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CCI2020 : Joint Congress on Computational Intelligence

AI/ML Research at ACE Laboratories

Part I

Mohammad Jamshidi, Ph.D., DEgr. (h.c. TU Crete, U Waterloo)
Fellow IEEE, Fellow ASME, Fellow AAAS, Fellow TWAS, Fellow NYAS, A Fellow AIAA

Lutcher Brown Endowed Distinguished Chaired Professor
Member, Univ. Texas System's Chancellor's Council
Department of Electrical and Computer Engineering
and
Director Autonomous Control Engineering - ACE Laboratories
The University of Texas, San Antonio, Texas
www.acelab.wixsite.com/acelab
https://www.facebook.com/UTSA.ACE.LAB
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Sept 2-4
Ferdowsi University of Mashhad
Mashhad, Iran

AI for Good
2020 Joint Congress on Computational Intelligence
8th Joint Congress on Fuzzy and Intelligent Systems, 19th Iranian Conference on Fuzzy Systems, 17th Conference on Intelligent Systems, and 4th Conference on Swarm Intelligence and Evolutionary Computation
2-4 September, Ferdowsi University of Mashhad, Mashhad, Iran.

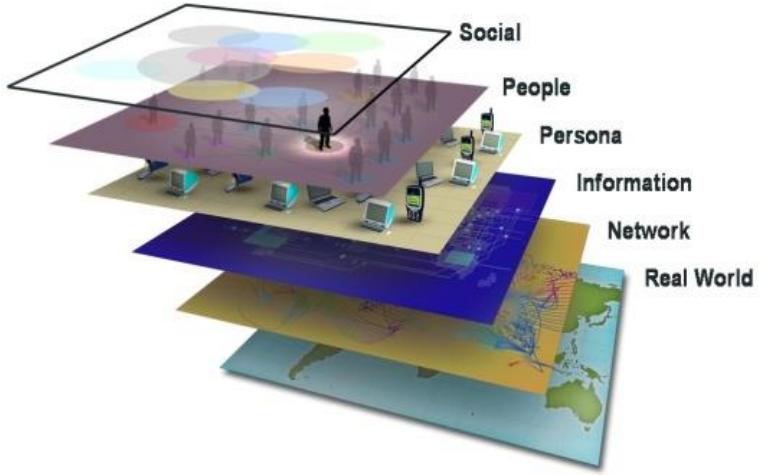
Former and Current Graduate students involved

Arezou Mousavi, PhD.
Yashar Manjili, Ph.D.
Bernie Tannahill, MS
Jonathan Lwowski, PhD
Abhijit Majumdar, MS
Yunus Yetis, PhD
Conor Wallace, MS
James Nelson, MS
Sean Ackels, MS

SoS and their types

- **Operational independence of component systems**
- **Managerial independence of component systems**
- **Geographical distribution**
- **Emergent behaviour**
- **Evolutionary development processes**

(Maier, 1998)



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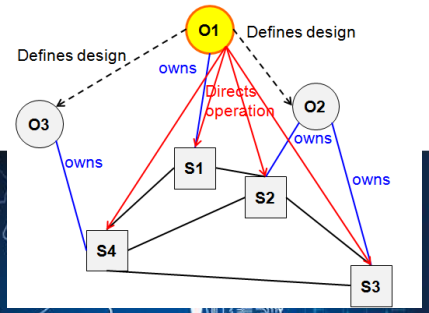

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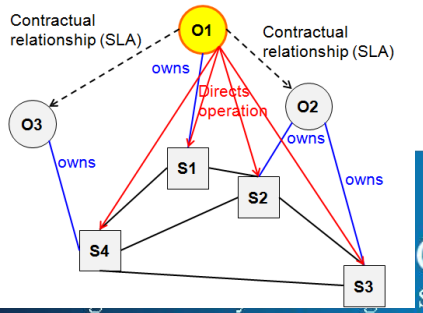
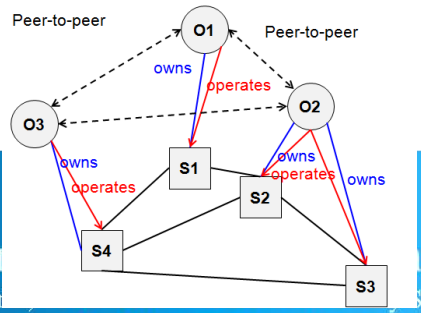
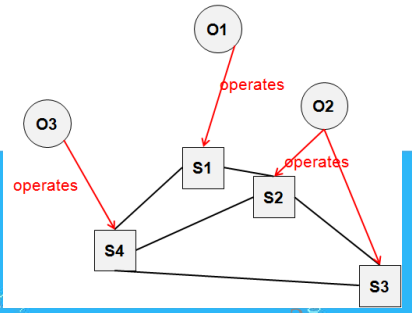


