

EVALUATION OF A SPOKEN DIALOGUE SYSTEM FOR VIRTUAL REALITY CALL FOR FIRE TRAINING

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Outline

- Virtual Reality Call for Fire Training
- The Radiobot-CFF System
- Evaluation method
- Evaluation Results
- Next Steps



Radiobots: Project History

- 2004: Piloted within ICT Mission Rehearsal Exercise (MRE) Project
 - Simple dialogue systems for radio characters
 - Output through radio
- 2004-2005: seedling effort
 - Further development of MRE radiobots
 - Analysis of radiobot domains & tools
 - Focus on call for fire
 - Tools for data collection & semi-automatic operation
 - Initial data collection at Ft Sill and analysis
- 2005 - 2006: Radiobots for JFETS: Radiobot-CFF





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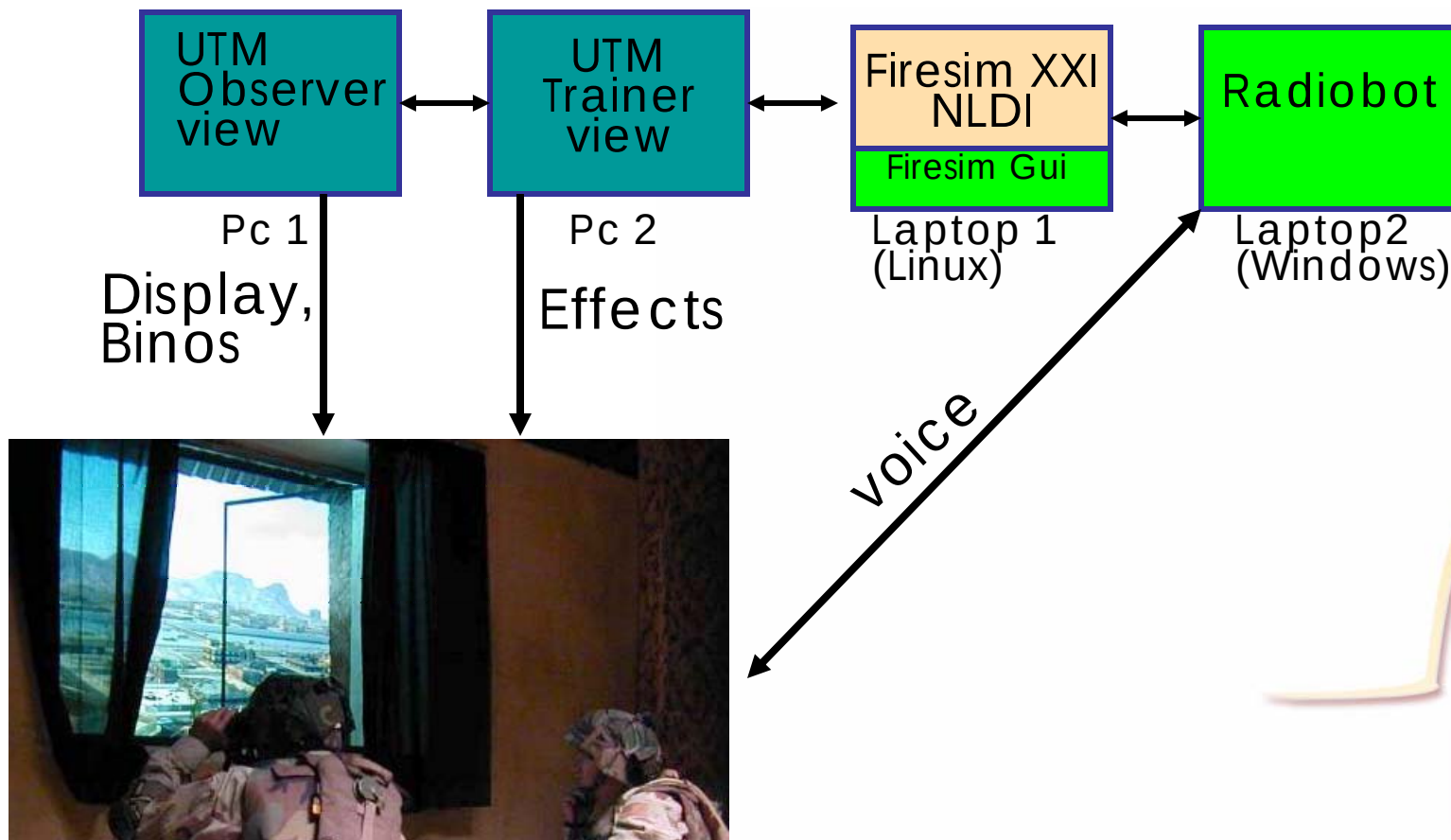
Radiobots for JFETS: Team members

