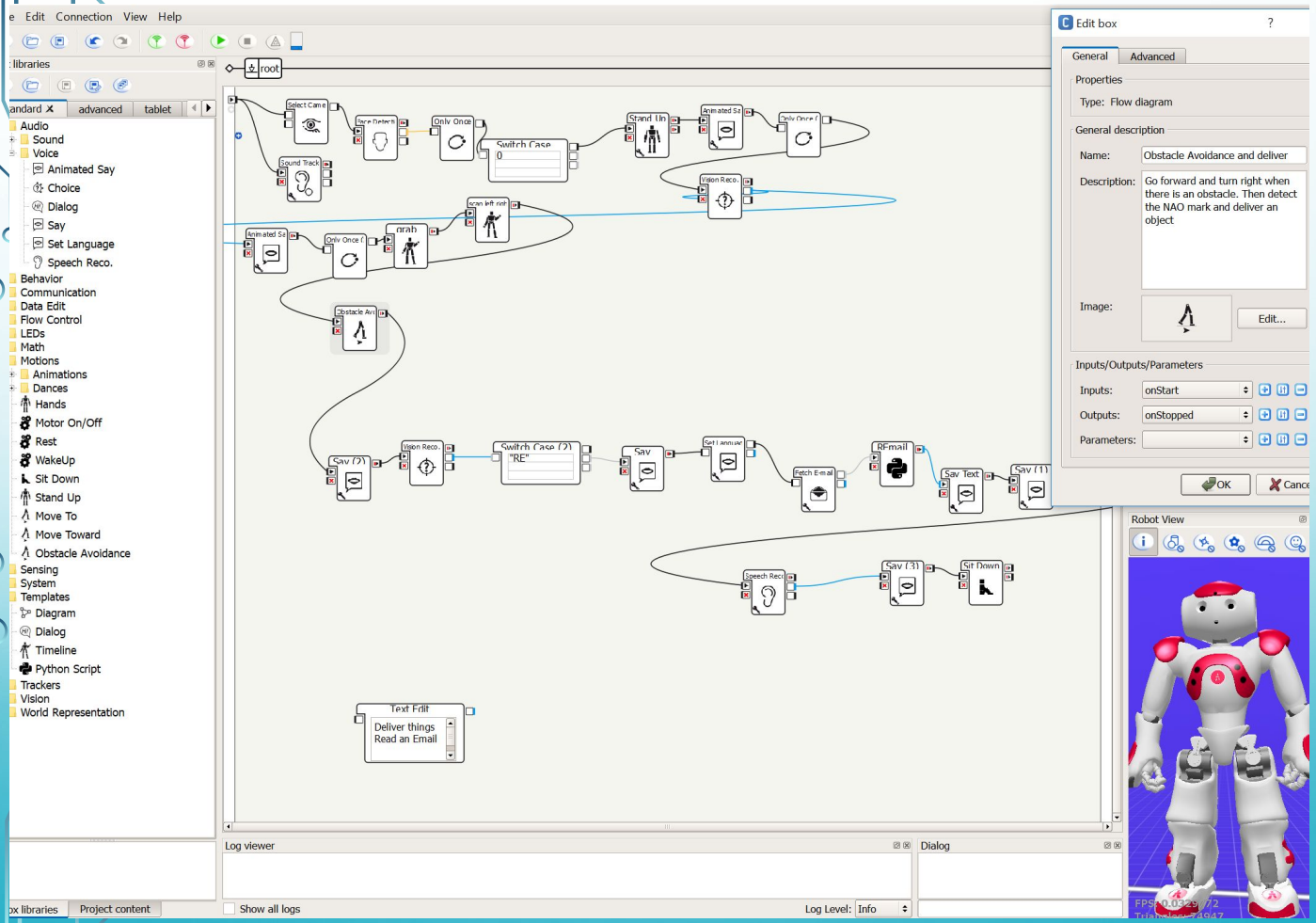
HOW IT WORKS

Interaction with NAO by Sign Language

- Help to deliver objects
- Read the new coming Email
- Take a picture/video for emergency