Collaborative

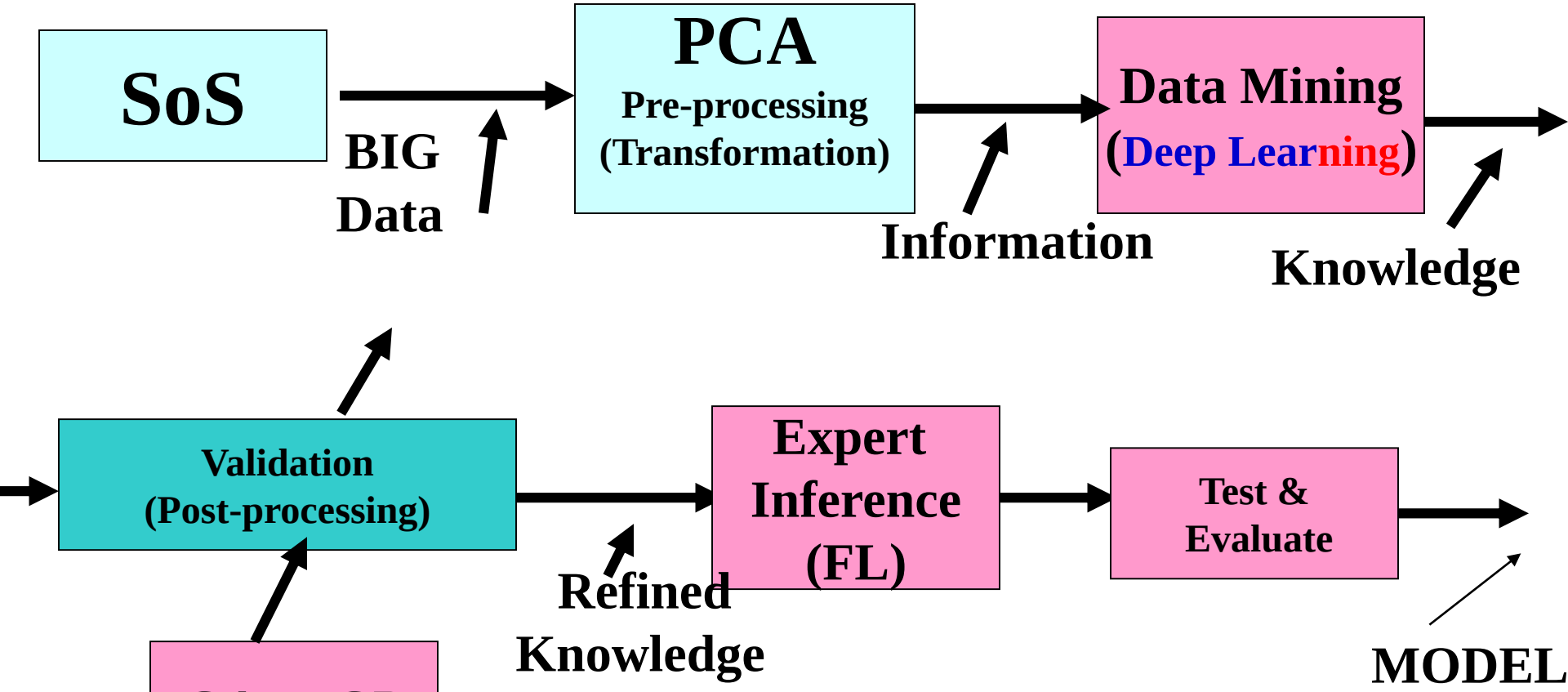


Virtual



SoS BIG DATA ANALYTICS

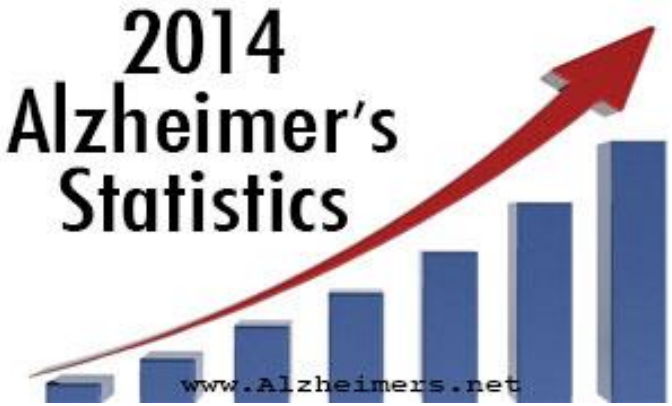
Modeling of System of Systems via Data Analytics – Case for "Big Data" in SoS

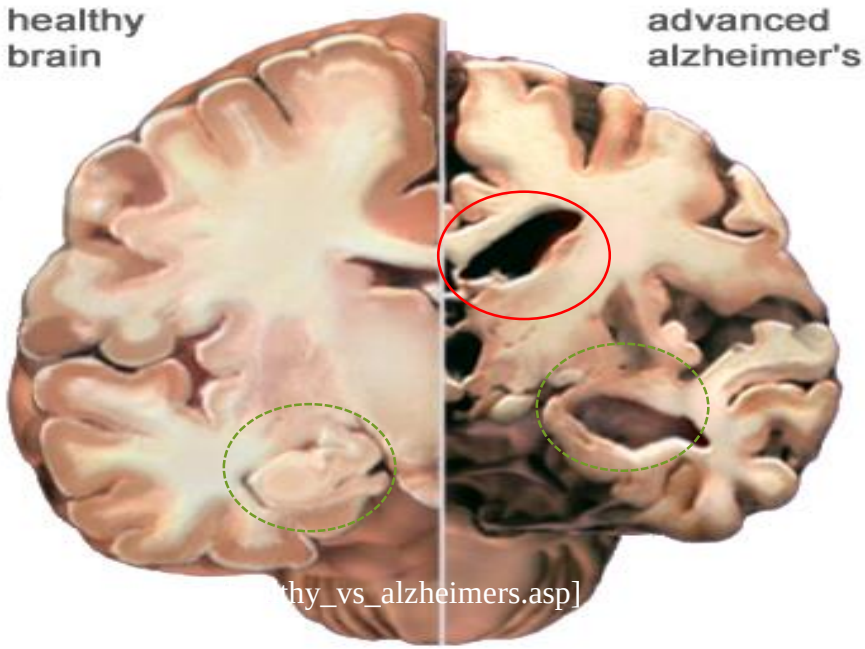


Research on AI /Machine Learning

Case: Alzheimer's Disease Stage Forecasting
Solar Energy Forecasting
Case of Search and Rescue Missions
Fault—Diagnostics of Autonomous Vehicles
Edge Computing of Autonomous Systems
Networked Control of Autonomous Vehicles
Case: Security of Banks' Vestibules – Human/Object Recognition

The importance of AD diagnosis: Application of nominal data (image analysis)

