Friedrich-Alexander-Universität

FAU

Advance Business Analytics Seminar - WiSe 2023/24

Evaluating Patient Trust and Acceptance of 'Furhat' in Emergency Room Settings – a lab experiment with a social robot

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Agenda

Introduction

Need for social robots

- Potential solution to increasing labour shortage
- Our use case: Social robots in an emergency room

Objectives

- Identify the factors that contribute to patients either accepting or resisting the 'Furhat'
- Quantify the level of trust and acceptance

Description of process

- Literature review, Design of conversation, Questionnaire, Methodology of analysis, Results

Literature Review

Process

01

Tools

- https://www.connectedpapers.com/
- https://www.researchrabbit.ai
- https://chat.openai.com/

02

Keywords used

"Social robots", "Healthcare", "Trust in social robots", "Social robot in Emergency", "Methods of trust", "Factors affecting trust in (social) robots"

03

Databases

- IEEE
- PubMed
- Science Direct
- Research Gate etc.

04

Selection Process

- Title Screening
- Abstract Review
- Relevance to use case

05

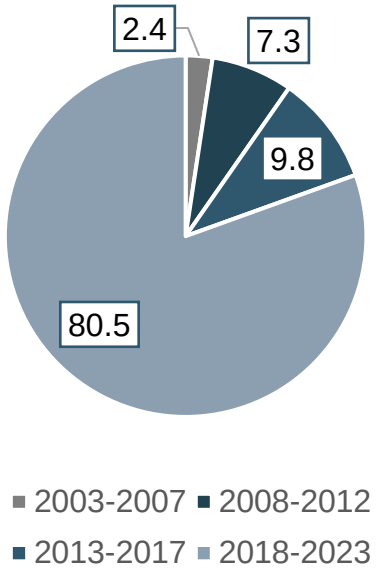
Starting point

41 papers were selected

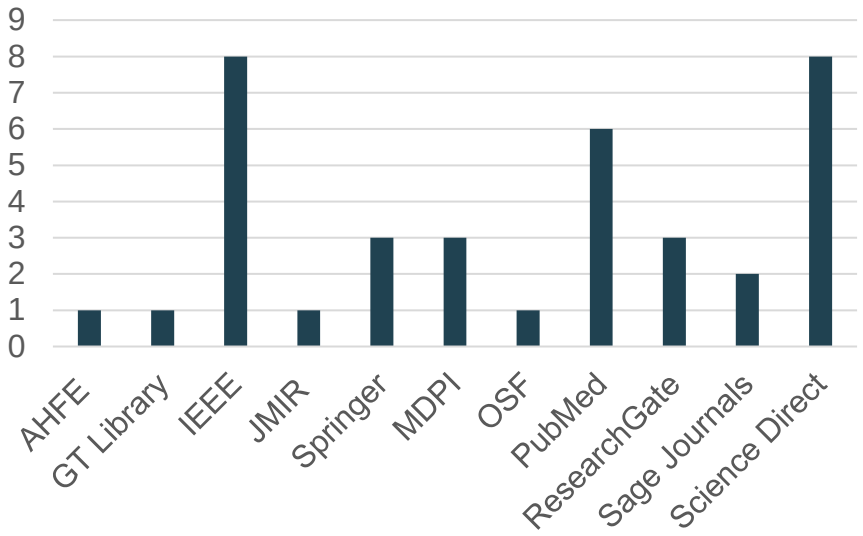
Literature Review

Visualizations

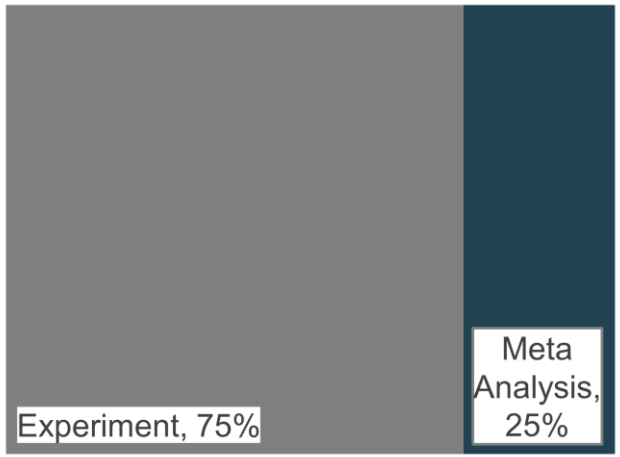
Pie chart representing papers reviewed by year of publication



Bar chart representing papers reviewed by source



Treemap representing percent of papers reviewed according to type of paper



- Most of the papers reviewed were recently published
- A large collection of papers reviewed where from IEEE or ScienceDirect
- Almost 75% of the paper covered were experiment based

Literature Review

Theory model

Based on the literature review results, the below models would be relevant for our experiment

UTAUT	TAM	Other
• ANX • ATT • FC • SI	• PEOU • PU • PENJ	• Trust • ITU • SP • PS • PAD

Literature Review

Models used - Code explanation

The below corresponding codes have been taken into consideration for our experiment.

Code	Construct	Definition
ANX	Anxiety	Evoking anxious or emotional reactions when using the system.
ATT	Attitude	Positive or negative feelings about the appliance of the technology.