- USC ICT (Dr. David Traum, Antonio Roque, Susan Robinson, Dr Anton Leuski, Jarrell Pair, Tae Yoon, Dr Bilyana Martinovski, Ashish Vaswani, Sudeep Gandhe, Emily Flores, Jillian Gerten)
 - overall integration & management
 - dialogue systems
 - corpus creation & development
 - evaluation
- USC SAIL (Dr. Shri Narayanan, Vivek Sridhar, Shankar Anathakrishnan)
 - speech processing
- TechMasters Inc (TMI) (Bill Millspaugh)
 - FireSIM XXI simulation
 - Text to tactical messaging (NLDI)
- ARL-HRED (Charles Hernandez, Dr Janet Sutton)
 - Evaluation

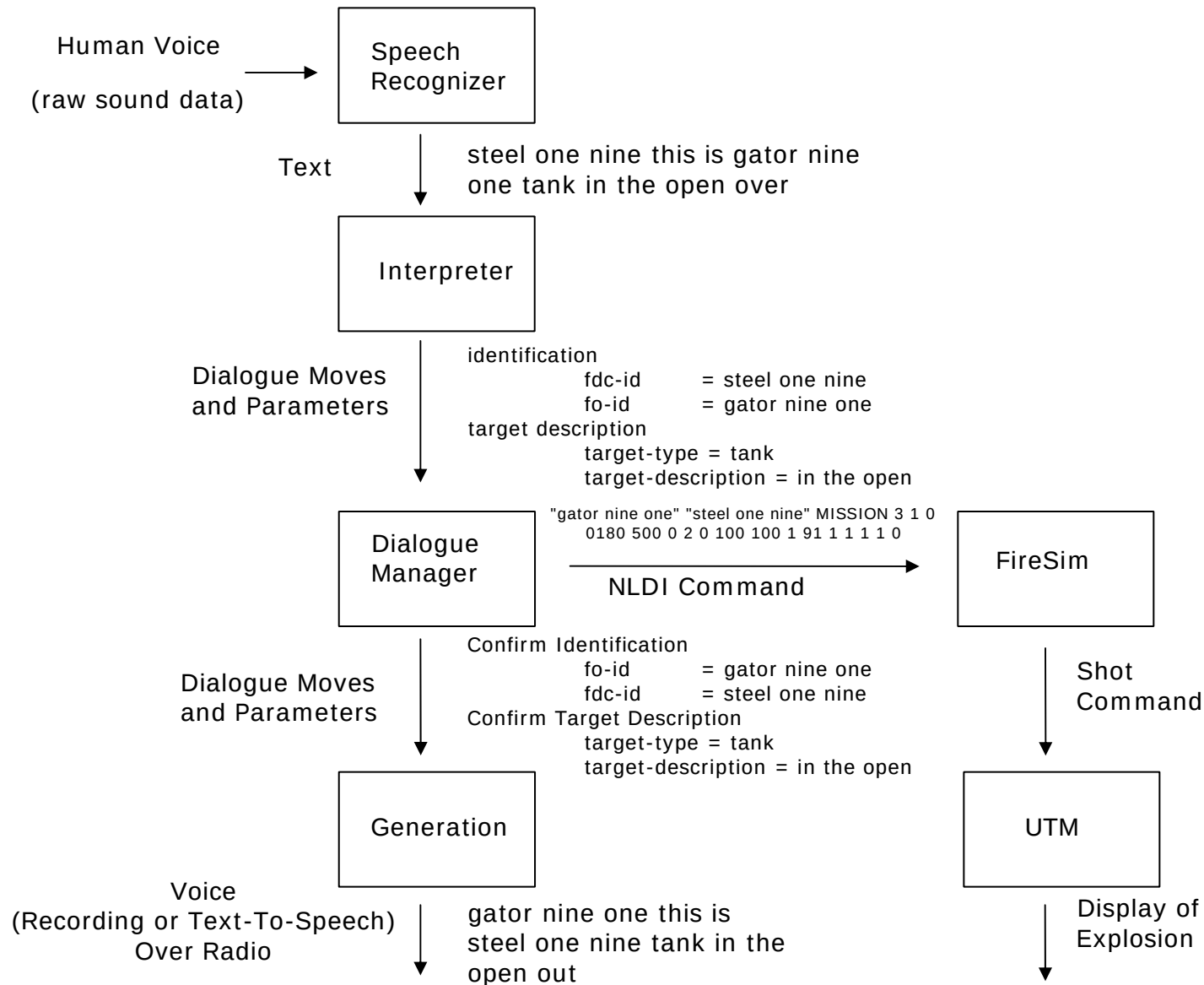


With help from Ft Sill Battle Lab & Tchrizon

System Architecture: Hardware and User Interaction



System Architecture: Software components and dataflow



Example Radiobot Interactions

G91: steel one niner this is gator niner one
, adjust fire over , 

S19: gator nine one this is steel one nine ,
adjust fire out ,

G91: grid four five one , three six four over

S19: grid four five one three six four out ,

G91: one z_s_u in the open , i_c_m in
effect over ,

S19: one z_s_u in the open , i_c_m in
effect out .