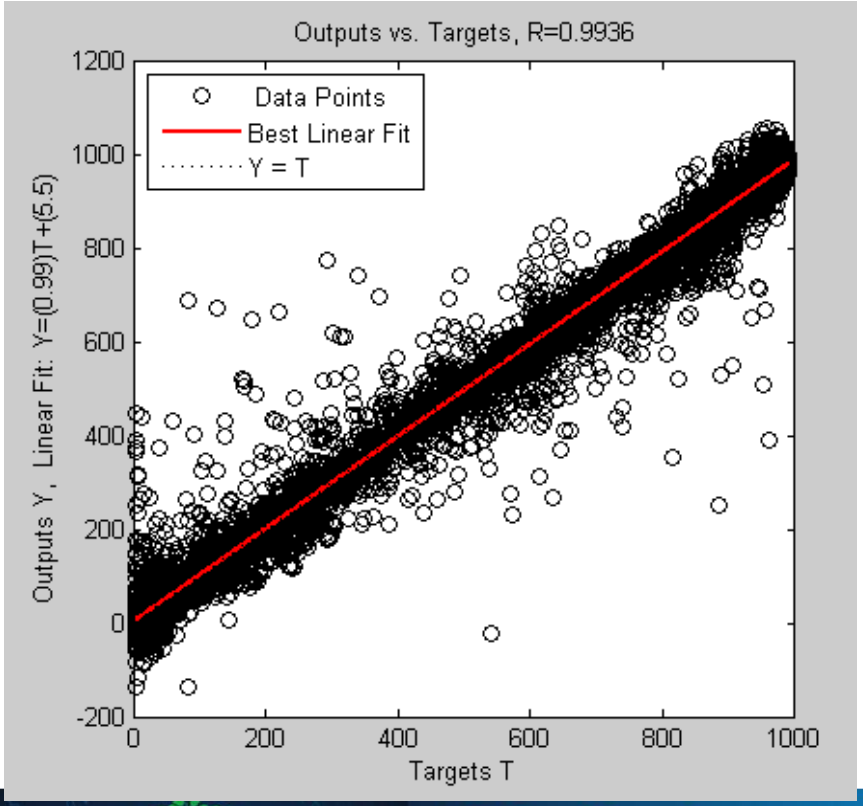




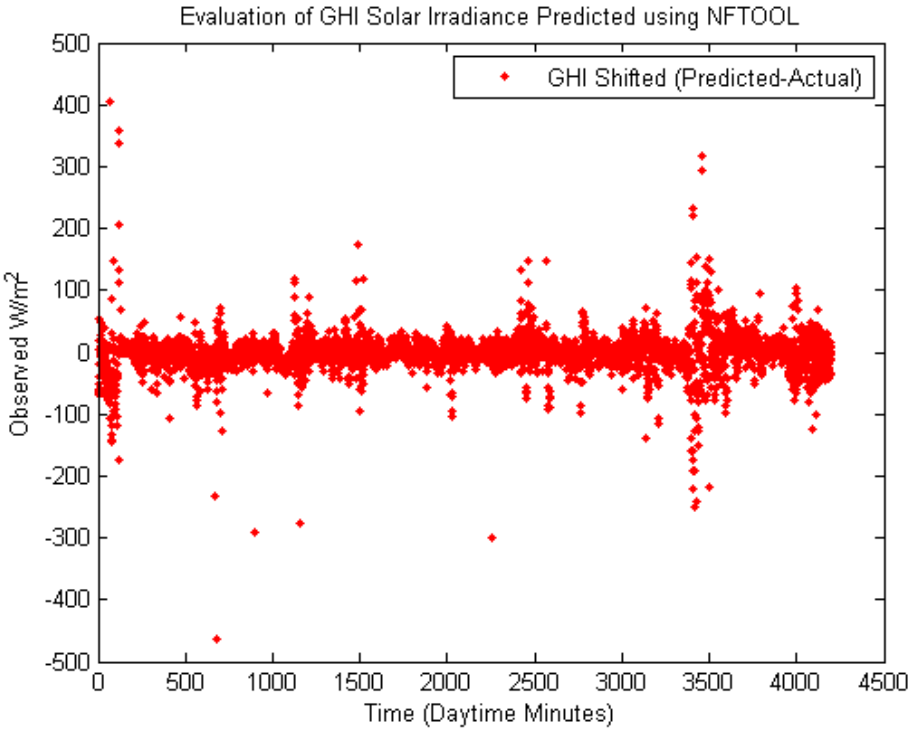
thy_vs_alzheimers.asp]

