Coursework 2 – Human Robot Interaction (group work 4-5 students) deadline for the all document submissions is Week 11 on the 28.11.2019 15:30 pm and the presentation will be held on 29.11.2019 and the 6.12.2019.

Implement a human-robot-game using a Cozmo robot and run an experiment to evaluate its usability and user experience.

The Game

Components:

- 1 Cozmo robot
- 2 Cubes
- (minimum) 8 Control cards
- 1 Execution card
- 1 Egg timer

Control Cards: Each control card shows a different ARMarker [1]. Each of these markers is associated with a specific action that Cozmo can execute. These actions are:

- Detect cube (find a cube in the current camera view)
- Approach cube (move towards the cube until Cozmo touches it)
- Raise forklift
- Lower forklift
- Turn left (turn 90 deg counter clockwise)
- Turn right (turn 90 clockwise)
- Move forward (move 10cm forward)
- Move backward (move 10cm backward)

Execution Card: A single card that contains an ARMarker different to the markers on the control cards. This marker is used as the trigger to start executing the programme the human has given Cozmo using the Control Cards.

Set-up: The cubes are placed on a table together with the Cozmo. The control cards are handed to the human playing the game. Cozmo is started and explores its environment, creating a map of where the cubes and the player are located.

Goal: The player has to program Cozmo to pick up one of the cubes and put it on top of the other cube using the Control Cards.

How to play: The player is presented with the set-up. Cozmo approaches the player, explains the goal of the game, and gives the player the trigger to start. Once Cozmo has started the game, the player will start the egg timer and show any number of Control Cards to the robot one after the other to build up a programme of actions to execute. This programme should lead to the successful execution of the given goal. Once the player has finished programming Cozmo using the Control Cards or the time on the egg timer has run out, the player shows the Execution Card and Cozmo will start executing the programme. If this leads to a successful completion of the task, Cozmo notifies the player. If it does not lead to a successful completion of the task, Cozmo will reset the playing field and start again.

Steps of the game:

1. Cozmo explains the goal (stack one cube on top of the other)
2. One after the other, the player shows a sequence of Control Cards to Cozmo.
3. The player shows the Execution Card.
4. Cozmo executes the sequence of actions Programmed in step 2.
5. Cozmo checks if the goal has been achieved
6. End of the game
    a. If the goal has been achieved, Cozmo congratulates the player,
    b. Otherwise, Cozmo resets the game and starts at step 1.

This game has to be evaluated in an experiment using the other participants of the course. Evaluated the game using success rate, speed for finishing the game, and System Usability scale questionnaire.

Technical implementation details: In order to create this game, the system has to include:

- A map that stores the starting position of the cubes and the player and keeps track of Cozmos current position.
- An exploration algorithm that creates this map
- A world model that keeps track of the current state of the world (position of cubes, player, and goal condition)
- A victory condition check (comparing the current state of the world to the desired goal condition)
- A reset procedure that uses Cozmo to put all the cubes in the places they have been in when the game was started and subsequently approach the player
- A set of actions representing the actions on the Control Cards, i.e. *Detect cube (find a cube in the current camera view), Approach cube (move towards the cube until Cozmo touches it), Raise forklift, Lower forklift, Turn left (turn 90 deg counter clockwise), Turn right (turn 90 clockwise), Move forward (move 10cm forward), Move backward (move 10cm backward)*
- A programme memory that stores the sequence of Control Cards shown by the player
- A communication component able to explain the goal of the game, declare victory or defeat, and give feedback to the player during play.
- Face detection
- ARMarker detection

Physical implementation details: The game set-up has to include the components listed above. The Control and Execution Cards have to be created. The target environment is a tabletop. The game can be enhanced by creating a maze or obstacles for Cozmo.

Evaluation and outcome: You have to evaluate the game with your peers. Invite people out with your group to play the game. Make observations about success rate and completion time, and have your participants fill your UX questionnaire. Details of the technical and physical implementation together with the evaluation results are to be presented during the lecture in 15-minute presentation.

[1] http://www.hitl.washington.edu/artoolkit/

Marking Scheme

Technical Part – 30%

- **Map Creation – 10%**
  - A map that stores the starting position of the cubes and the player and keeps track of Cozmos current position. – **2%**
  - An exploration algorithm that creates this map. – **4%**
  - A world model that keeps track of the current state of the world (position of cubes, player, and goal condition). – **4%**

- **Human interaction**
  - Face detection and greeting the human operator. **- 3%**
  - Successful detection of the ARmarker or any other similar object underpinning the steps in the game. **- 3%**
  - Successful Logging of the human-robot-game interaction data. **- 4%**

- **Game Logic**
    - a finite state machine to execute the actions on the cozmo robot in a correct order to complete the game task. **- 5%**
    - Successfully implement the victory condition and implement the reset mode. **- 5%**

Evaluation Part – 30%

A four-page ACM SIGCHI template paper covering the following aspects should be submitted,

- **Introduction and Motivation – 5%**
- **Research Question – 3%**
    - Hypothesis defined.
- **Concise and complete evaluation plan - 8%**
    - Participants – includes demographics and attributes of the participants.
    - Procedure – a concise and complete procedure followed to conduct the evaluation.
    - Setup and Materials – a pictorial representation of the setup and description of the materials used.
    - Measurements – a list of metrics along with their meaning used to study the impacts of evaluations
- **Results - 8%**
    - Statistical analysis to test the hypothesis.
    - Descriptive statistics supporting or rejecting the hypothesis should be clearly described.
- **Discussion of the results - 4%**
- **Quality of the report – 2%**
    - Abstract and Conclusion sections are included.
    - Sections are well-organized.
    - Writing is clear and free from typos or grammatical errors.

Presentation Part – 10%

Details of the technical and physical implementation together with the evaluation results are to be presented during the lecture in 15-minute presentation.

Plagiarism will not be tolerated (you should review the university guidelines on plagiarism, which you can find on Vision under Course Information). The usual university penalty of 30% off for work up to 5 working days late applies. Reports that are over 5 working days late will not be marked, except in the case of valid Mitigating Circumstances.