Tangible Virtual Humans:
Meet Your New Role-players

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Larger ONR Project Team

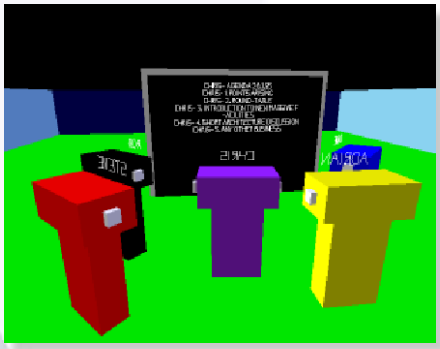
(Project: "3D Display and Capture of Humans for Live-Virtual Training")

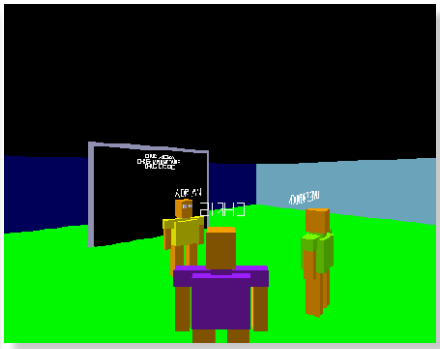
- **University of Central Florida** (IST & CS)
  - Dr. Greg Welch (Project PI)
  - Dr. Charlie Hughes (Co-PI)
  - Dr. Nagendran, Dr. Tappen, Dr. Pattanaik, students
- **Naval Postgraduate School** (MOVES)
  - Dr. Amela Sadagic (Co-PI)
  - MOVES Visualization team
  - Charles Kinzer, Noah Lloyd-Edelman, student interns
- **University of North Carolina at Chapel Hill** (CS)
  - Dr. Henry Fuchs (Co-PI)
  - (Dr. Greg Welch, PI)
  - Dr. Ilie, Andrei State, students

Outline

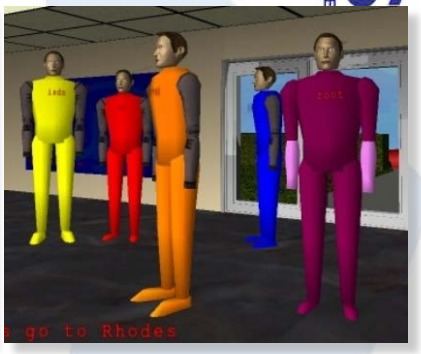
- Why Do We Need Virtual Humans?
- Different Display Technologies
- Research Questions
- Past and Current Studies
- Student Thesis Opportunities
- Upcoming Studies
- Q & A

A Quest for More Realistic Virtual Humans





MASSIVE, early & mid 1990s



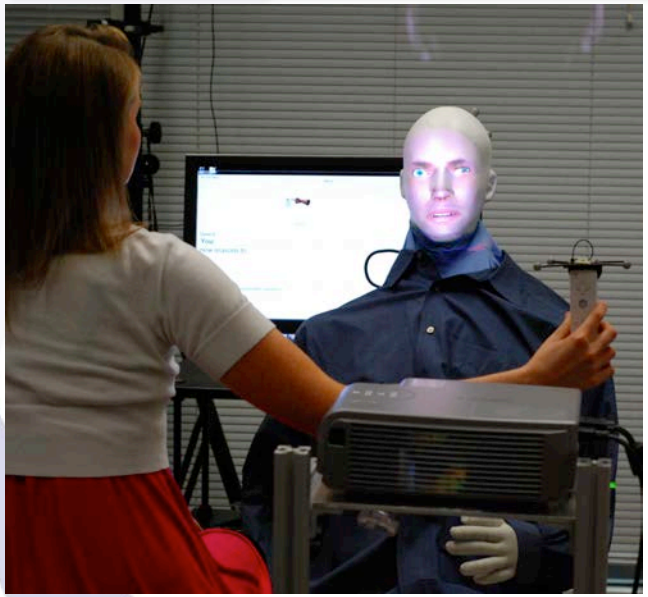
DIVE, late 1990s

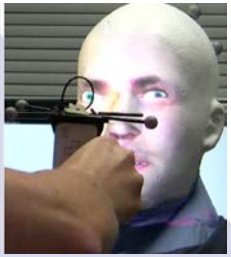
National Tele-immersion Initiative, 1997-2000