Results

- Discussion of Results … Best Model Performance



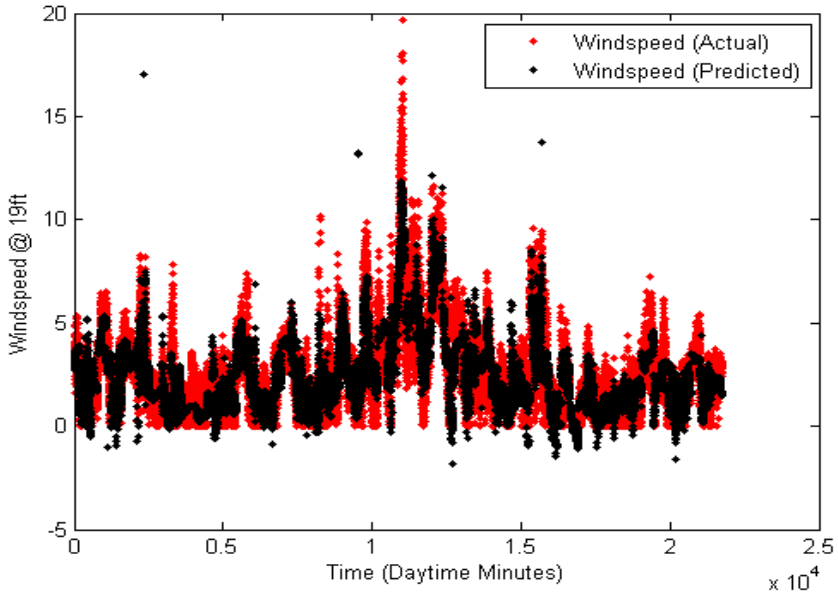
Best Linear Regression Performance



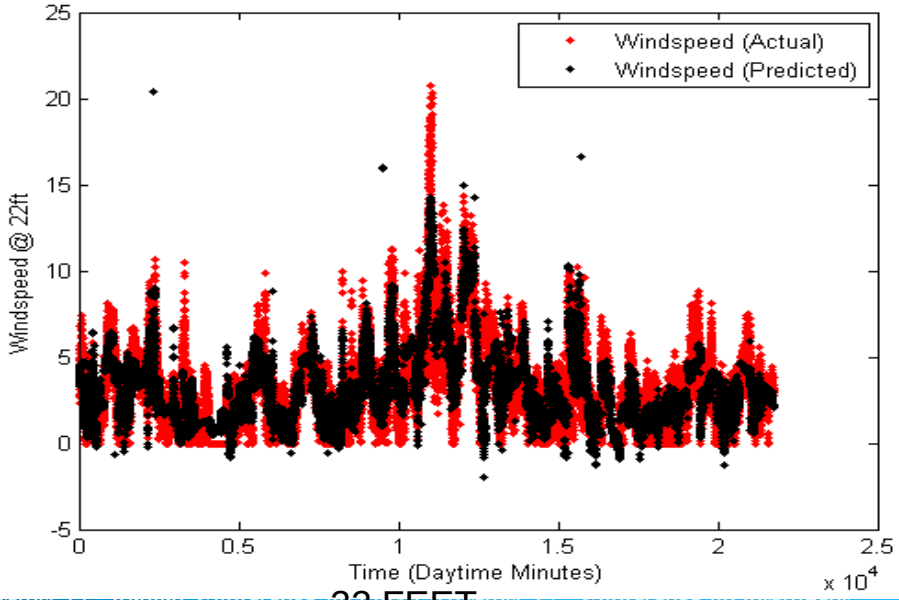
Best Model GHI Prediction Error

Results: **WIND ENERGY FORECASTING**

- Considering all the configurations, the best performing neural networks were those using a pre-expanded (via nonlinear expansion) data set fed into a conventional feed forward neural network with ten neurons in the hidden layer.
- The following figures show the results and error generated using this network to predict wind speed an hour in advance.