FC	Facilitating conditions	Objective are factors in the environment that facilitate using the system.
ITU	Intention to use	The outspoken intention to use the system over a longer period in time.
PAD	Perceived adaptability	The perceived ability of the system to be adaptive to the changing needs of the user.
PEOU	Perceived ease of use	The degree to which the user believes that using the system would be free of effort
PS	Perceived sociability	The perceived ability of the system to perform sociable behavior.
PU	Perceived usefulness	The degree to which a person believes that using the system would enhance his or her daily activities
Trust	Trust	The belief that the system performs with personal integrity and reliability.

Factors Affecting Trust In Our Use case

An overview of factors in relation to their effect on trust

Construct	Factors	Relation to trust
PU	Errors in the context	Increase in error decreases trust
ATT	Cognitive/affective attitudes	Emotional appeal on affective attitudes, increases trust. Emotional appeal on cognitive attitudes, decreases trust.
Trust	Privacy disclosure	Increases in privacy disclosure increases trust
PS	Social skills , Anthropomorphic features, Human Likeliness, Stating Apology	Increase in social skills increases trust
ITU	Interest in using Social Robot	Increase in interest leads to increase in trust
PAD	Degree of decision-making power, Sense of control, Autonomy and Cooperativeness	Higher autonomy results in higher trust
PEOU	Comfort, familiarity with different technologies	Increase in comfort, familiarity with different technologies increases trust
ANX	Psychophysical reaction	Decrease in psychophysical reaction increases trust
FC	Social Navigation	Increase in social Navigation increases trust

Experiment

Scenario considered

The patient fell down the stairs and their hand is in pain. Furhat will be there to support them and take down their basic information.

Designing Conversation

Two versions of scripts have been designed for the same scenario and have been fed to both Furhats via the SDK

Conducting experiments

Each person will talk to both robots with the given script

Filling Questionnaire

After conversing with the robots, the questionnaire is filled for both versions of conversation

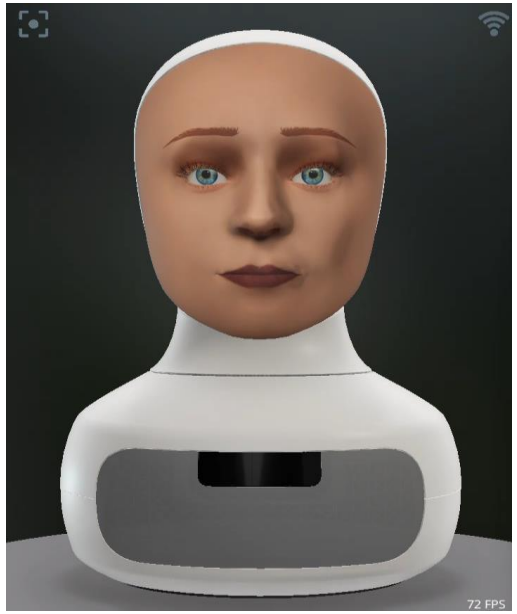
Functions of the robot:

1. Cannot give information about health status
2. Cannot assist physically
3. Cannot prescribe medications
4. Can have a social presence - friendly, supportive
5. Can inform the doctors, attendants
6. Can collect patient information with disclosure

Experiment

Comparison

	Humanoid	Robotic
Gestures	“smile”, “sad”, “nod”, “oh”	No gestures
Voice	Joanna	Matthew
Total length of conversation	257 words	108 words

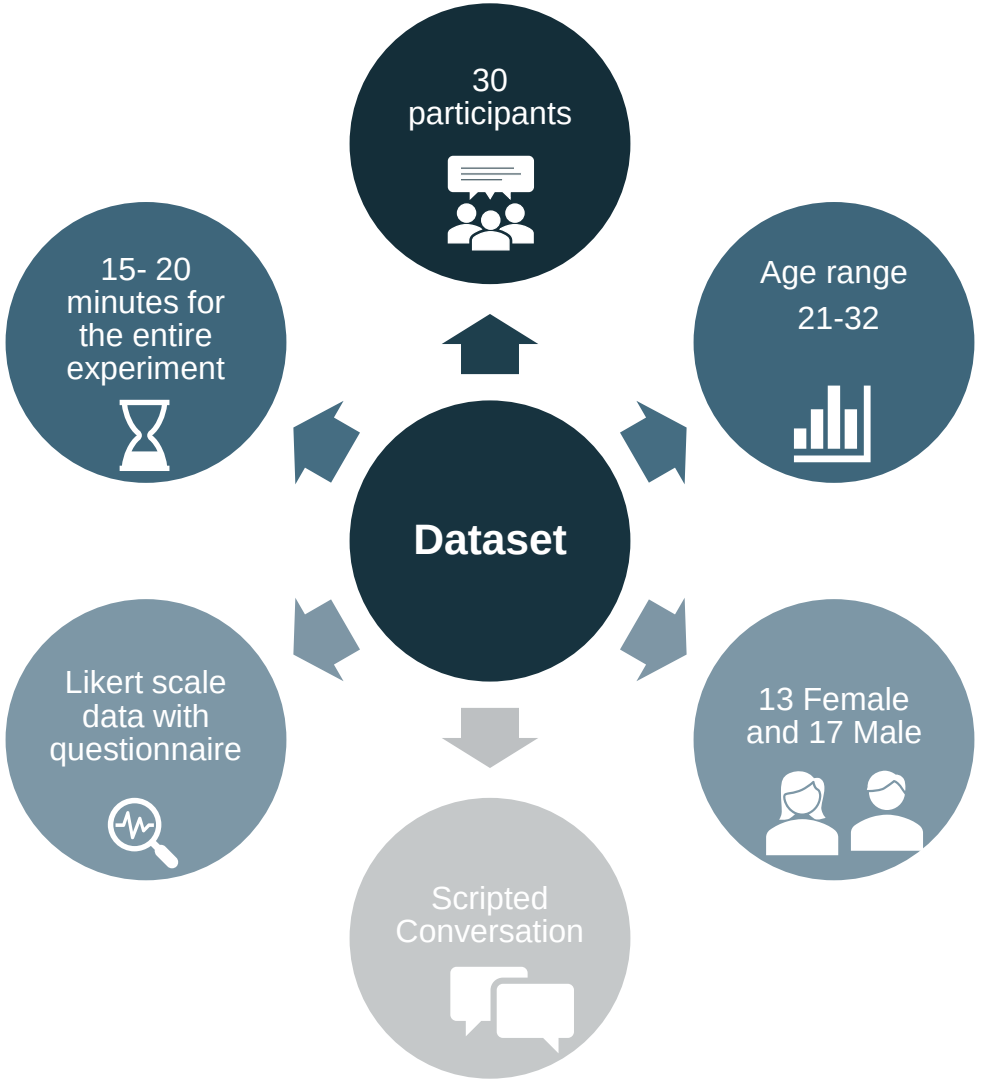


Video of Humanoid Furhat talking

Video of Robotic Furhat talking

Experiment

Dataset



Experiment

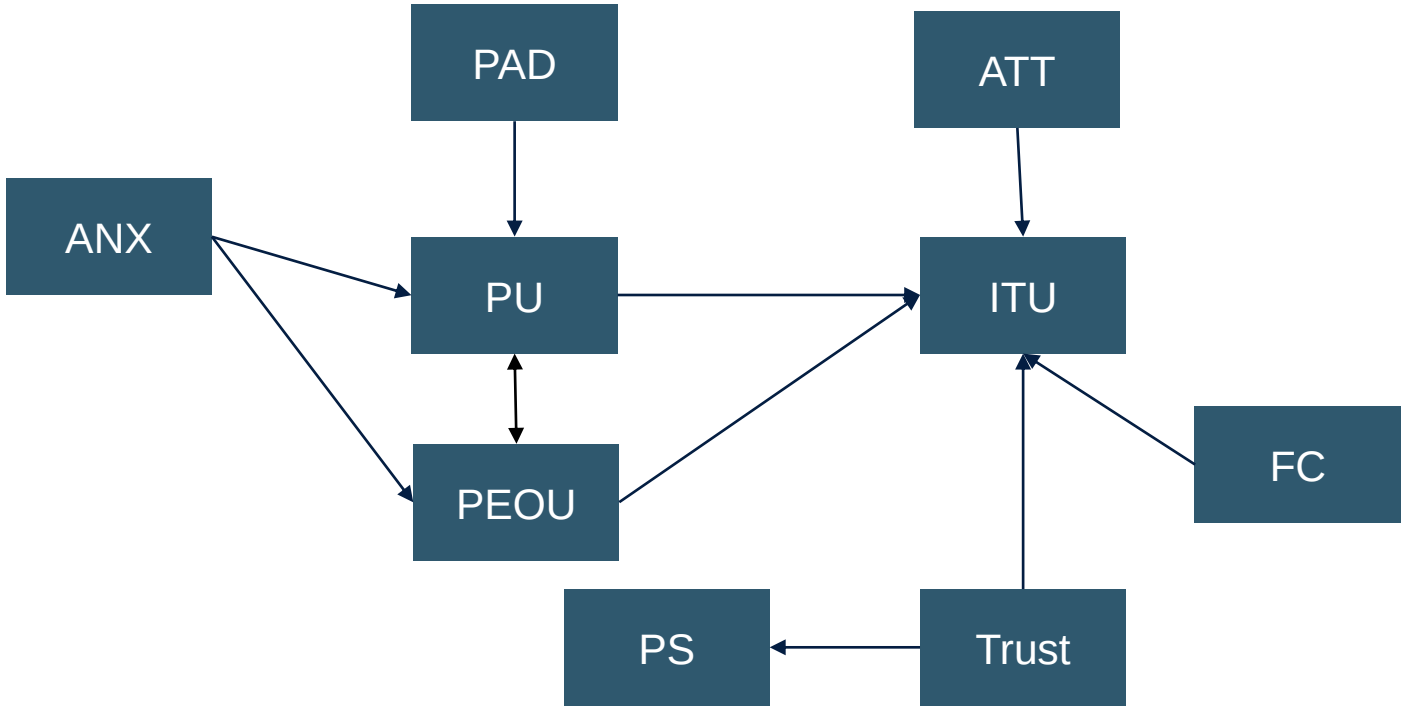
Questionnaire

Perceived Adaptability	I think the robot will only do what I need
	I think the robot can be adaptive to what I need at that particular moment
Perceived Usefulness	I think the robot can help me with many things
	I think the robot completed the task successfully
Perceived Sociability	I feel the robot is friendly
	I feel the robot understands me
Perceived Ease Of Use	I find the robot easy to use
	I think I can use the robot when I have a good manual
Facilitating Conditions	I did not have any external challenges in using the robot
	I know enough of the robot to make good use of it
Trust	I am comfortable giving my personal details to the robot
