Politecnico di Milano
School of Industrial and Information Engineering
Computer Science Master Degree
Advanced User Interfaces Course

Teo 2 (Emotional Teo)

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Abstract

Robotic companions have been proved effective to promote social skills. It is thought that this capability is enhanced when the robot exhibits some "emotional" behavior.

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Introduction

The goal is to re-engineer and extend the existing version of Teo 2 with a Cognitive Module (enabling emotional sensing, expression features, adaptive Human-Robot Spatial Behavior and adaptive polite/intimate Behavior) and possibly evaluating the results against Teo 1.
The document is structured in this way:

- Chapter 1: it describes the users, their needs, the goals of the system and the requirements analysis
- Chapter 2: it describes what Teo can do and how he models the environment
- Chapter 3: it describes some possible scenarios
- Chapter 4: it describes a tasks list for the development team

Chapter 1

Chapter 1

1.1 Users and needs

User:	Needs:
School children/NDD-affected children	- Learn to recognize emotions from others - Interact socially with others - Convey emotional rewards to the children throughout learning activities
Special Teachers/Therapists	- Improve emotional growth of the children introducing robotics in the traditional therapy

Table 1.1: Primary users and their needs

1.2 Goals of the system

- Develop empathetic behaviors
- Include socially correct spatial management
- Produce emotional reactions that make Teo 2 more emotionally natural than Teo1

1.3 Requirements of the system

1.3.1 Functional requirements

- The user has to be able to talk with Teo
- The system has to understand the user mood
- The system has to be empathetic towards the users
- The system has to provide user statistics

1.3.2 Non-functional requirements

- Short response time
- Unharming materials
- Adequate battery autonomy

Chapter 2

Chapter 2

2.1 Teo behaviours

2.1.1 Movement

- Moving
- Rotating

2.1.2 Non-verbal communication

- Face expression

2.1.3 Verbal communication

- Talking

2.1.4 Senses

- Hearing
- Distance measuring
- Touch

2.2 Spatial relatioship Model

2.2.1 Classification of the zones of interpersonal distance (Teo and child)

- Intimate zone: from 0 to 30 cm
- Personal zone: from 31 to 120 cm
- Social zone: from 121 to 365 cm

- Public zone: from 365 to ∞

2.2.2 Classification of the bodily position (child with respect to Teo)

- Front: 0°
- Diagonal: +/-30°, 45°, 60°
- Side: +/-90°
- Back: 180°

Chapter 3

Chapter 3

3.1 Games

3.1.1 Marco-Polo Game

3.1.1.1 Input

The therapist selects «Marco-Polo Game».

3.1.1.2 Goal

The goal of the game is to help the child to recognize spatial relations with Teo.

3.1.1.3 Rules

The child and Teo share sufficiently large space to move around.
The game starts with a 'blindfolded' Teo, which explains the child the dynamic of the game.
Teo prompts the kid to move away from him.
Anytime Teo needs help would ask 'Where are you, (name of the child)?' and the child must answer back 'Teo, here!'.

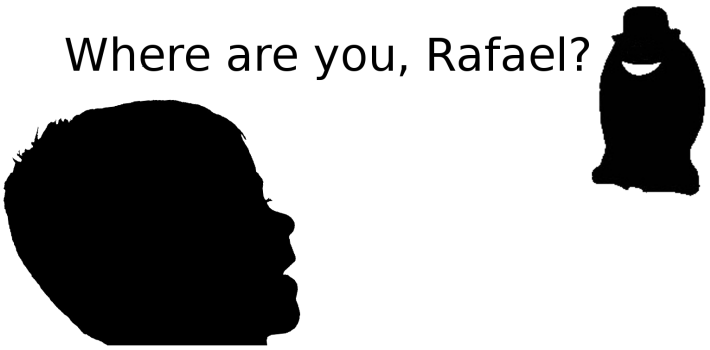

Figure 3.1: 1st step of Marco-Polo game

Teo will, then try to move towards the child.