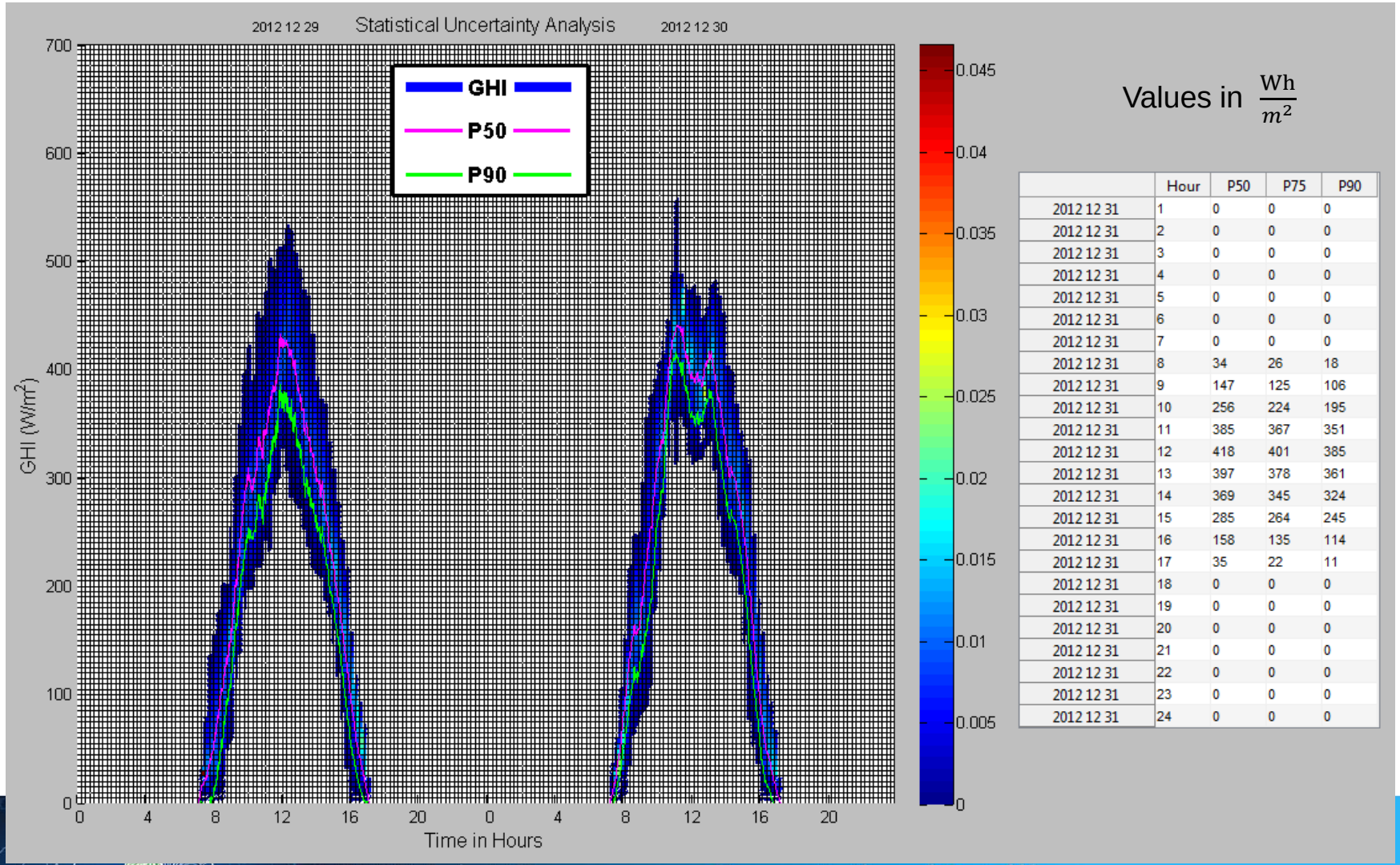


19 FEET



22 FEET

Day-ahead Forecast Interface



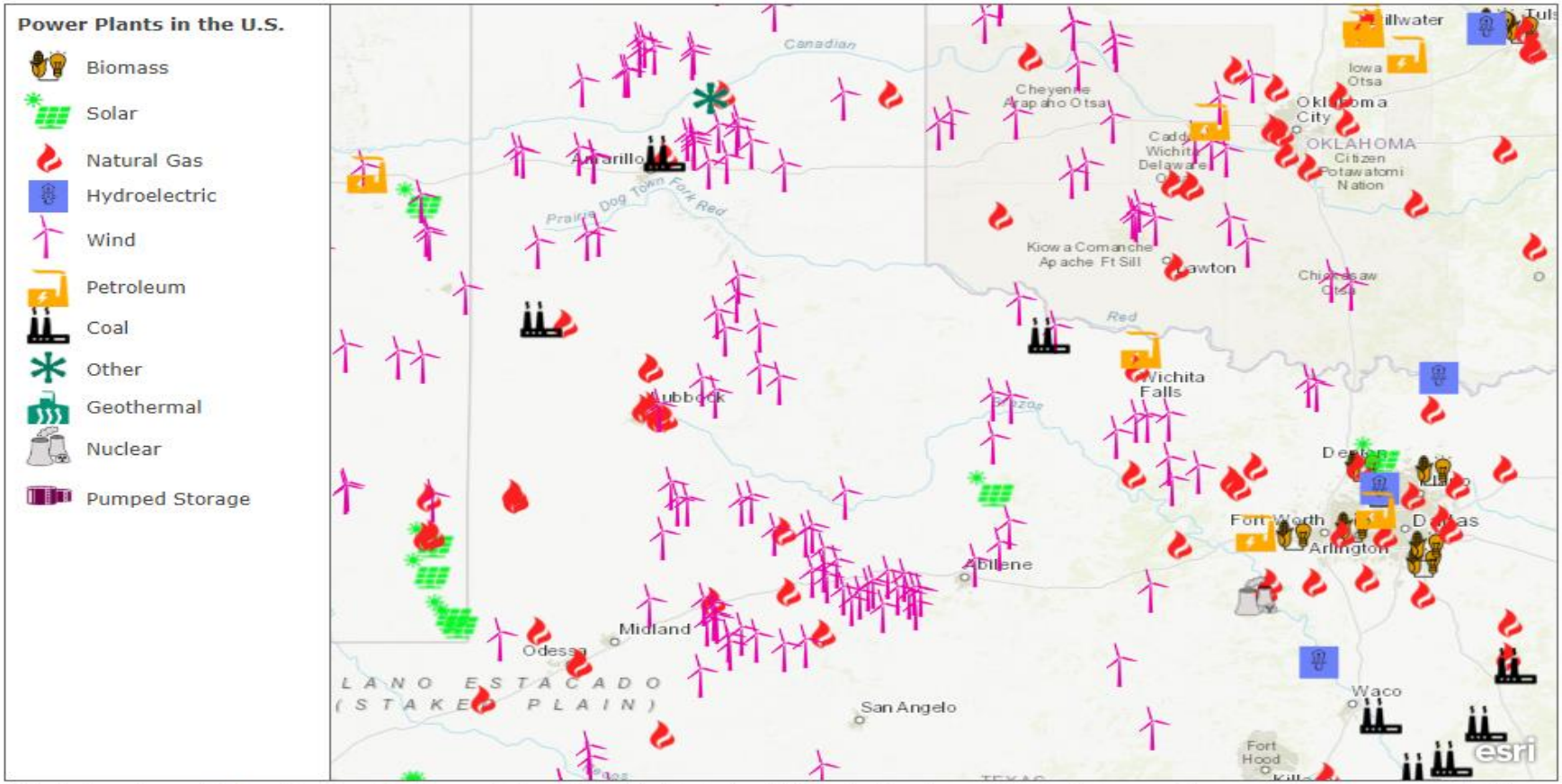
Values in $\frac{\text{Wh}}{m^2}$

	Hour	P50	P75	P90
2012 12 31	1	0	0	0
2012 12 31	2	0	0	0
2012 12 31	3	0	0	0
2012 12 31	4	0	0	0
2012 12 31	5	0	0	0
2012 12 31	6	0	0	0
2012 12 31	7	0	0	0
2012 12 31	8	34	26	18
2012 12 31	9	147	125	106
2012 12 31	10	256	224	195
2012 12 31	11	385	367	351
2012 12 31	12	418	401	385
2012 12 31	13	397	378	361
2012 12 31	14	369	345	324
2012 12 31	15	285	264	245
2012 12 31	16	158	135	114
2012 12 31	17	35	22	11
2012 12 31	18	0	0	0
2012 12 31	19	0	0	0
2012 12 31	20	0	0	0
2012 12 31	21	0	0	0
2012 12 31	22	0	0	0
2012 12 31	23	0	0	0
2012 12 31	24	0	0	0