Behavior Design

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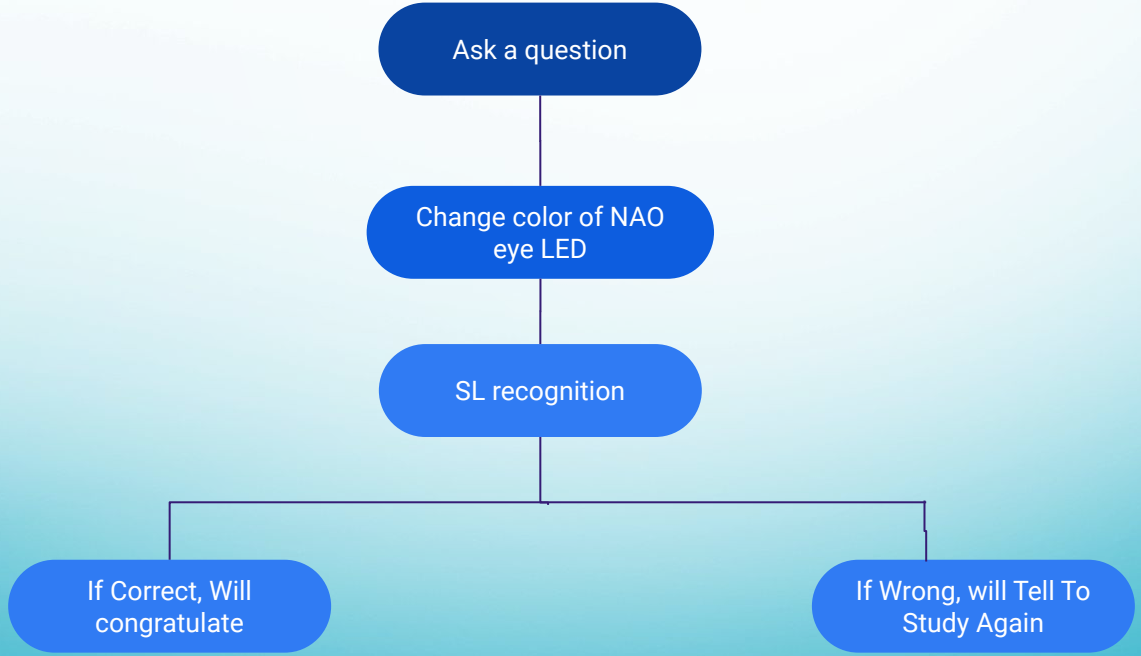
libraries
root
Edit box
General
Advanced
Properties
Type: Flow diagram
General description
Name: Obstacle Avoidance and deliver
Description: Go forward and turn right when there is an obstacle. Then detect the NAO mark and deliver an object
Image:
Edit...
Inputs/Outputs/Parameters
Inputs: onStart
Outputs: onStopped
Parameters:
OK
Audio
Sound
Voice
Animated Say
Choice
Dialog
Say
Set Language
Speech Reco.
Behavior
Communication
Data Edit
Flow Control
LEDs
Math
Motions
Animations
Dances
Hands
Motor On/Off
Rest
WakeUp
Sit Down
Stand Up
Move To
Move Toward
Obstacle Avoidance
Sensing
System
Templates
Diagram
Dialog
Timeline
Python Script
Trackers
Vision
World Representation
Text Edit
Deliver things
Read an Email
Robot View
Log viewer
Dialog
Show all logs
Log Level: Info