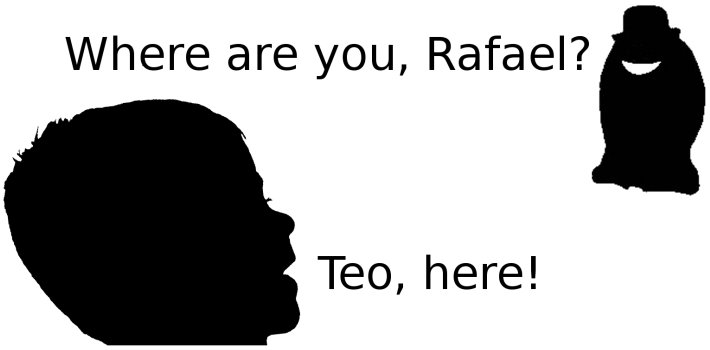

Figure 3.2: 2nd step of Marco-Polo game

If Teo is able to reach to the 'intimate region' with the kid for a moment, Teo wins and shows happiness congratulating the kid for helping him.

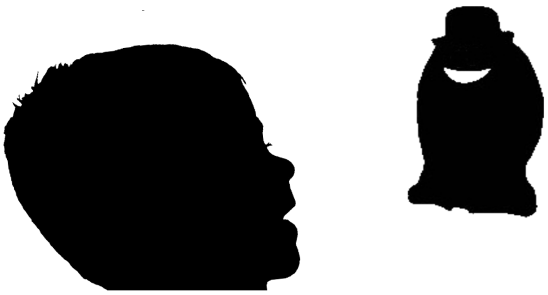

Figure 3.3: 3rd step of Marco-Polo game

Else, Teo keeps asking the kid for help and continues looking.

3.1.1.4 Conclusion of the game

The game ends when the child hugs Teo.

3.1.1.5 HW and SW requirements

Use:	Hardware:	Software:
Determine spatial orientation based upon the child's call	Microphones	Sound Localization
Verbal communication for the facilitator and rewarding roles	Speakers	Voice Synthesizer
Emotional rewarding	LED Matrix and strips	Emotional face generation
Measure the region of interaction between Teo and the child's	Distance/Motion sensors	Child's proximity and presence
To detect whether the child touch Teo to indicate he found him	Pressure sensors	Touch detection
Teo movement	Motors	Control

Table 3.1: HW and SW requirements of Marco-Polo game

3.1.1.6 Feasibility

- the accuracy of the microphones must be sufficient in order to locate the voice (0-90°, 91°-179°, 180°-269°, 270°-359° wrt to Teo)
- constraining the child to stay in a fixed spot until Teo finds him woud allow to complete the game, even though is not mandatory for the implementation

3.1.2 Guide Blind-Teo Game

3.1.2.1 Input

The therapist selects «Guide Blind-Teo Game».

3.1.2.2 Goal

The goal of the game is to help the child to associate the sequence presented to a spatial relation with the physical checkpoints.

3.1.2.3 Rules

The child and Teo share sufficiently large space to move around.
The game starts with a 'blindfolded' Teo, which explains the child the dynamic of the game.
A projector will show on the floor a sequence of images (checkpoints).
The child must move to the checkpoint and call 'Teo, here!' so Teo could start moving in his direction.

Figure 3.4: 1st step of Guide Blind-Teo game

Figure 3.5: 2nd step of Guide Blind-Teo game

Whenever Teo arrives to a correct checkpoint, congratulates the child happily and prompts him to keep doing a great job.
The game ends when Teo reaches the final checkpoint.