	I would trust the robot if it gave me advice
Intention To Use	I think I'll use the robot again, if I get a chance
Anxiety	I am not afraid to use the robot
Attitude	I feel the robot would make my life more interesting

Experiment

Hypotheses

- H1: Intention to Use is influenced by Perceived Usefulness, Perceived Ease of Use, Attitude ,Trust and Facilitating Conditions
- H2: Perceived Usefulness is influenced by Perceived Ease of Use, Perceived Adaptability and Anxiety
- H3: Perceived Ease of Use is influenced by Anxiety and Perceived Usefulness
- H4: Perceived Sociability is influenced by Trust



Results

Descriptive Statistics: Measures of central tendency, Max, Min

Likert scale answers were considered as **interval type data.** Subsequently, measures of central tendency and other descriptive statistics were calculated (1 - Strongly Disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly Agree)

Table showing calculated values of minimum, maximum, mean and standard deviation from results of Humanoid Furhat experiment

Humanoid Furhat				
Construct	*Min*	*Max*	*Mean*	*Std Dev*
ANX	2	5	4.067	0.69
ATT	2	5	3.67	0.88
FC	2.5	5	3.8	0.7
ITU	2	5	4	0.95
PAD	2	5	3.43	0.73
PEOU	2.5	5	4.02	0.88