S19: message to observer . kilo alpha high
explosive four rounds . adjust fire target
number alpha bravo one zero zero zero
over ,

G91: message to observer , kilo alpha ,
high explosive in effect four rounds ,
target number alpha bravo one zero
zero break ,

S19: shot over ,

G91: shot out ,

S19: splash over ,

G91: splash out

G91: steel one nine this is gator nine one
, adjust fire polar over , 

S19: gator nine one this is steel one nine
, adjust fire polar out ,

G91: direction five nine seven zero ,
distance four eight zero over ,

S19: direction five nine seven zero ,
distance four eight zero out ,

G91: one b_m_p in the open ,
d_p_i_c_m in effect over .

S19: one b_m_p in the open . i_c_m in
effect out .

S19: message to observer . kilo bravo
high explosive four rounds . adjust fire
target number alpha bravo one zero
zero two over

G91: message to observer , kilo alpha
quick in effect h_e four rounds , target
number alpha bravo one thousand
two over ,

S19: shot target number alpha bravo one
zero zero two over ,

G91: shot out ,

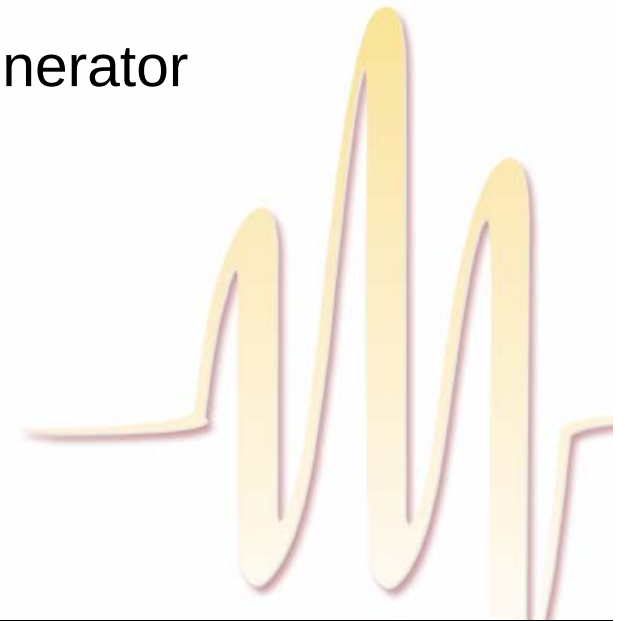
Evaluation Goals

- Measures of performance of system and components
- Measures of effectiveness of system for use in training in the JFETS Urban Terrain Module
- Measures of User Satisfaction
- Identify areas of needed improvement



Evaluation Metrics

- System Performance Metrics
 - mission completion, timing to fire, accuracy, transmission quality
- Component Performance Metrics
 - ASR, interpreter, dialogue manager, generator
- Subjective Data
 - Questionnaires



Evaluation Conditions

- Automated: radiobot as FSO, automatically sends mission information to Firesim
- Semi-automated: As above, but fills in form for human operator to review (possibly correct) and submit
- Human control: Human FSO engages in radio dialogues and human operator sends missions through Firesim



Evaluation Sessions

- Preliminary Evaluation Nov 2005
 - 34 students in UTM training
 - Focused on semi-auto condition and refining user questionnaire
- Final Evaluation Jan-Feb 2006
 - 29 volunteers from Ft Sill, some repeat subjects across conditions
 - Demographic and user surveys for each session
 - 2 subjects per group, FO and RTO each did 2 missions then switched roles.
 - Conditions were varied across groups