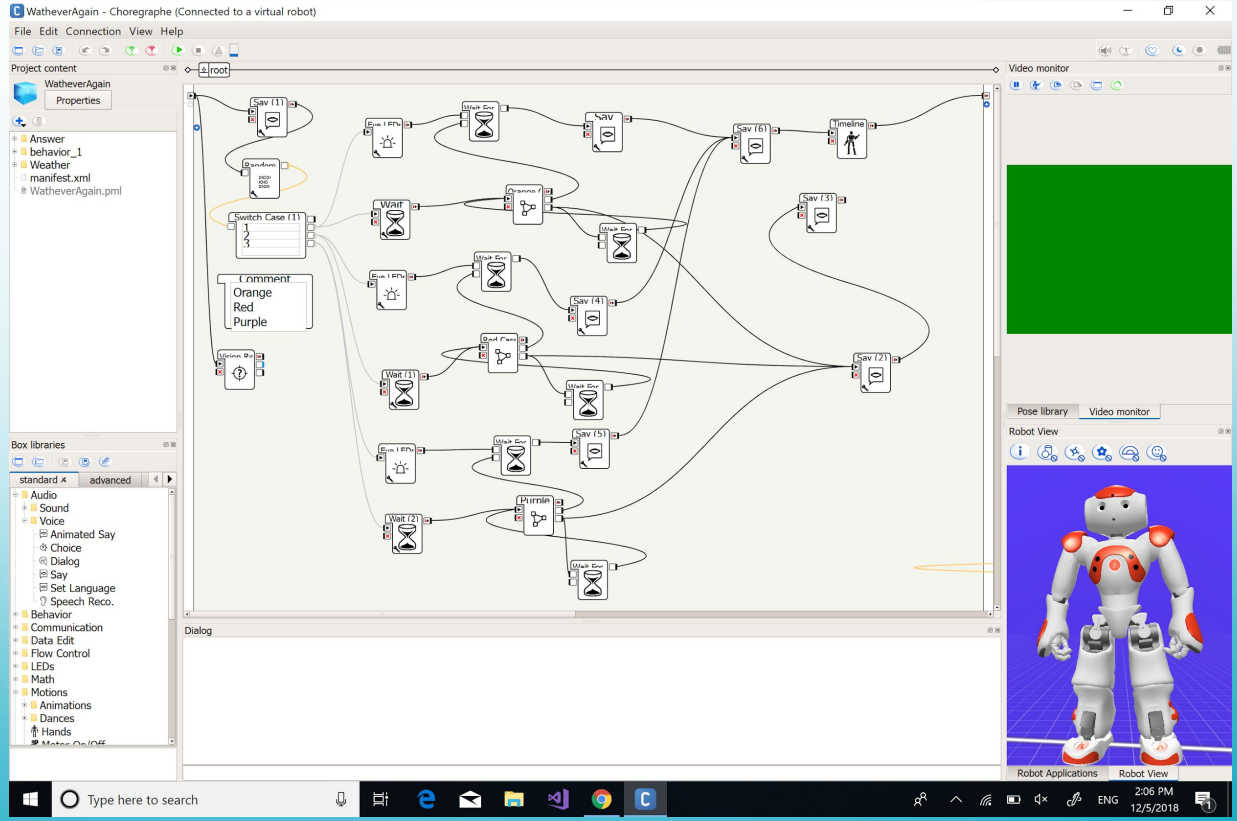
NAO Teaching Sign Language Through Interactive Game