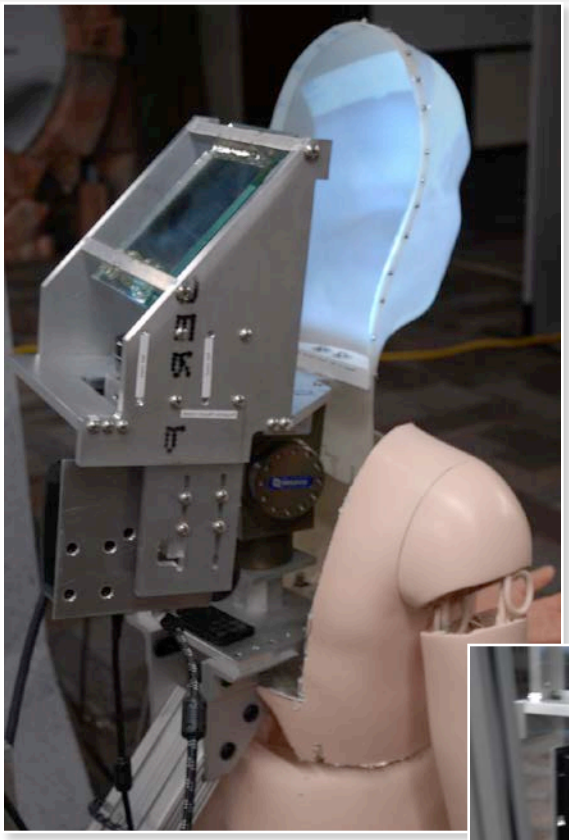
BASE-IT, 2008-2011

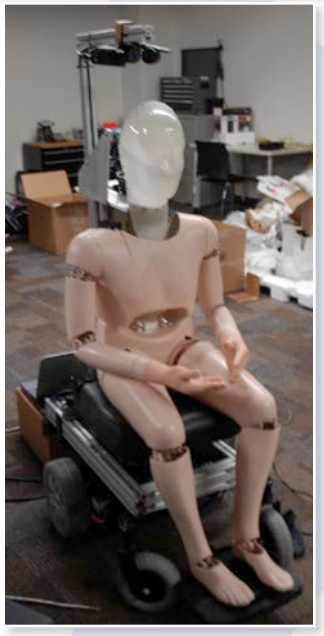
Tangible Virtual Humans, 2010 - 2012

Projective Displays: Rear Projection Head







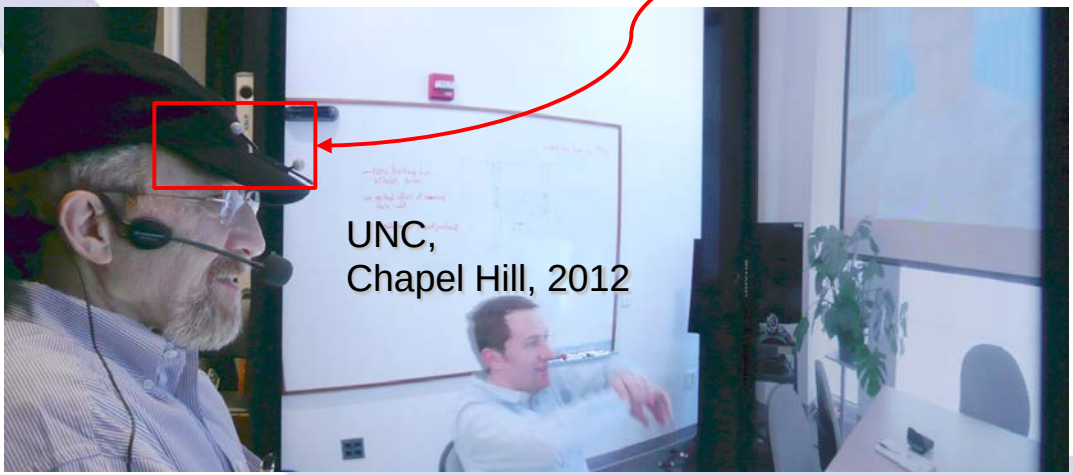


Performing ophthalmic exam on a **Physical-Virtual Patient**

UCF: Greg Welch (PI) and Juan Cendan
UF: Benjamin Lok and Diego Rivera-Gutierrez
UNC-Chapel Hill: M. Whitton Dr. D. A. Chesnutt, Prof. H. Fuchs, P. Lincoln, R. Skarbez

Projective Displays: Shader-Lamp Approach

In these demonstrations, the inhabiter is encumbered only by a head tracker



Animatronic Characters

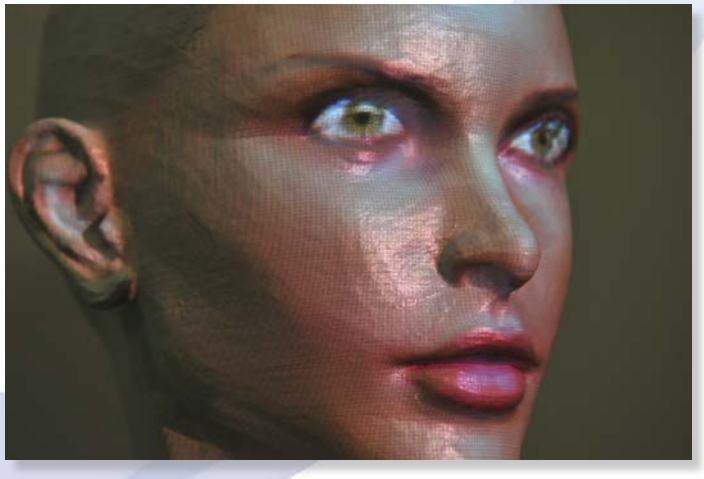
2D ‘Flat’ Projections In Military Training






A Problem Domain

- **Trends observed in IIT**:
  - Physical world has a priority. ‘Images’ on the wall get less attention
  - Extremely difficult to recognizing where a virtual human projected on the wall is looking
- **Research Questions:**
  - Is 3D virtual human more effective than 2D virtual human?
  - Are 3D virtual humans (physical-virtual) acceptable replacement for the real humans?