PATENT PENDING

ANALYSIS OF POWER PLANTS IN TEXAS

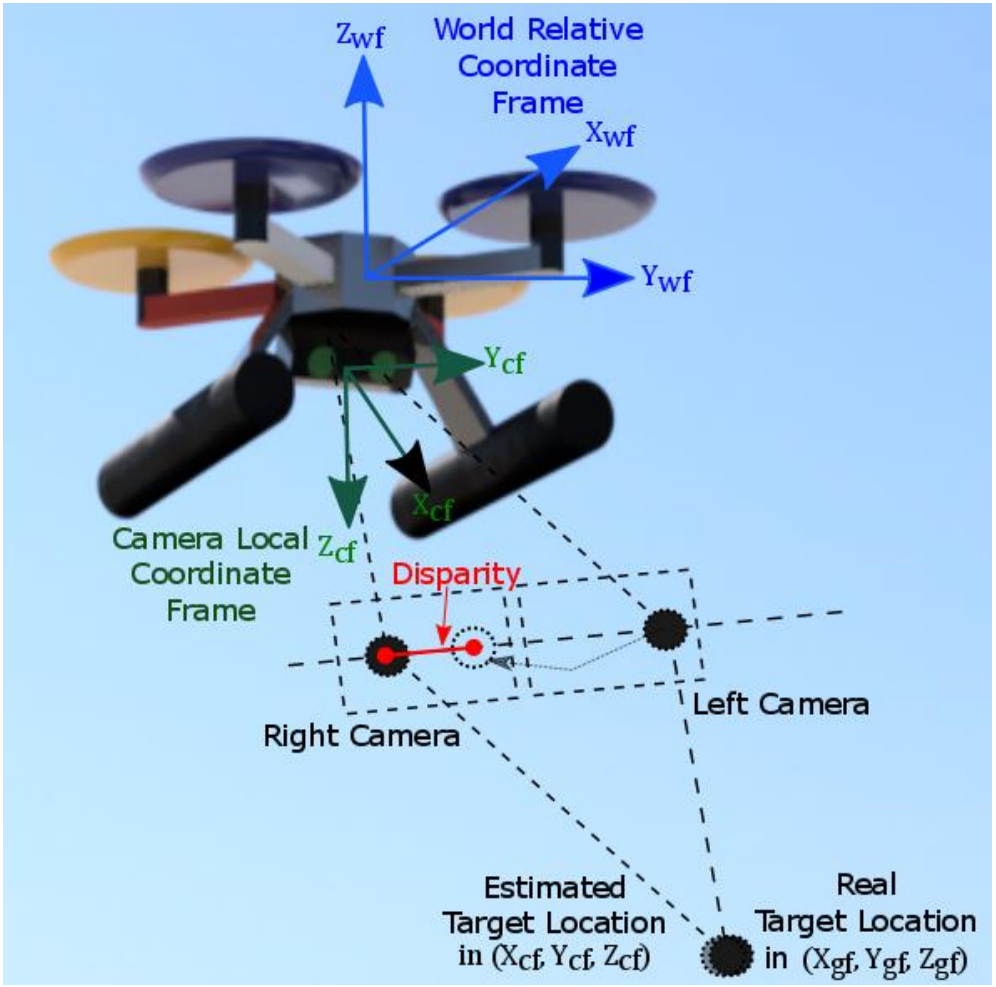
Power Plants in the U.S.



This feature layer, utilizing data from the Energy Information Administration (EIA), depicts all operable electric generating plants by energy source in the U.S.

Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS | Energy Information Administration (EIA)

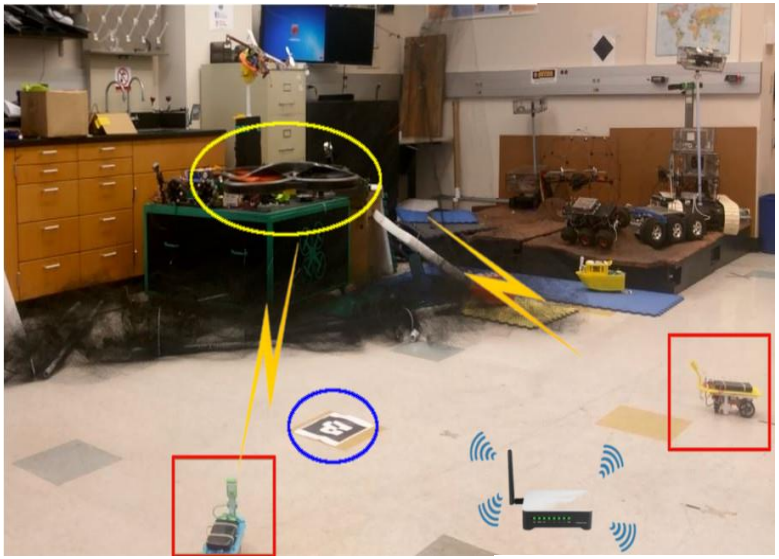
ACE LABS Project: Robotic Heterogeneous Swarm



Lwowoski, et al, 2017

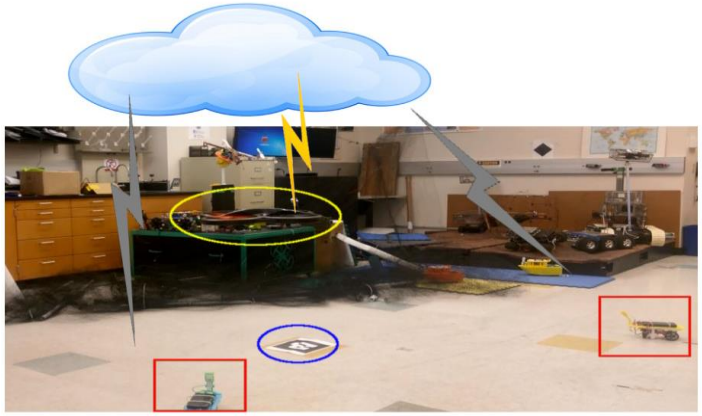
ACE LABS Project: Robotic Heterogeneous Swarm