- Learn Math
- Learn Color

Learn sign language with color



Code


WatheverAgain - Choregraphe (Connected to a virtual robot)
File Edit Connection View Help
Project content
WatheverAgain
Properties
Answer
behavior_1
Weather
manifest.xml
WatheverAgain.pml
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Switch Case (1)
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Purple
Wait
Wait (1)
Wait (2)
Purple
Video monitor
Pose library
Video monitor
Robot View
Box libraries
standard
advanced
Audio
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Voice
Animated Say
Choice
Dialog
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Speech Reco.
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Communication
Data Edit
Flow Control
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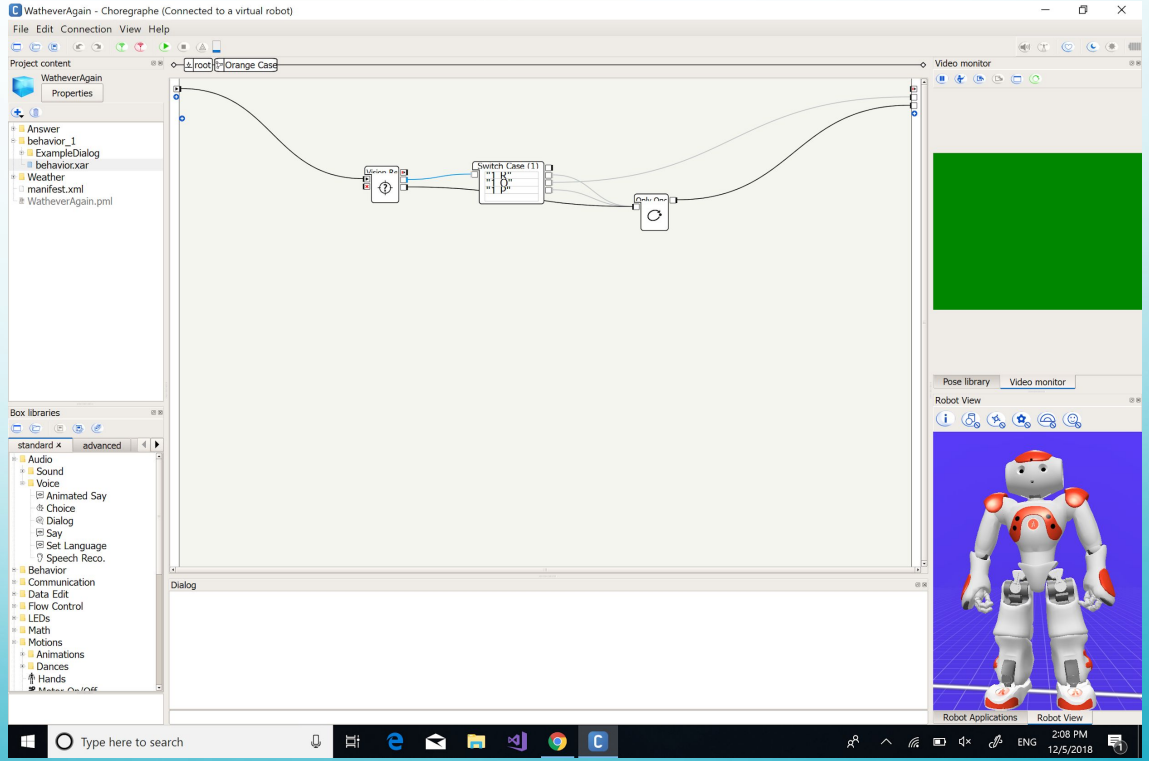
Code


WatheverAgain - Choregraphe (Connected to a virtual robot)
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Project content
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Animated Say
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Say
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Flow Control
LEDs
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Animations
Dances
Hands
Dialog
Video monitor
Pose library
Video monitor
Robot View
Robot Applications
Robot View
Type here to search
ENG
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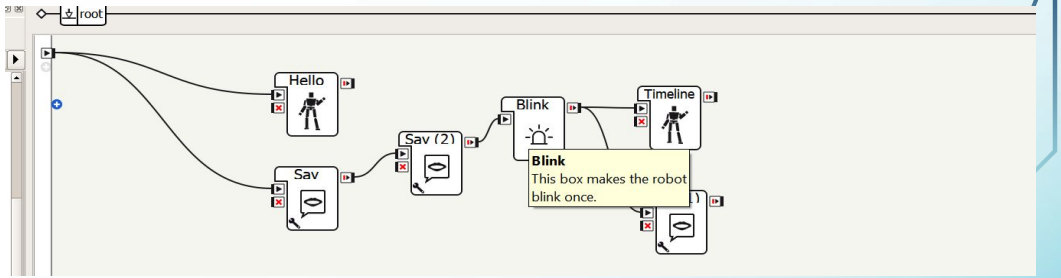
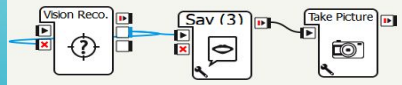
Mirroring Movements for Multiple Robots