Static & Dynamic Events

Specific issues:

- Determine ability of human visual perceptual system in evaluating eye-gaze direction for all conditions
- Subjective responses: how realistic, confortable, easy to guess, task accord, feeling ‘together’ with vir. hum.

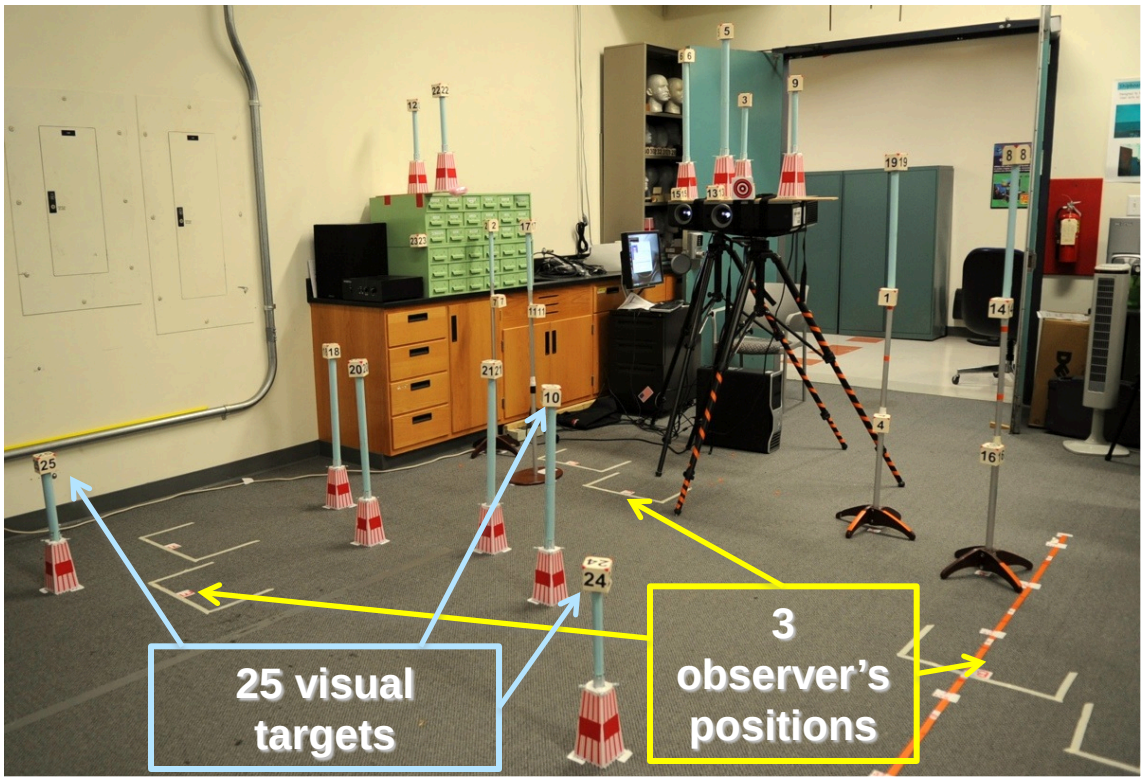
Study of Static Events:

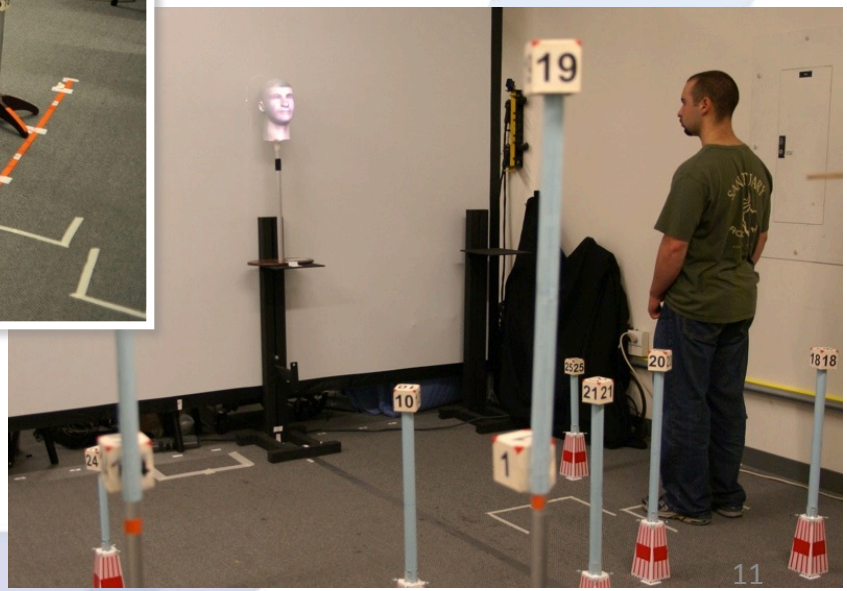
- Single 5 sec long eye-gaze event

Study of Dynamic Events:

- A simple eye-gazing scenario with 2 or 3 ‘connected’ static events (the eye transitions smoothly from one direction to the other one)

Front & Back View





Experimental Design

- # of subjects (within-subjects design): 42
- # of conditions: 3 (2D, 3D shared-lamp, human - HA)
- # of positions for each condition: 3
- # of gaze estimates from one position: 15 (12 + 3 replications)
- # of real targets & simulated positions: 22
- # of target decoys: 3
- # of visual targets evaluated in each condition in Static Events: 1890
- # of visual targets evaluated in each condition in Dynamic Events: 588

Static Events: Number of Exact Matches

Condition:	2D	3D	HA
Total Observations[1]	1890	1890	1890
Number Exact Matches, 1st Guess Only	176	446	944
Percent Exact Matches, 1st Guess Only	9.3%	23.6%	49.9%
Ratio	**1**	**2.5**	**5.4**
Number Exact Matches, 2nd Guess Only	20	62	44
Percent Exact Matches, 2nd Guess Only	1.1%	3.3%	2.3%
Number Exact Matches, 1st or 2nd Guess	196	508	988
Percent Exact Matches, 1st or 2nd Guess	10.4%	25.4%	52.3%
Ratio	**1**	**2.6**	**5**

[1]Observers x Targets x Observer Positions = 378 x 15 x 3 = 1890

Static Events: Average Yaw Angle by Condition

- All measures are in degrees

Condition:	2D	3D	HA
Total Observations[1]	1890	1890	1890
Average Yaw Error 1st Guess Only	12.77	7.52	3.52
Ratio	**3.6**	**2.1**	**1**
StDev Yaw Error 1st Guess Only	4.80	4.45	2.21
Average Yaw Error 2nd Guess Only	8.32	5.47	6.16
StDev Yaw Error 2nd Guess Only	5.21	3.65	5.88
Average Yaw Error 1st and 2nd Guess	12.67	7.47	3.63
StDev Yaw Error 1st and 2nd Guess	4.76	4.44	2.28

Second guess (which occurs 10% of the time) has negligible effect on Yaw error estimates.

Static Events: Average Pitch Angle by Condition

- All measures are in degrees

Condition:	2D	3D	HA
Total Observations[1]	1890	1890	1890
Average Pitch Error 1st Guess Only	9.84	6.54	2.82
Ratio	**3.5**	**2.3**	**1**
StDev Pitch Error 1st Guess Only	4.07	3.32	2.09
Average Pitch Error 2nd Guess Only	6.39	4.60	3.90
StDev Pitch Error 2nd Guess Only	4.91	3.91	5.14
Average Pitch Error 1st and 2nd Guess	9.78	6.50	2.84
StDev Pitch Error 1st and 2nd Guess	4.11	3.39	2.06

Static Events: Subjective Data

Condition:	2D	3D	HA
Feeling comfortable during the session	5.857	5.714	6.095
Realism of the representation	4.381	5.262	n/a
How easy was to guess visual targets?	3.381	3.786	4.786
How successful they thought they were?	3.405	3.738	4.714
Feeling as if individual is together with them?	2.976	3.810	5.5
Feeling as those were computer generated images or a real person	3.452	4.262	6.4
Feeling as if observed	2.667	3.762	4.452