PS	1,5	5	4.07	0.81
PU	2	5	3.87	0.73
Trust	1	5	3.3	0.92

Table showing calculated values of minimum, maximum, mean and standard deviation from results of Robotic Furhat experiment

Robotic Furhat				
Construct	*Min*	*Max*	*Mean*	*Std dev*
ANX	2	5	4.43	0.82
ATT	1	5	3.27	1.17
FC	2	5	3.75	0.80
ITU	2	5	3.80	1.03
PAD	2	5	3.32	0.83
PEOU	2.5	5	3.92	0.66
PS	1.5	5	3.38	1.03
PU	2	5	3.68	0.83
Trust	1	5	3.13	0.98

Results

Correlation Analysis

Testing hypotheses with correlation quantifies the degree and strength of the constructs within each hypothesis. Here, we use Pearson's Correlation coefficient and the two tailed t-test to reject or accept our hypotheses.

Humanoid Furhat				
Hypothesis	*Independent Variable*	*Dependent variable*	*Pearson*	*Sig(2 tailed)*
H1	PU	ITU	0.55	0.001
	PEOU		0.40	0.024
	ATT		0.78	0.0000003
	Trust		0.53	0.004
	FC		0.49	0.005
H2	PEOU	PU	0.48	0.007
	PAD		0.69	0.00005
	ANX		0.22	**0.23**
H3	ANX	PEOU	0.10	0.59
	PU		0.48	0.006
H4	Trust	PS	0.30	0.11

Inferences

- In Humanoid Furhat, all relationships between constructs within Hypothesis 1 and most relationships within Hypothesis 2 can be confirmed with correlation scores
- In Hypothesis 2, Anxiety determining Perceived Usefulness is not significant.