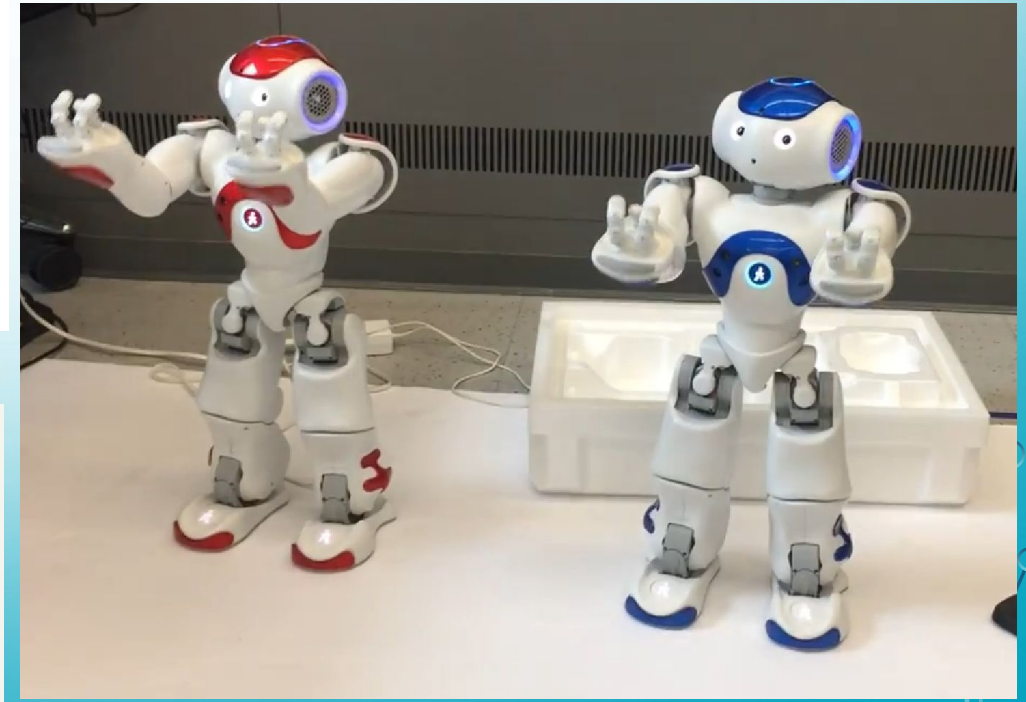
- Rehabilitation at home
- Remote physical therapy

```
from naoqi import ALProxy
memProxy = ALProxy("ALMemory","192.168.1.27",9559)
clientMotion1 = ALProxy("ALMotion","192.168.1.24",9559)

serverMotion = ALProxy("ALMotion","192.168.1.27",9559)
names="Body"
stiffnessl=0.6
stiffness=0
timeLists=0.05
isAbsoulte=True
sensor = True
speeds = 0.2
while(1):
        data0= serverMotion.getAngles(names,sensor)
        clientMotion1.setAngles(names,data0,speeds)
```



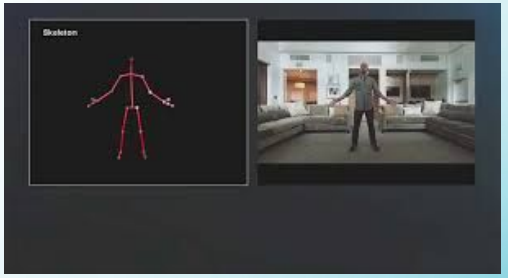




Math Game

By Aleena Tim

Future Plan



NAO Robot - Social Assistive Assistant

Aleena Tim, Mohammad Azhar, PhD

Abstract

RFID is a common technology used in all environments for a wide variety of applications. RFID tags can be used for inventory control, RFID credit cards can be used for wireless payments, and RFID identification cards can be used to access control. However, RFID offers only a single defense mechanism to electronic attack: its low range. In this project, various contactless transmissions are rated against various methods of attack. This rating is then used to understand what vulnerabilities RFID possesses and how best to overcome an RFID-based security checkpoint. Once this determination is made, a model RFID checkpoint will be made, used, and attacked to determine whether this analysis is accurate, and what fixes can be made to improve RFID security.

Theory

The primary defense mechanism against attack is RFID's low range. RFID circuits are bathed an a radio signal that simultaneously powers the circuit and sends data. Once powered, the circuit will respond with its own data, usually comprising of its unique identifier and its user-defined information. Because of RFID's low power, this exchange only occurs over distances of ten centimeters.

However, this limitation is far from absolute. Various attacks are based on circumventing the low range without informing the rightful user of the RFID circuit. These attacks include Relay, Cloning, and Man in the Middle.