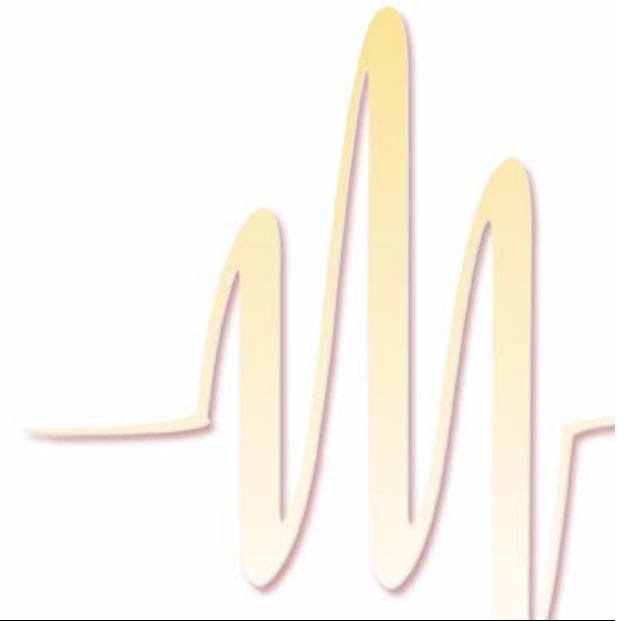
Evaluation Data Overview

- Eval 1: Jan 2006
 - 20 sessions (10 teams)
 - 4 human, 8 semi-auto, 8 auto
- Eval 2: Feb 2006
 - 27 sessions (14 teams)
 - 6 human, 9 semi-auto, 12 auto



Evaluation Results: Mission Performance

- Average time to fire:
 - Human: 1 min 46
 - Semi: 2 min 19
 - Auto: 1 min 44
- Accuracy rate:
 - Human: 100%
 - Semi: 97%
 - Auto: 92%
- Task completion rate:
 - Human: 100%
 - Semi: 98%
 - Auto: 86%



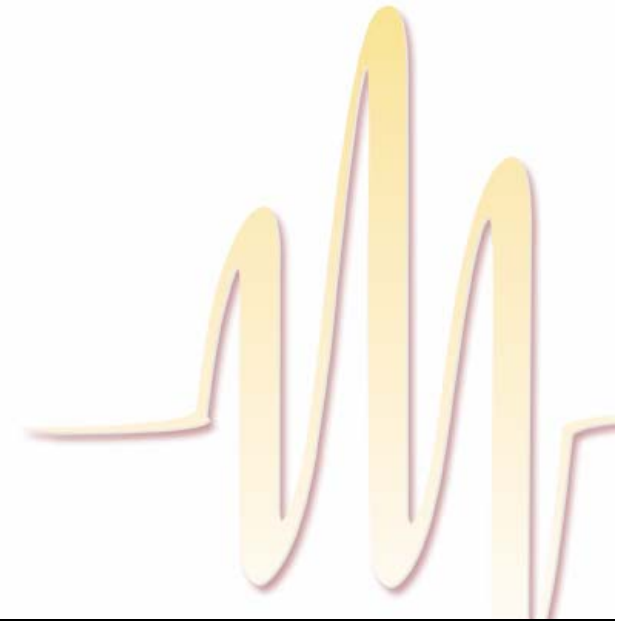
Transmission Quality

Session	System transmissions	Acks req	% Acks	Repair Requests	Correct responses	Flawless Responses	Flawless transmissions
W1-2	27	12	100%	8%	92%	58%	82%
W3-1	26	14	100%	14%	93%	50%	73%
T2-2	15	8	88%	0	71%	71%	87%
T4-2	21	13	85%	0	91%	46%	71%
T5-2	67	39	97%	11%	76%	53%	70%
T6-1	29	18	89%	0	75%	50%	66%
T6-2	13	6	100%	0	100%	83%	92%
T7-2	26	12	100%	0	92%	75%	89%
T9-1	29	18	83%	27%	87%	53%	72%
T9-2	22	12	92%	9%	100%	55%	77%
Median Scores	26	12.5	93.5%	4%	91.5%	54%	75%



Components evaluated

- Automatic Speech Recognizer (ASR)
- Interpreter
- ASR + Interpreter
- Dialogue Manager





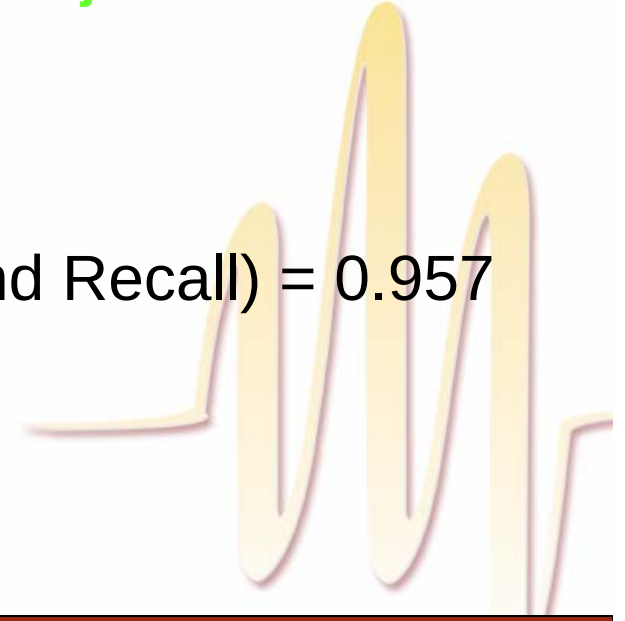
Component Evaluation Metrics

- Compare system results with replicable human coding (Gold Standard)
- Basic Scoring Methods
 - Precision (correct recognized/ all recognized)
 - Recall (correct recognized / all correct)
 - F-Score (harmonic mean of P & R)
 - Error Rate (errors / all correct)
- Dialogue Measures
 - Over whole dialogue
 - Average of scores of each utterance in the dialogue