Results

Correlation Analysis

Robotic Furhat				
Hypothesis	Independent Variable	Dependent variable	Pearson	Sig(2 tailed)
H1	PU	ITU	0.75	0.33
	PEOU		0.59	0.45
	ATT		0.62	0.05
	Trust		0.55	0.0006
	FC		0.71	0.71
H2	PEOU	PU	0.56	**0.08**
	PAD		0.68	0.009
	ANX		0.06	0.0001
H3	ANX	PEOU	0.23	0.004
	PU		0.56	**0.07**
H4	Trust	PS	0.57	0.15

Inferences

- In Robotic Furhat, most relationships between constructs within Hypothesis 2 and Hypothesis 3 can be confirmed with correlation scores.
- In Hypothesis 2, PEOU determining PU is not significant and in Hypothesis 3, PU determining PEOU is not significant.

Results

Regression Analysis

The following tables show the regression coefficients associated with the dependent and independent variables as part of the hypotheses. A higher R squared value explains how well the model fits the data, combined with values suggesting significance of these coefficients (two tailed t-test).

Humanoid Furhat					
Hypothesis	*Independent Variable*	*Dependent Variable*	*Coefficients*	*sig(2 tailed)*	*R squared error*
H1	PU	ITU	0.09	0.60	**0.98**
	PEOU		0.08	0.86	
	ATT		0.62	0.0001	
	Trust		0.24	0.06	
	FC		0.17	0.34	
H2	PEOU	PU	0.31	0.01	**0.99**
	PAD		0.57	0.00005	
	ANX		0.16	**0.141**	
H3	ANX	PEOU	0.29	2.008	**0.97**
	PU		0.72	4.71	
H4	Trust	PS	1.16	8.8587E-18	**0.92**

Inferences

- In Humanoid Furhat, regression results confirm only part of the hypothesis H2 and completely for H4.
- ATT determining ITU has the highest coefficient (0.62), and we could attribute this to the humanoid robot having more anthropomorphic features, gestures and longer statements.
- Under the second hypothesis, PAD determining PU also carries a high coefficient, implying that the adaptability of the robot has a strong influence on its usefulness.

Results

Regression Analysis

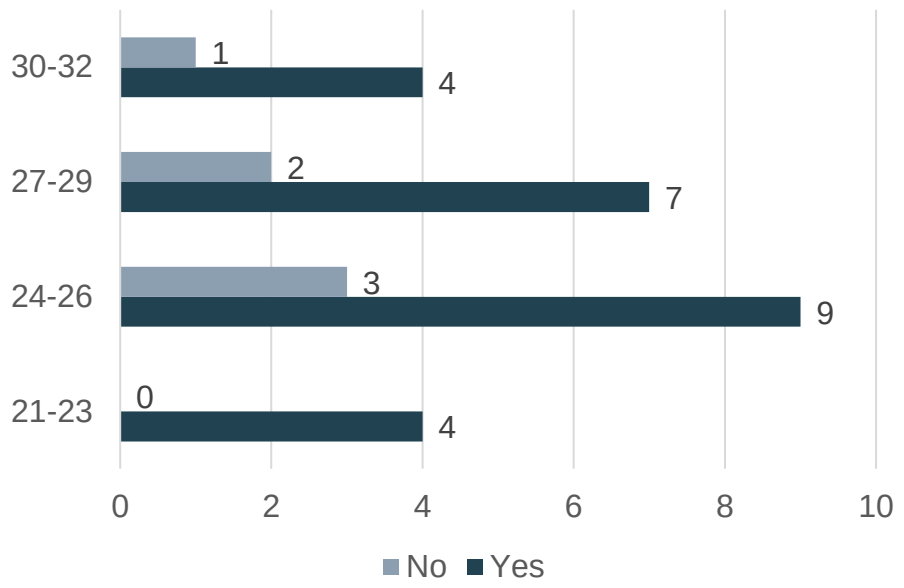
Robotic Furhat					
Hypothesis	*Independent Variable*	*Dependent Variable*	*Coefficients*	*sig(2 tailed)*	*R squared error*
H1	PU	ITU	0.38	0.041	**0.77**
	PEOU		0.17	0.40	
	ATT		0.22	0.05	
	Trust		0.28	0.02	
	FC		0.3	0.11	
H2	PEOU	PU	0.45	0.02	**0.53**
	PAD		0.38	0.001	
	ANX		0.034	**0.81**	
H3	ANX	PEOU	0.15	0.21	**0.35**
	PU		0.43	0.0001	
H4	Trust	PS	0.59	0.001	**0.33**