Prior Research

- Francis, L., et al. "Potential misuse of NFC enabled mobile phones with embedded security elements as contactless attack platforms." 2009 International Conference for Internet Technology and Secured Transactions, (ICITST), 2009, doi:10.1109/icitst.2009.5402513.
- Pescatore, John. "Back to Basics: Focus on the First Six CIS Critical Security Controls." SANS, Jan. 2017, pp. 1–6.
- "Near Field Communication (NFC) Technology, Vulnerabilities and Principal Attack Schema." InfoSec Resources, 18 Apr. 2015, resources.infosecinstitute.com/near-field-communication-nfc-technology-vulnerabilities-and-principal-attack-schema/#gref.
- Kirschenbaum, Ilan. "How to Build a Low-Cost, Extended-Range RFID Skimmer." USENIX Security Symposium, vol. 15, 8 May 2006, pp. 43–57., www.usenix.org/legacy/events/sec06/tech/full_papers/kirschenbaum/kirschenbaum_html/index.html.
- Fahrianto, Feri, et al. "Denial-of-Service attack possibilities on NFC technology." 2016 4th International Conference on Cyber and IT Service Management, 2016, doi:10.1109/citsm.2016.7577582.
- Adafruit NFC Library https://github.com/adafruit/Adafruit-PN532
- serialTest python script by Ishaq Sloan
- pySerial documentation https://pythonhosted.org/pyserial/
- openPyxl documentation https://pypi.python.org/pypi/openpyxl

Analysis

The attacks shown in prior research are probably still viable against RFID security systems. Below is a brief description

1. Relay

   Relay attacks work by activating an RFID circuit at close range, then transmitting the data obtained over long distances. RFID Circuits are vulnerable to this method of attack, but this attack requires a complex hardware solution and implementation. [Francis, L et al.]

2. Man in the Middle

   Man in the Middle attacks work by eavesdropping on an authentic communication between RFID circuit and receiver. The data is intercepted and usable by the attacker. Even if the data is encrypted, this data is usually still usable as the decryption algorithm is operated by the receiver.

3. Skimming

   Similar to Man in the Middle, Skimming works by discretely obtaining the data held in an RFID circuit. Unlike Man in the Middle, skimming can occur anywhere, as the attacker will usually possess an RFID receiver compatible with the target's RFID circuit. The goal of this attack, unlike Relay, is to simply obtain a copy of the RFID data.

4. Cloning

   Cloning works by obtaining a perfect copy of the data held on an RFID circuit and writing that data to another circuit. This copy is used by the attacker and will be authenticated by the RFID security system as if it was the original. This attack relies on obtaining the original data, usually via skimming. Cloning is the most likely attack vector in facilities that rely on RFID Cards to gate access to authorized users, such as schools that use ID Cards to allow only students into buildings.

5. Corruption

   A denial-of-service attack where the attacker transmits corrupted data towards an RFID receiver. The receiver will read the corrupted data and fail to read authentic data from an RFID circuit.

6. Testing

   Testing will involve performing each attack listed above on the RFID scanner produce in this experiment and searching for results.

Experiments

A small RFID/NFC scanner has been built and programmed to function as a check-in check-out punch card system for student researchers working in the Computer Science Lab in Fiterman Hall. This works using and off-the-shelf NFC transceiver, an Arduino microcontroller, and a host computer running a Python script. This scanner will function as both the punch card system and as a testbed for vulnerabilities.

Demo

Conclusion

- Completing this implementation and further testing will reveal the ultimate security offered by RFID/NFC cards as an access control device and offer solutions to any vulnerabilities
- Because facilities such as hospitals, government buildings, and schools, including BMCC, use RFID for access control, any vulnerabilities found here will apply to them as well.
- New solutions offered will help further secure the same facilities

Future work

- Perform penetration test against NFC Scanner
- Offer solutions based on results
- Test future revisions.

Acknowledgments

- This work is supported by the BMCC Foundation Fund.

Sign-Language Games Using Humanoid Robots for Hearing-Impaired Children

Aleena Tim, Karan Yang, Halizah Sukriyanto, Dr. Mohammad Azhar

Abstract

To explore the potential role for humanoid robots for the education of hearing impaired young children, we employ the NAO robot to design simple, interactive games to teach sign language through mathematics and color matching games. NAO robot is a humanoid robot developed by SoftBanks [1] and equipped with sensors to make it more human-like. By incorporating NAO's sensors and humanoid features, the learning process will be more entertaining and effective!