Example: ASR evaluation

- Transcribed Utterance (Exact reproduction of audio signal)
steel one nine this is gator niner one adjust fire over
- Output from ASR
steel one nine this is gator one niner one adjust fire over
- Merged view
steel one nine this is gator [one] niner one adjust fire over
- Measures
- Precision = 11/12
- Recall = 11/11
- WER = 1/11
- F-Score(Harmonic mean of Precision and Recall) = 0.957

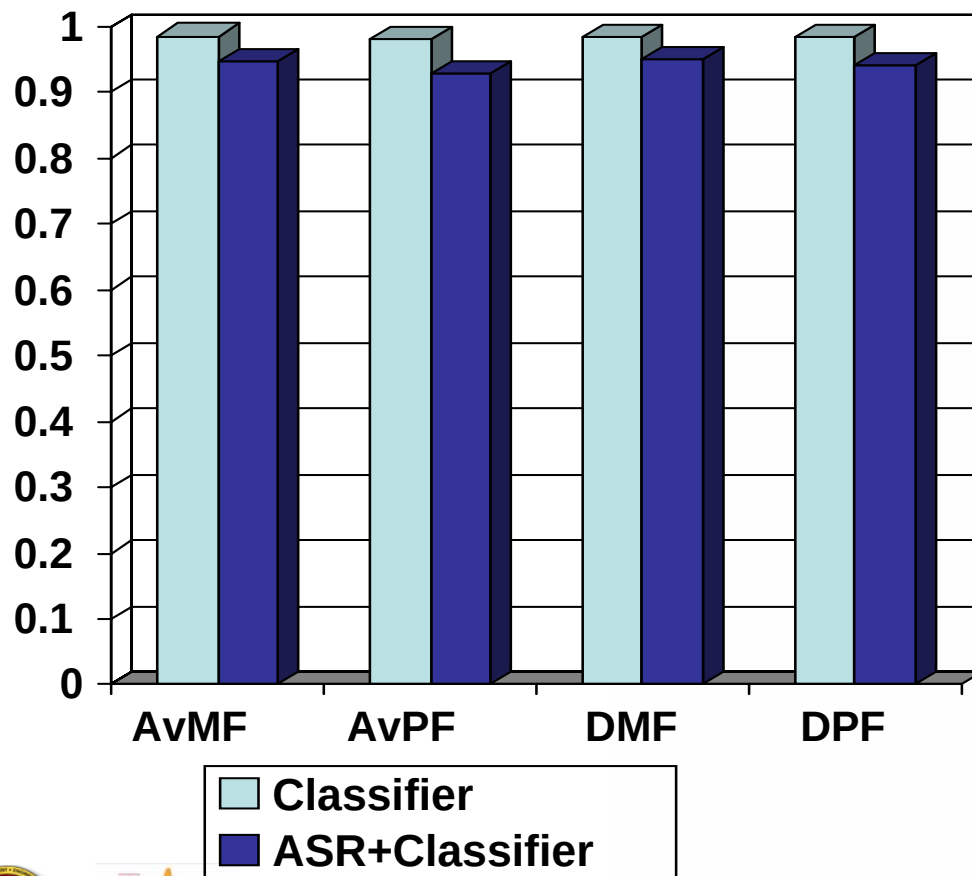


■ Evaluation Results: ASR scores

- Dialogue precision score (DP) = 0.900
- Dialogue recall score (DR) = 0.920
- Dialogue F score (DF) = 0.910
- Dialogue Word Error Rate (DWER) = 0.114
- The average precision score is (AvP) = 0.920
- The average recall score (AvR) = 0.935
- The average F score (AvF) = 0.927
- The average word error rate (AvWER) = 0.097