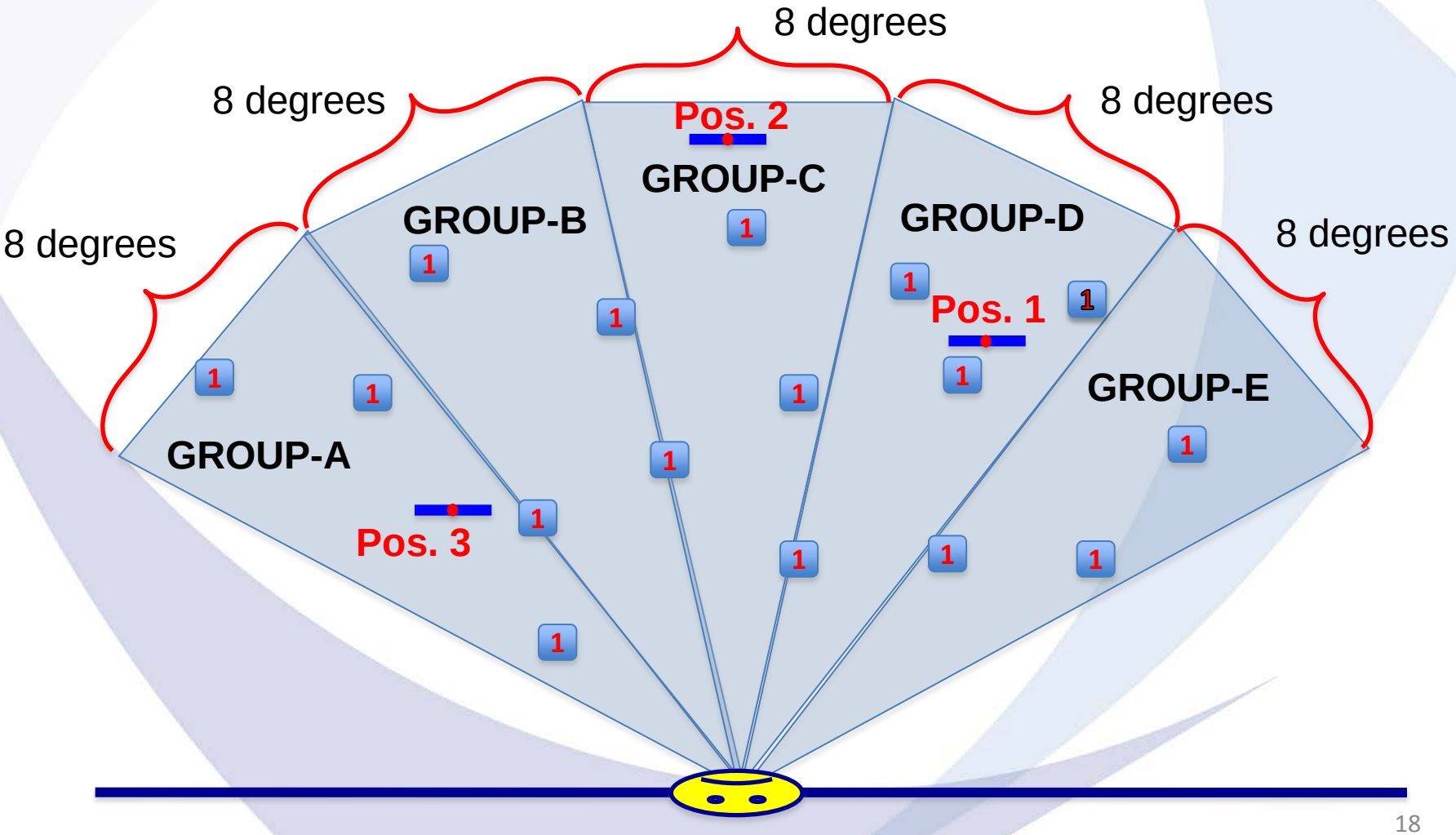
All average values, Linkert scale 1-7 (1 = lowest, 7 = highest)

Social Avoidance and Distress (**SAD test**): found no correlation with the results

Static Events: Conclusions

- Highly **significant improvement** in observer judgment regarding eye gaze direction for the **3D condition over the 2D condition** and for the HA condition over the 3D condition.
- A rough rule of thumb: **2x** improvement of 3D over 2D, and a **2x** improvement of HA over 3D.
- Except for issues regarding the spatial distribution of targets, there does not appear to be any significant biases in the experiment.
- None of the demographic factors (e.g. sex, eye height, age, eye glass usage) and observer positions showed any significant effects on observer performance.

Static Events:
"Mona Lisa is Always Looking at You"



Static Events:
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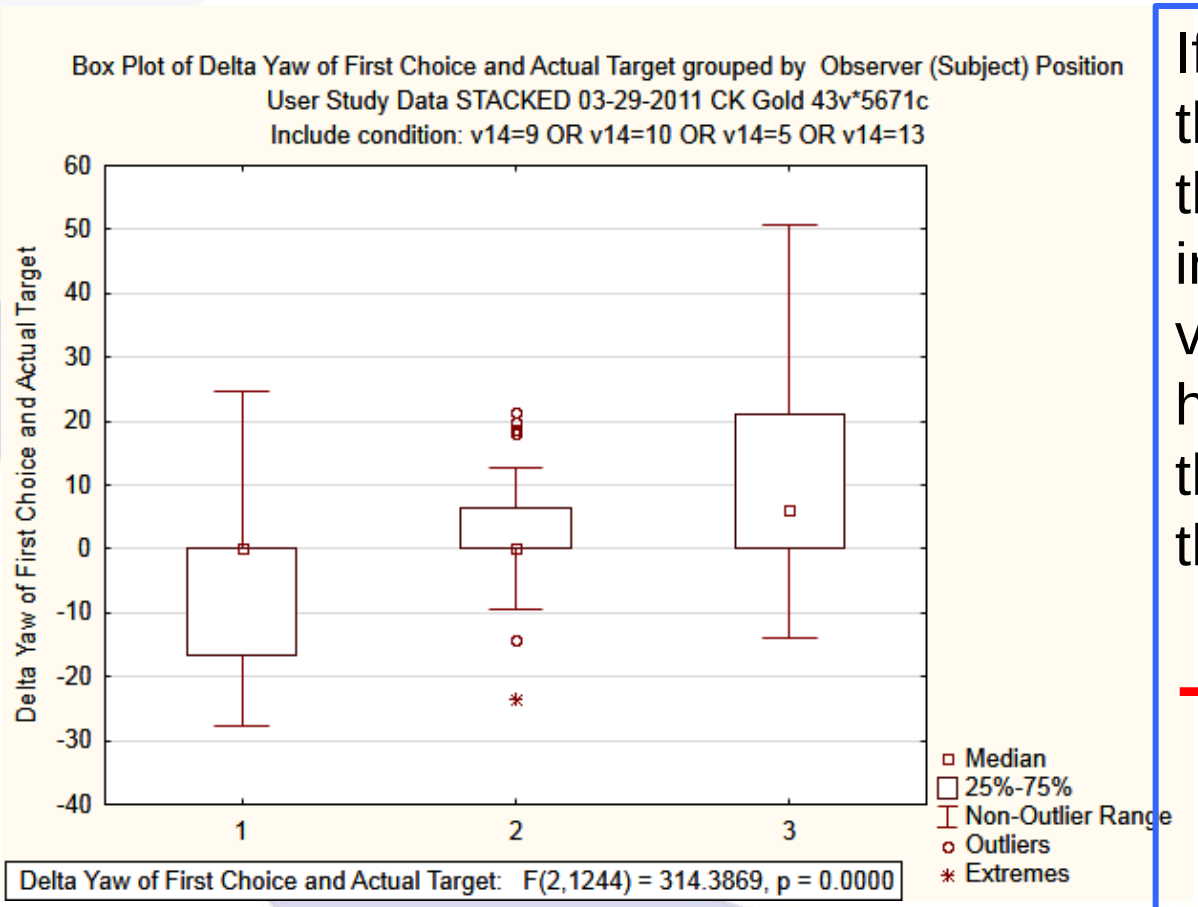