Inferences

- In Robotic Furhat, regression results confirm only part of the hypothesis H2 and completely for H4.
- PEOU determining PU has the highest coefficient under Hypothesis 2. This means that ease of use is an important factor to consider in usefulness.

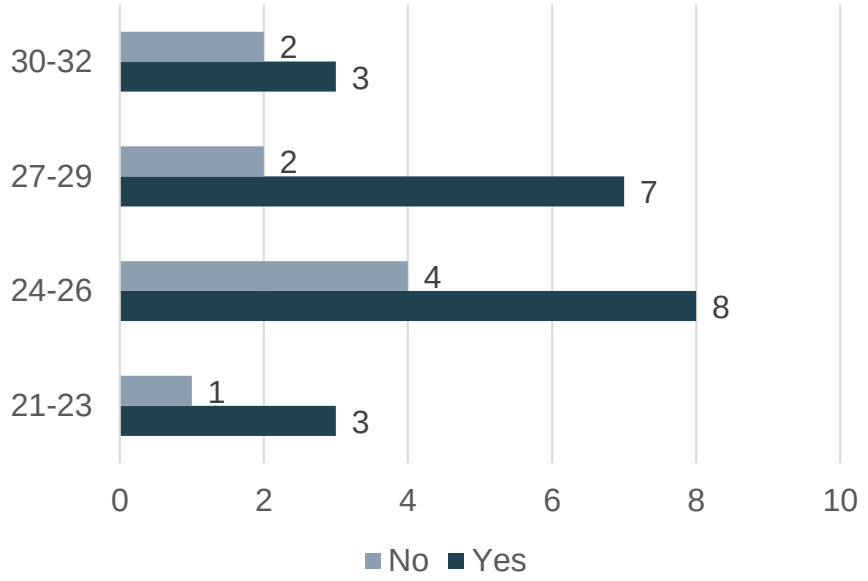
Results

Bar chart representing decision of using Furhat in the emergency room for different age groups (humanoid)



#No = 6, #Yes = 24

Bar chart representing decision of using Furhat in the emergency room for different age groups (robotic)



#No = 9, #Yes = 21

Conclusions

1. 70% of respondents showed interest in using Robotic Furhat in the emergency room as compared to 80% for the Humanoid Furhat. This indicates higher “acceptance” of Humanoid Furhat.
2. Perceived Sociability has the highest difference in mean values of Robotic Furhat and Humanoid Furhat.
3. R squared values under Regression analysis are higher for the Humanoid Furhat as compared to the Robotic Furhat.
4. PU is one of the least influencing factors on ITU for the Humanoid Furhat, while it is the highest influencing factor on ITU for the Robotic Furhat.

Areas For Further Improvement

Scripted conversations for a specific use case in the ER	Ability to adapt according to users needs Longitudinal Studies Additional use cases
Small sample size and fixed user group	Diversity in participant demographics - age, gender, cultural background, and technological familiarity to enhance generalization
Trained only in English	Train in other languages to explore potential cultural or linguistic differences in human-robot interactions
Virtual robot, lack of physical presence	Employ the physical version to amplify social presence, anthropomorphic features and usability in the real world scenario

References

1. https://ieeexplore.ieee.org/document/5326320
2. Literature Review
3. https://docs.furhat.io/
4. GitHub Repository - Robotic Experiment, Humanoid Experiment
5. Tools- connected Paper, Research Rabit, Open AI

Thank you!