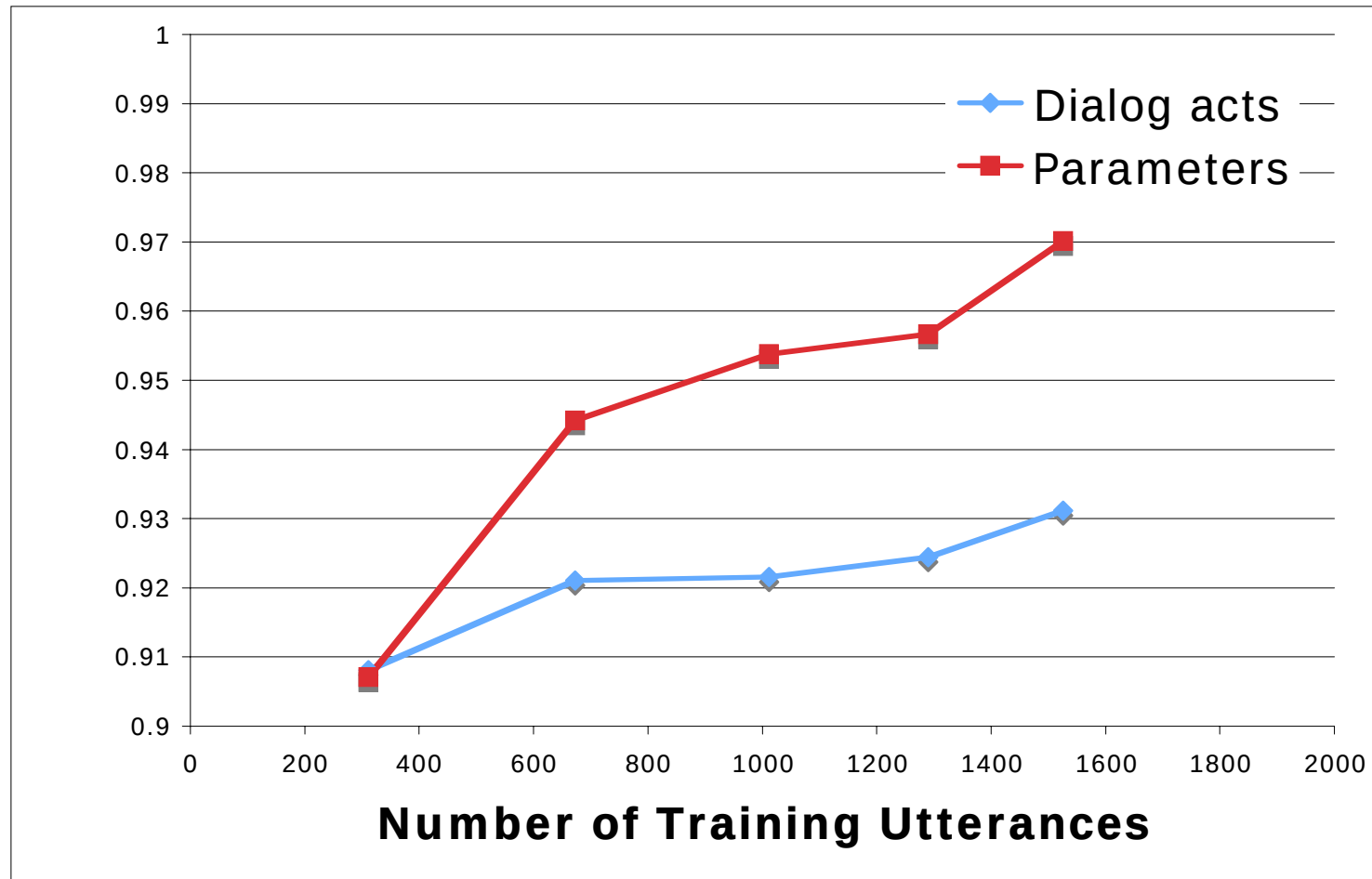
Interpreter vs ASR+Interpreter



- Interpreter Evaluation
 - Interpreter results on perfect input compared to human coding
- ASR + Interpreter Evaluation
 - Interpreter coding on ASR output compared to human coding



Radiobot Interpreter performance related to size of training data



Dialogue Manager Evaluation

- Comparison of Machine coded Information state against human coded Information state.
- MACHINE:
 - has_warning_order true
 - has_target_location false
 - has_grid_location false
- HUMAN:
 - has_warning_order true
 - has_target_location false
 - has_grid_location false
- DIsER, DIsP, DIsR..., AvIsER, AvIsP...