Control of heterogeneous vehicles



Decentralized

Centralized

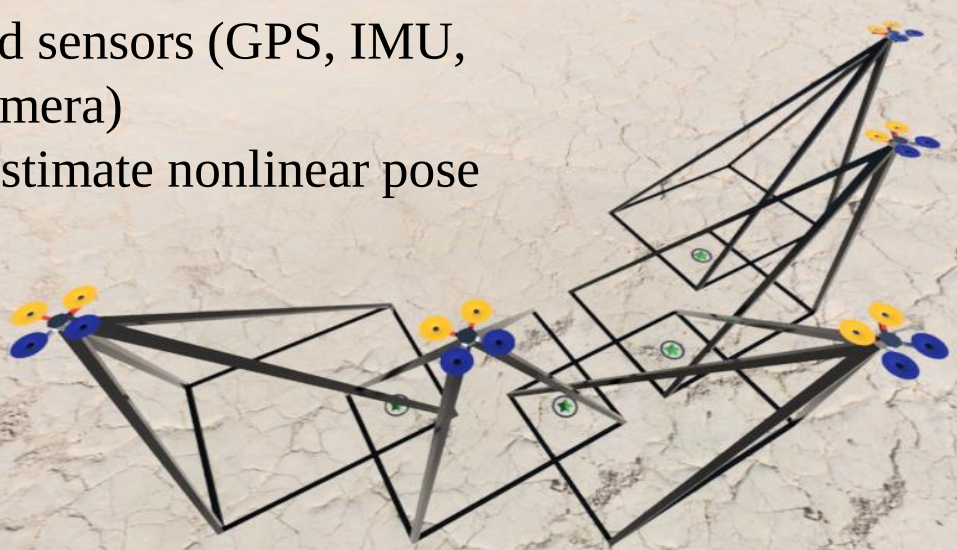


Cloud-Based

Biologically-Inspired Swarm Control

Bird Flocking Inspired Formation Control for Unmanned Aerial Vehicles Using Stereo Camera

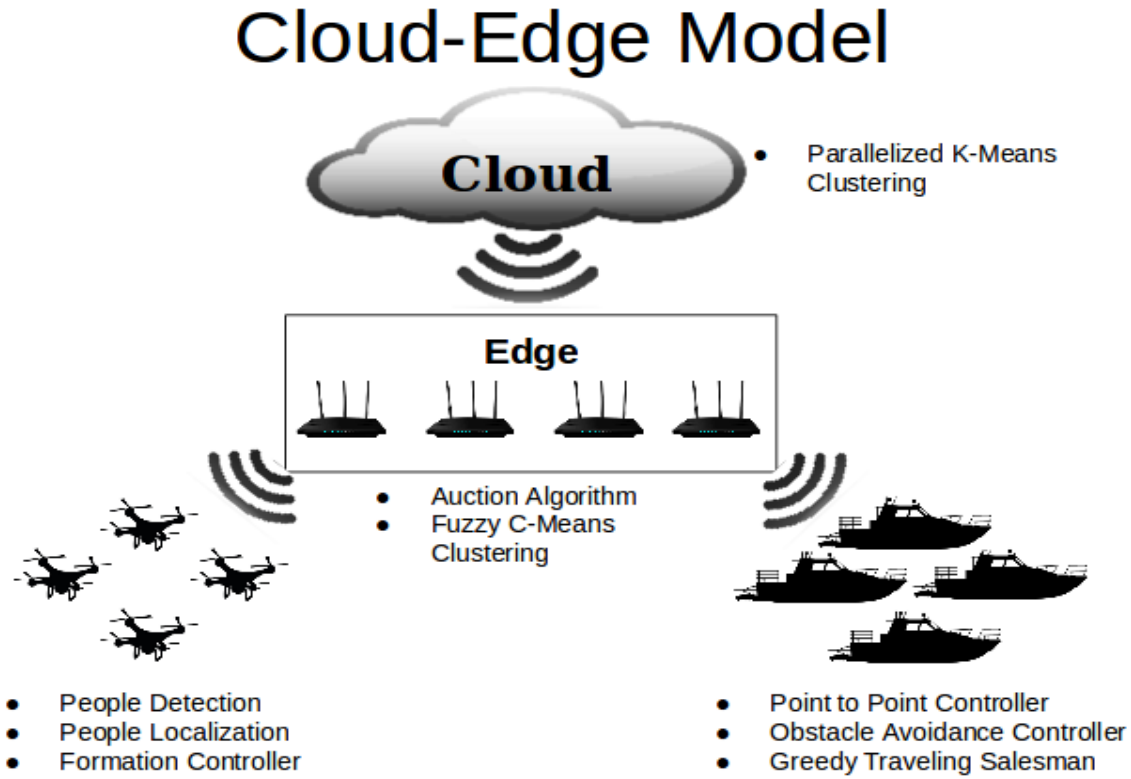
- ROS/Gazebo Simulation
- Simulated sensors (GPS, IMU, Stereo Camera)
- EKF to estimate nonlinear pose positions



Autonomous Vehicle Research at UTSA

Networked Control of Multiple Vehicles

- **Mitigating Time-Delay Problems with Cloud-based Networked Controlled UGVs**
- **A time varying, efficient estimator was used to diagnose the operability of a UGV in a network**
- **Several control paradigms and optimization techniques were compared in their performance for real-time control of a UGV system under various packet losses and time delay.**
- **Nonlinear model predictive control using sequential least squares quadratic programming for optimal control**
- **Solved the optimal control problem quickly enough and with enough fidelity to be employed for real-time control.**
- **Future: A means to mitigate time-delay directly through AI applications to place approach on a cloud-edge model will be explored under cybersecurity constraints.**