3.1.2.4 HW and SW requirements

Use:	Hardware:	Software:
Determine spatial orientation based upon the child's call	Microphones	Sound Localization
Determine if Teo arrives to the right checkpoint	Kinect/RFID tags	Spatial Localization/Checkpoint ID
Display the sequence of checkpoints for the child to follow	Display	User interface to display information
Verbal communication for the facilitator and rewarding roles	Speakers	Voice Synthesizer
Emotional rewarding	LED Matrix and strips	Emotional face generation
Measure the region of interaction between Teo and the child's	Distance/Motion sensors	Child's proximity and presence
Teo movement	Motors	Control

Table 3.2: HW and SW requirements of Guide Blind-Teo game

3.1.2.5 Feasibility

- this is an extension of the Marco-Polo game, so its implementation depends on the completion of the latter one
- it is necessary to install a RFID reader on Teo in order to recognize the checkpoints (the RFID tag will be dressed by the child)
- it is necessary to have a projector in the room

3.2 Interactions

3.2.1 Talk2Teo

3.2.1.1 Input

The therapist selects «Talk2Teo».

[optional]
The therapist can configure a joypad (which controls Teo) assigning an action to each button.

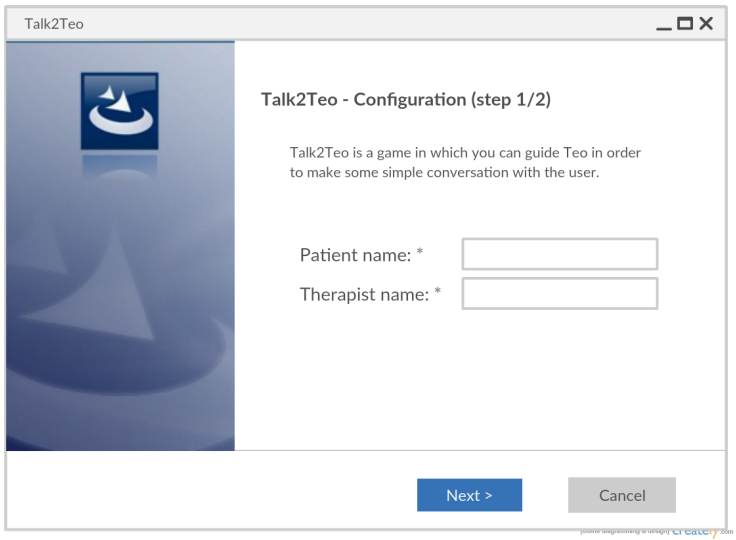

Figure 3.6: 1st step of Talk2Teo configuration phase

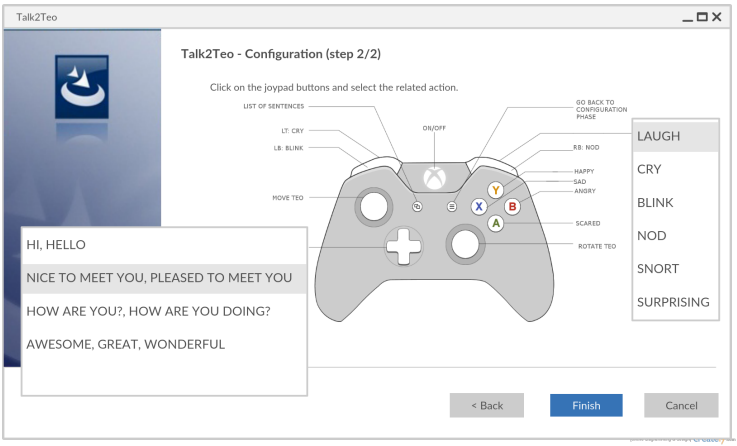

Figure 3.7: 2nd step of Talk2Teo configuration phase

In order to make things easy to use, there are the following presets of such configurations, so the therapist can choose what she prefers.