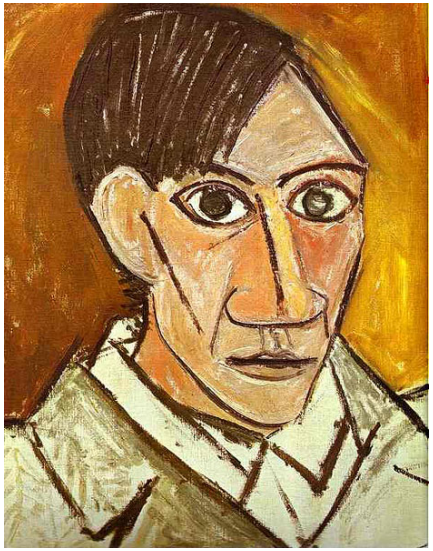
If the iris is in or around the center of the eyes, the observer has impression as if 2D virtual human looks at him/her regardless of the position from which the image is observed.

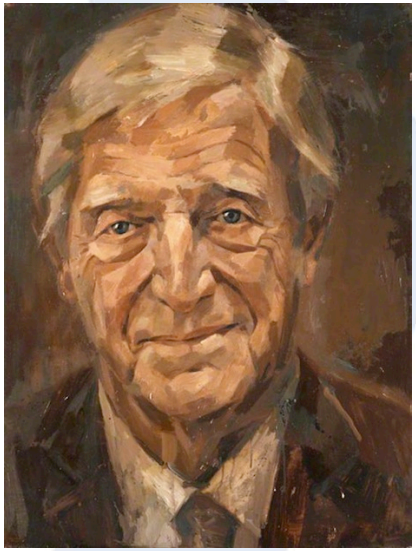
→ 1st time it has been proven and quantified in an empirical study!

Connecting Results with Realistic Training Scenario

= Asking the Marines to conduct an impossible task (as far as the capabilities of human visual perceptual system are concerned)

Connecting Results with Civilian Domain



→ Great painters did not have a special technique when they made the portraits whose eyes always 'followed' you – they simply (perhaps unknowingly) exploited inability of human visual perceptual system to discern eye-gaze direction from the 'flat' images.

Apologies to all big portrait artists… but your work is still remarkable!

Possible cause of phenomena: A lack of binocular depth cues

Dynamic Events: Number of Exact Matches

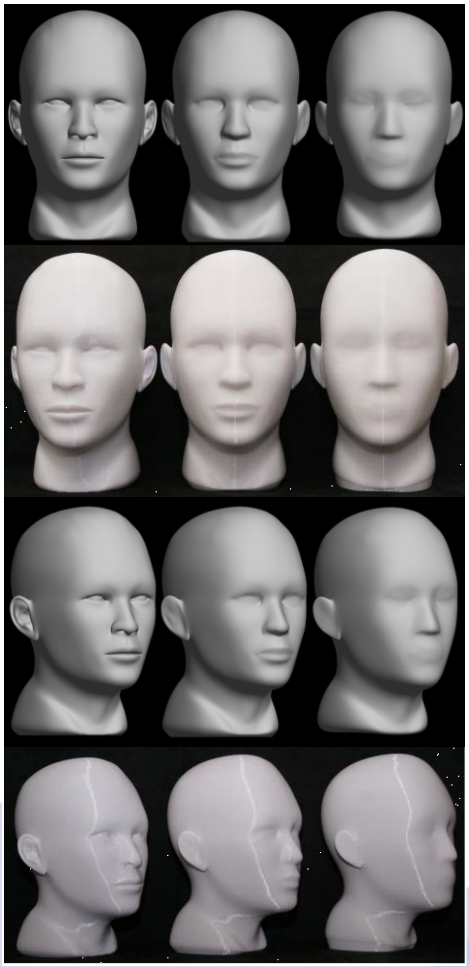
Condition:	2D	3D	HA
Total Observations Reported	559	566	573
Number of Exact Matches	101	124	279
Percent of Exact Matches	18.1 %	21.9 %	48.7 %
Ratio	**1**	**1.2**	**2.7**
Comparison with results in Static Events			
Total Observations	1890	1890	1890
Number Exact Matches, 1st Guess Only	176	446	944
Percent Exact Matches, 1st Guess Only	9.3 %	23.6 %	49.9 %
Ratio	**1**	**2.5**	**5.4**