Motivation

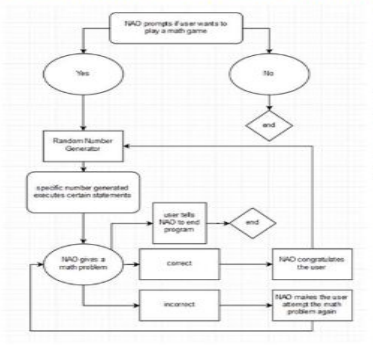
One of the motivations for our research is to explore the potential role for humanoid robots in the field of education, especially the education of young children in their formative years of pre-school and grammar school. We propose to investigate the following questions: (1) How can children, teachers and robots work together to improve the academic skills as well as social and cognitive skills for children with disabilities? (2) Can humanoid robots inspire and expand the creativity for children with disabilities? Research[2] shows that children with disabilities are more fascinated with robotic interactions and its capabilities.

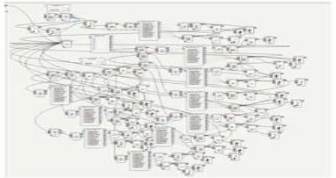
Approach: Sign-Language Math Game for NAO robot

For this experiment, we designed a simple math game program where the NAO utilizes its speakers, speech recognition and object recognition. The NAO needs to detect specific images in order for the math game to work effectively.

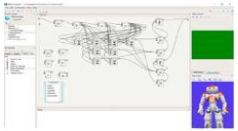
The math game program consists of a small variety of multiplication, division, addition and subtraction problems. When running the math game program, the NAO asks the user if they want to play a math game. If the user responds with "yes" (using speech recognition) then the random number generator block is executed. It chooses a range of numbers (from 1-10) and depending on the number selected, it will execute a specific series of statements. These statements consists of different math problems. The user then uses the sign language number pictures (1-10) to answer the problem. Afterwards, if the user is correct, then they are congratulated. If the user is incorrect, NAO will say it is incorrect and the user will be asked to try again.

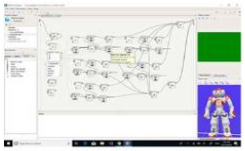
Development: Sign Language with Math Game





Development: Sign Language With Color Game





Approach: Sign-Language Color Game for NAO robot

Another way the NAO robot can be used to help children learn sign language is through a color matching game. So, we design to make a color guessing game with the NAO robot. Sign-Language color game work as follows:

1. The robot, NAO, will first explain the rule of the game.
   Robot: Let's play a game, answer what is the color of my eyes with the correct sign language of the first letter of the color
   Robot: What is the color of my eyes?
2. After that NAO will randomly change it's LED eye color and ask us what colors are his eyes. So far, NAO can change to five different colors, Red, Green, Blue, Orange, and Purple.
3. The game player will then use the Sign Language paper cut-outs provided to choose the corresponding answer.
4. The game will repeat itself 3 times and then NAO will tell us our result. If the player got 3 or 2 correct answers, NAO will ask for a high five. If we got 1 correct or no correct answer NAO will wipe its forehead.

Conclusion and Future Work

- The NAO Sign Language games are interactive programs that introduces an effective way to engage children in order to build a comfortable relationship with robots while also strengthening cognitive thinking.
- Currently, the NAO Robot cannot detect enough hand motion data for Sign-Language from its built-in camera. Recently, researchers have used Kinect hardware successfully with NAO robot to detect real hand motion data for Sign-Language [3].
- In the future, we wanted to use the NAO robot with Kinect hardware to capture real-time sign language that the user presents. We hope to use real-time sign language and implement it into educational games in order to enforce positive social and academic skills for children with disabilities.

References

1. NAO the Humanoid Robot | SoftBank Robotics EMEA." *SoftBank Robotics - Group*, www.softbankrobotics.com/emea/en/nao.
2. Applied Behavior Analysis (ABA): https://www.autismspeaks.org/what-autism/treatment/applied- behavior-analysis-aba
3. "Kinect Sign Language Translator - Part 1." *Microsoft Research*, 23 Aug. 2016, www.microsoft.com/en-us/research/blog/kinect-sign-language-translator-part-1/.

Acknowledgments

- This work is supported by WiTNY @BMCC