Default:	
Button:	Action:
X	Sad
Y	Happy
B	Scared
A	Angry
UP	“Hello”
DOWN	"Do you want to play?"
LEFT	«Great!»
RIGHT	“Well done”
ANALOG STICK 1	Move
ANALOG STICK 2	Rotate
LT	“Yes”, Nod
LB	Laugh
RT	“No”
RB	Cry
START	Reset to idle
SELECT	Unassigned

Table 3.3: Manual joypad actions - More Emotion preset

Greetings:	
Button:	Action:
X	Sad
Y	Happy
B	Scared
A	Angry
UP	“Hello I’m Teo!”
DOWN	"What’s your name?"
LEFT	“Nice to meet you!”
RIGHT	"Do you want to play?"
ANALOG STICK 1	Move
ANALOG STICK 2	Rotate
LT	“Yes”, Nod
LB	Laugh
RT	“No”
RB	Cry
START	Reset to idle
SELECT	Unassigned

Table 3.4: Manual joypad actions - More Emotion preset

More Emotions:	
Button:	Configuration:
X	Sad
Y	Happy
B	Scared
A	Angry
UP	Surprised
DOWN	Bored
LEFT	*Sigh*
RIGHT	*Gasp*
ANALOG STICK 1	Move
ANALOG STICK 2	Rotate
LT	"Yes", Nod
LB	Laugh
RT	"No"
RB	Cry
START	Reset to idle
SELECT	Unassigned

Table 3.5: Manual joypad actions - More Emotion preset

If she skips this configuration phase, then the default preset will be associated to the joypad.

3.2.1.2 Goal

Talking to the user showing empathetic behaviours.

3.2.1.3 Activities

The therapist controls Teo using a joypad, allowing a *free2play* approach.
The actions can be divided in manual and automatic ones (if both, the manual command have higher priority on an automatic reaction).

Manual:	**Automatic:**	**Action:**
x		Move/Rotate
x		Speak
x		Select mood (happy, sad, angry, scared)
x	x	Facial expressions (laugh, cry, ...)
	x	Non-linguistic utterances (yeah, ok, uh huh, mhmm)
	x	Follow (keep eye contact)

Table 3.6: Manual and automatic Talk2Teo actions

3.2.1.4 HW and SW requirements

Command:	Hardware:	Software:
Move/Rotate	Motors	Control
Speak	Speakers	Voice Synthesizer
Select mood (happy, sad, angry, scared)	LED Matrix and strips	Emotional face generation
Facial expressions (laugh, cry, ...)	LED Matrix and strips, speakers	Emotional face generation, voice synthesizer
Non-linguistic utterances (yeah, ok, uh huh, mhmm)	LED Matrix and strips, speakers	Emotional face generation, voice synthesizer
Follow (keep eye contact)	Distance/Motion sensors, RFID tags, motors	Control

Table 3.7: HW and SW requirements of Talk2Teo

3.2.1.5 Feasibility

- the automatic actions are more complex with respect to the manual ones, so they will be implemented in case there will be enough time

Chapter 4

Chapter 4

4.1 Hardware tasks

Component:	Task:	Priority:
Sensors	Place PIRs inside Teo	HIGH
Motors	Check batteries and cables	HIGH
Microphones	Test	MEDIUM
	Place mics inside Teo	MEDIUM
VR Shield	Test	LOW
FSR	Test	LOW
	Create rigid allocation for FSR stripes	LOW
RFID	Place RFID reader inside Teo	LOW
	Test	LOW

Table 4.1: Hardware tasks

4.2 Software tasks

Component:	Task:	Priority:
Sensors	Zone detection	HIGH
	Movement detection	HIGH
	Zone detection	HIGH
	Position detection	HIGH
Led stripes and matrix	Faces and emotions	HIGH
Motors	Library testing	HIGH
Microphones	Audio level	MEDIUM
	Position detection	MEDIUM
FSR	Touch detection	MEDIUM
Bluetooth	PC-Arduino	HIGH
	PC-Speaker	HIGH
	PC-Xbox controller	HIGH
Control application	Place RFID reader inside Teo	HIGH
	Test	LOW

Table 4.2: Hardware tasks