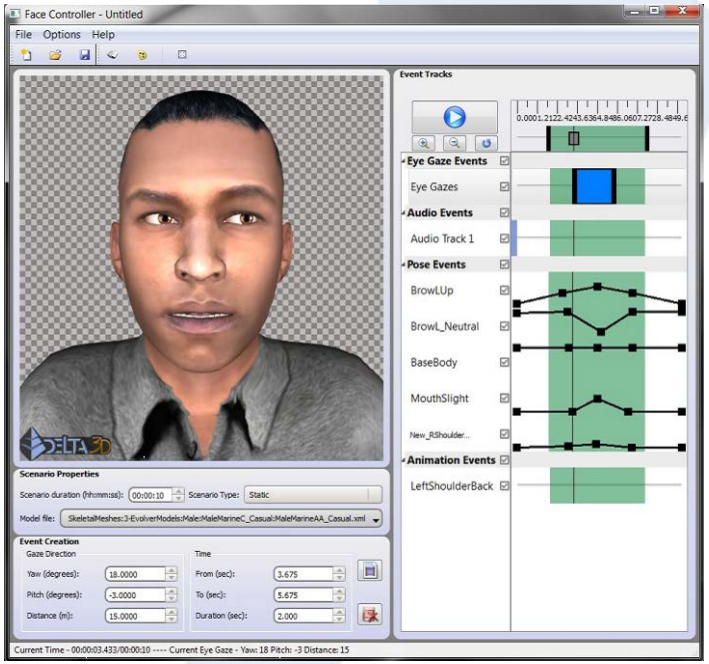
Dynamic Events: Conclusions

- Dynamic tests show exact match results which are very similar to static tests except 2D dynamic is considerably better than 2D static
  - One hypothesis: connected events (a scenario = better context) may have positively influenced subjects' performance.
- When portion reported OUT is used as metric 3D performance over 2D was almost a factor of 2
  - Shows a significant performance gain of 3D over 2D in the dynamic experiments.

Upcoming Studies

- Studies that introduce audio, animation of human face with micro-shifts of the head musculature (multi-posture mannequin)