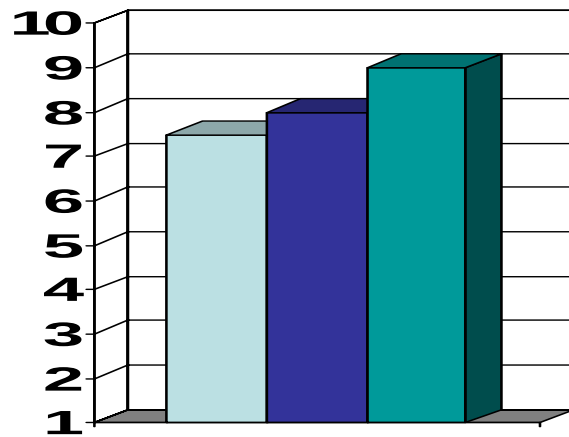


■ Dialogue Manager scores

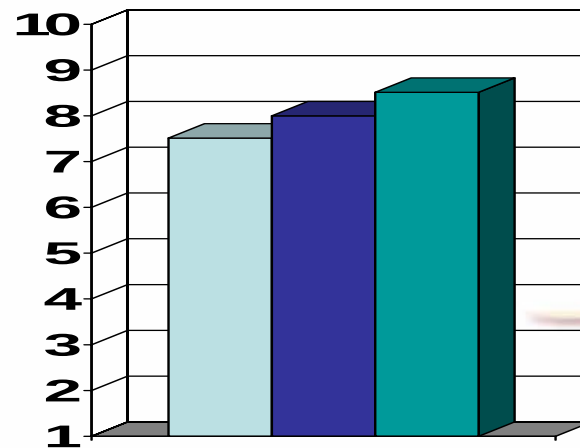
- Dialogue Information State Error Rate (DIsER) = 0.0106
- Dialogue Information State Precision (DIsP) = 0.9893
- Dialogue Information State Recall (DIsR) = 0.9893
- Dialogue Information State F score (DIsF) = 0.9892
- Average Information State Error Rate (AvIsER) = 0.0106
- Average Information State Precision (AvIsP) = 0.9893
- Average Information State Recall (AvIsR) = 0.9893
- Average Information State F Score (AvIsF) = 0.9893



Questionnaire Results: Dialogue



How well did
the FSO
understand
you?