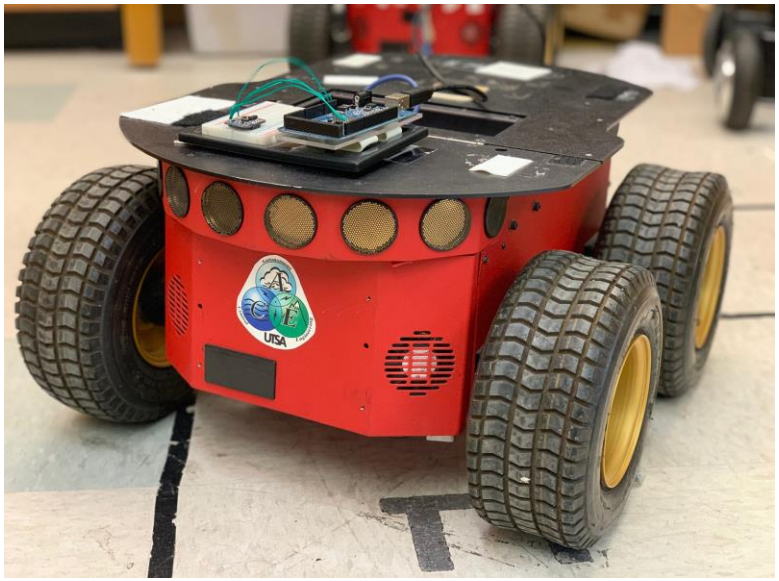


Edge Computing: Extending the cloud to the edge of the network through computation on networking devices such as routers Cloud Computing: Performing computation in a cloud network

Cloud-Edge Model: Combination of computation on the edge devices and cloud network

Fault Detection of Networked Autonomous Vehicles Using Deep Learning

- Detect a fault in a system and compensate said fault.
- System: Pioneer UGV
- Fault: Tire Deflation

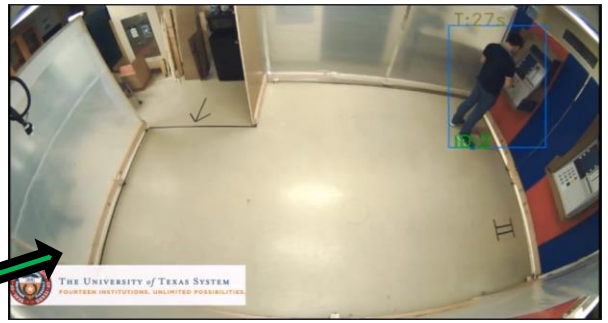


More Details on UTSA Posters 7 and 14 (Conor Wallace)

Commercialization of Bank's Vestibule - Scenes from Demo

ID 2 enters the vestibule

ID 2 performs transaction



ID 3 enters the vestibule

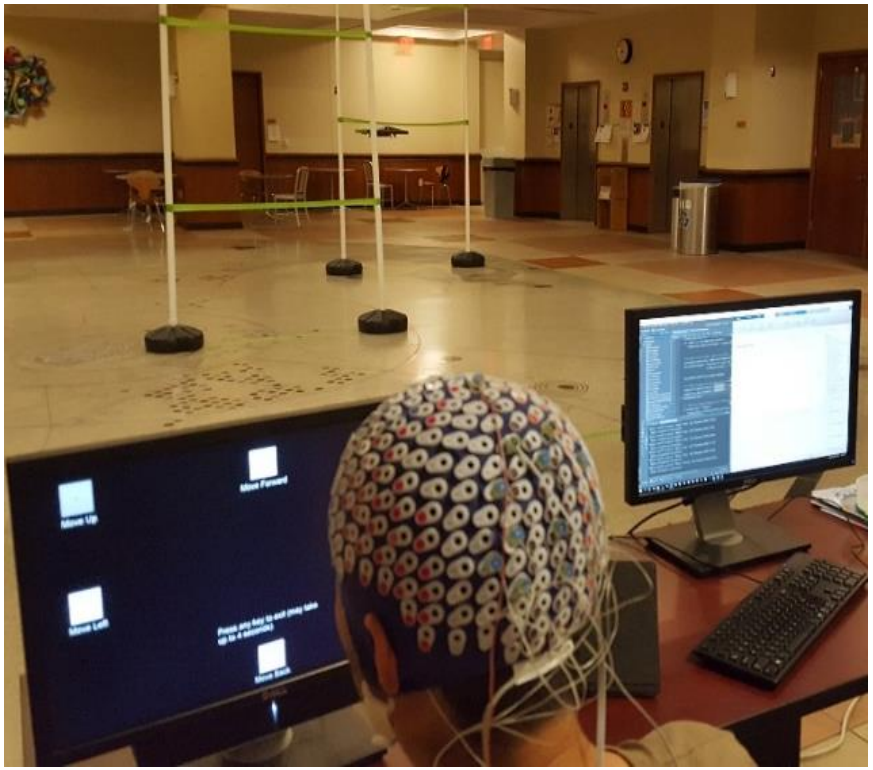
ID 2 exceeds normal transaction time threshold; notification displayed

Person lying on the floor

Unattended object alert

Technology Exported projects : Control UAV using Asynchronous BCI

Steady-State Visual Evoked Potentials (SSVEP)



Current work: Asynchronous BCI Control of a Paraplegic Person on a Wheelchair

Completed work: Smart walker for the blind

AI for Good
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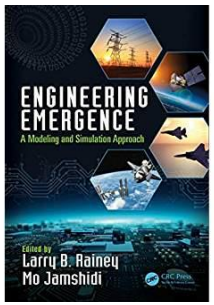
2-4 September, Ferdowsi University of Mashhad, Mashhad, Iran.

Free Publications

- 12 Textbooks in Systems, Controls, Robotics, AI and Systems of Systems (one on LSS &FL in French)



- **Publication link :**

http://www.wacong.org/freepublicationsbymojamshidi/,

ID and PW not needed.

THANK YOU

AI for Good

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