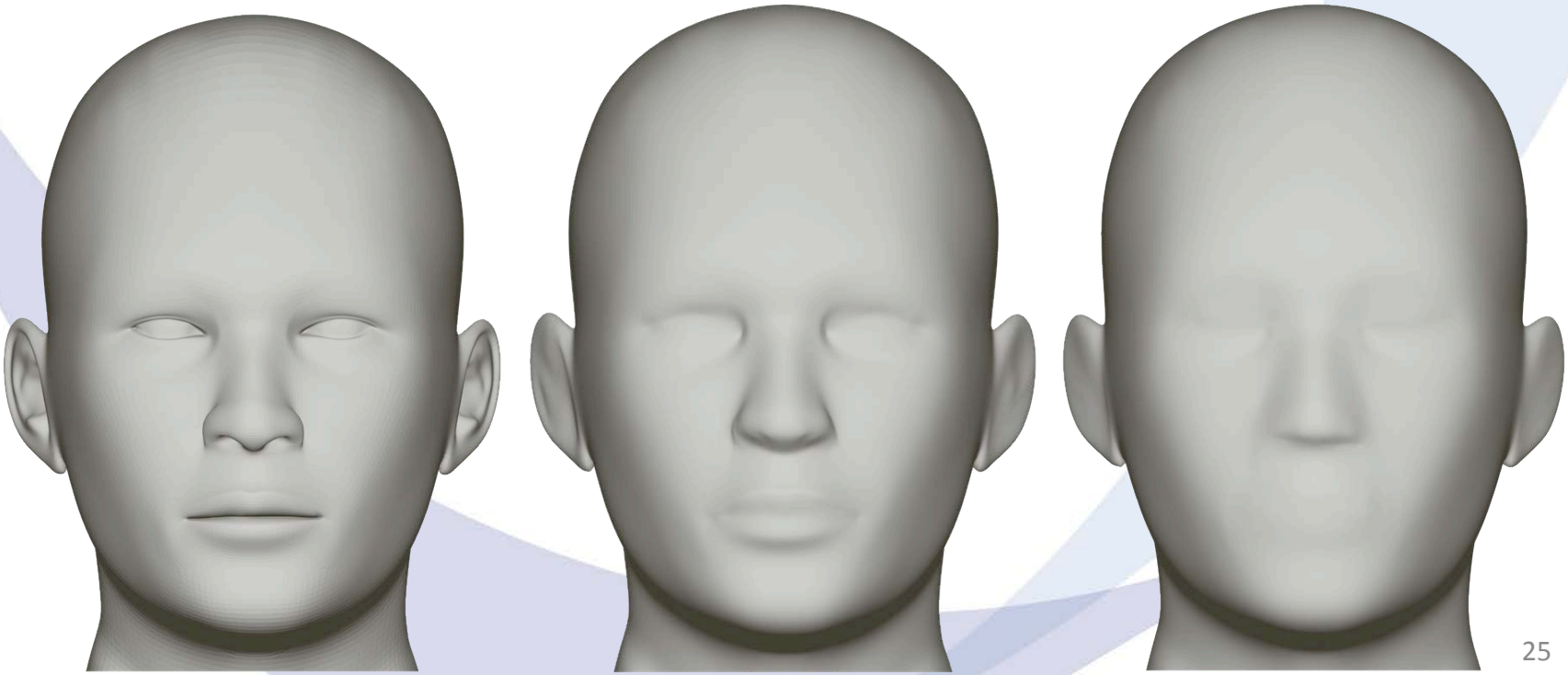


3D FaceController Editor

New laboratory setup created in support of user studies

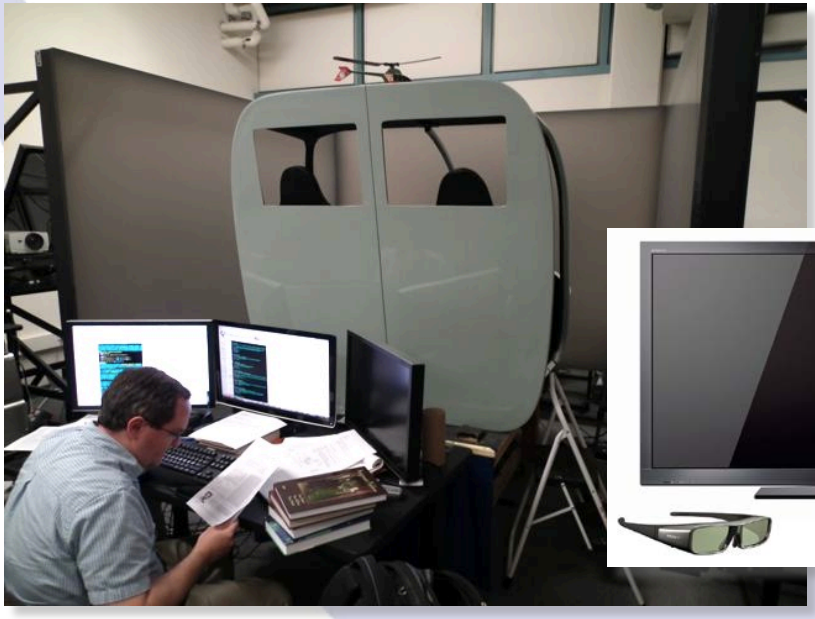
Upcoming Studies

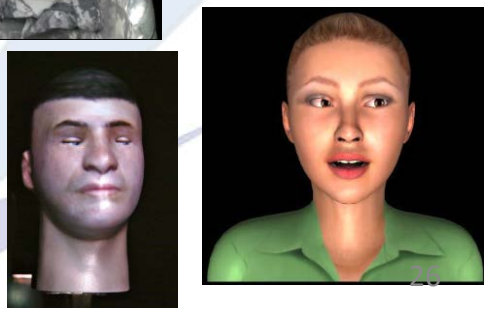
- Multi-posture virtual humans (mannequins)
- Work with Ryan Schubert (Sadagic a member of his PhD committee)
  - Optimal surface determination for multiple postures and synthetic animatronics



New Conditions and Situations to Be Studied

- **Stereoscopic Displays**: Add an additional condition – 3D active stereo – to test if a binocular depth cue is a 'crucial' ingredient for correct eye-gaze estimation.
- **More complex behaviors**
- **Groups of Avatars**: 2D/'flat', 3D (stereoscopic) & 3D physical-virtual



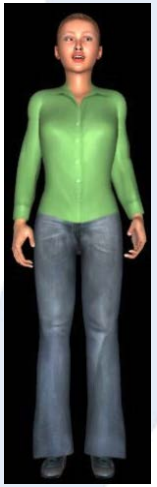


Opportunity for Student Thesis: Perceptions, Bias and Acceptance

- Studies on perception, bias, and acceptance: Male vs female virtual humans (2D and 3D), civilian vs military uniform clothing, skin tones.












Tomorrow's Demo Night

Come & see us in WA-275/285 and 212A Lab

With out Summer student interns Kristina, Juanita & Luana!

Q & A

Come and see our demo