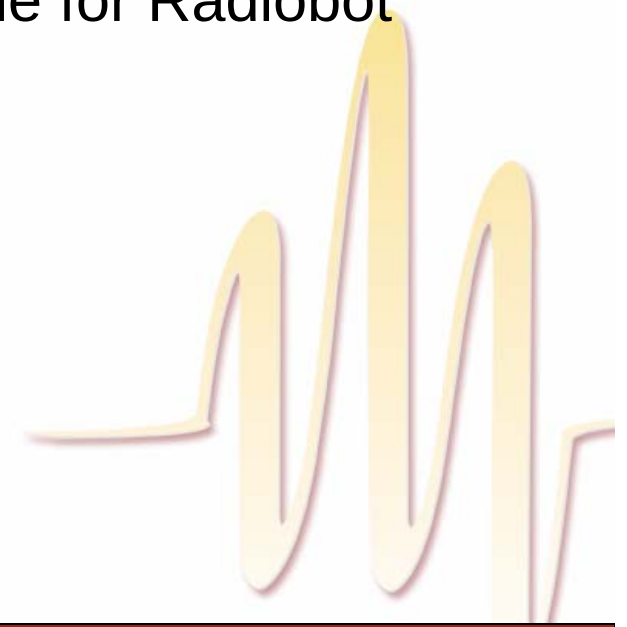


FSO's adherence
to correct CFF
protocol



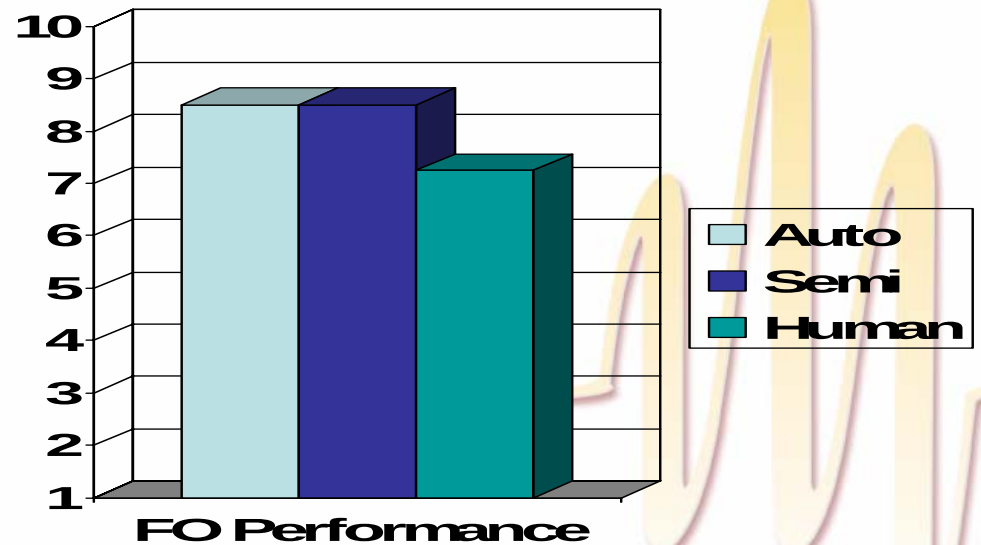
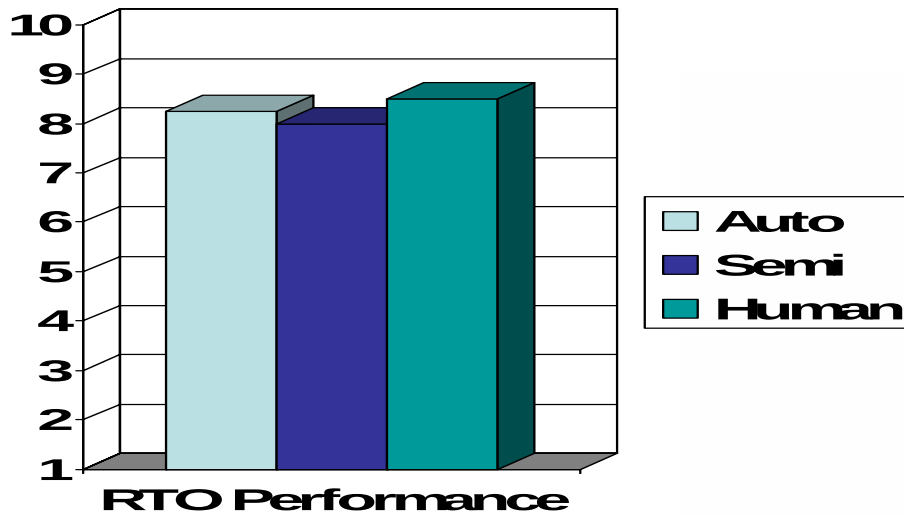
User Survey Feedback

- Near-human level quality on understandability and adherence to protocol
- Subjective judgments of trainee and partner (FO & RTO) performance higher or the same for Radiobot compared to human FSO



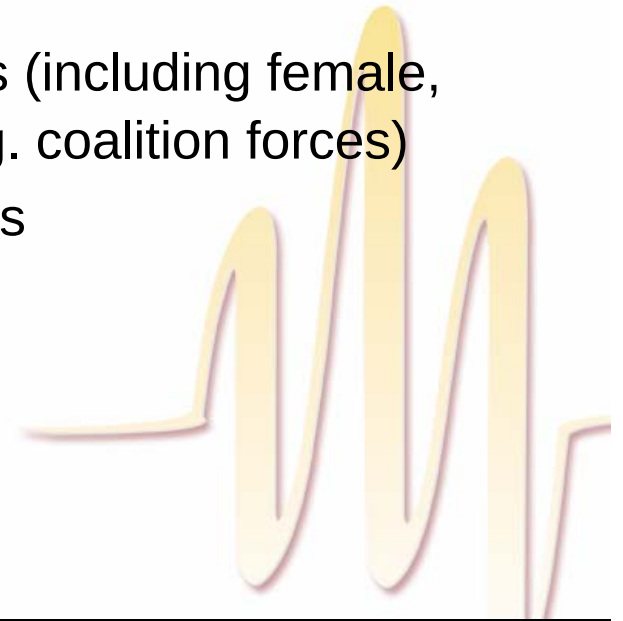


Questionnaire Results: Trainee Performance



Current Status

- Achievements
 - Allows large range of mission types (e.g., adjust fire, fire for effect, offset from known position, polar, grid)
 - Good performance on calls from men with standard American accent
- Needs work:
 - Improve recognition rate on Range of speakers (including female, regional accents, and non-native speakers (e.g. coalition forces))
 - Improve error handling due to recognition errors
 - Improve transparency and prompting
 - E.g. answer why firesim denies missions
 - Hardware robustness



Next Steps

1. Improving UTM Radiobots to performance level capability
 - Suitable for use in regular training
 - Improved error handling and feedback
 - Multiple synchronous missions
 - Better performance on wider range of speakers
 - multiple use cases, trainer aids, AAR aids
2. Adaptation to other CFF domains & platforms
 - Other parts of JFETS
 - Laptop trainer
 - Mobile/field use



■ Radiobot Future Plans

- Produce useful automation of radio communication in training simulations
 - off-load tasks from operator controller
 - standardize training
- Extension to other domains
 - E.g., 9-line, sitreps, fraternal unit communication
- Toolkits for non-expert radiobot construction for new domains



Soldiers with UTM Radiobot

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

