

Planner Design for Optimization of Power Utilization for BIO-Plex in Advanced Life Support Systems

NASA IS CURRENTLY BUILDING the Bioregenerative Planetary Life Support Test Complex (BIO-Plex) for long duration testing of advanced life support systems and procedures. One of the primary objectives of BIO-Plex is the development and testing of an integrated monitoring and control system to coordinate the complex interactions of the numerous life support systems. A three-tiered software tool, 3T, is being used for this task. The planning tier of 3T currently consists of AP, an adversarial planner developed for the battlefield management planning domain. A planner is needed for BIO-Plex missions because of the large number of activities and limited crew time available to spend on planning and scheduling these activities. This research proposes to develop an electrical power utilization model and incorporate it into the planning tier of 3T. This model will allow the planner to select and schedule activities that meet the available power limits. This model takes into account the interactions between systems that effect the consumption of electrical power. For example, the kitchen stove, clothes dryer, incinerator, and lights all consume power but also increase the load on the thermal control system causing it to consume additional power. A model is required since an individual activity, such as running the growth bay lights, cannot accurately predict the additional power required by the thermal control system. A model-based planner can select and schedule activities to minimize the peak power demands and increase the effectiveness of power utilization.



Table 1. Partial List of BIO-Plex Devices

Device	Direct Use	Produce Heat	Consume O_2
Lights	X	X	
Incinerator	X	X	X
TCS	X	X	
Crew			X
Stove/Oven	X	X	
Clothes Dryer	X	X	
Computers	X	X	
Germination Box	X	X	

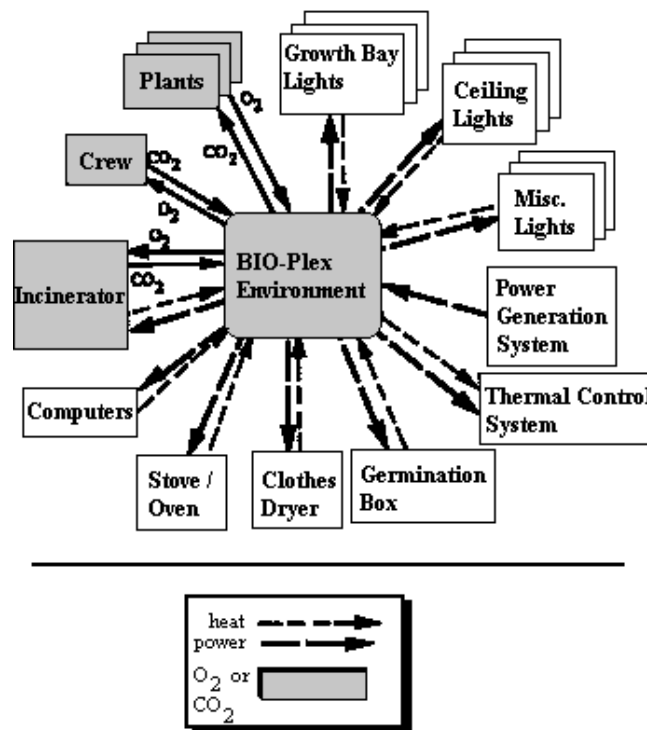


Fig. 1. Model Elements and Interactions

Publications

- Chen, G., G. R. Chen, and L. Hong. "A Perceptual Grouping and Fuzzy Logic Approach for Object Recognition from Ambiguous Images," *J. of Latin Amer. Appl. Research* 27 (1997): 207-2187.
- Chen, G. R. "Designing an Adaptive Controller in Fuzzy-Neural-Network," *J. of Jiangnan Petroleum Institute* 19 (1997): 115-20.
- Chen, G. R. and D. Zhang. "Back-Driving a Truck with Suboptimal Distance Trajectories: A Fuzzy Logic Control Approach," *IEEE Trans. on Fuzzy Systems* 5 (1997): 369-80.
- . "Back-Driving a Truck-Trailer with Suboptimal Trajectories: Fuzzy Controller Design and Stability Analysis," 2nd Workshop on Advances in Sys. Sci. Appl., San Marcus, TX, Jan. 9-11, 1997; invited paper in *Advances in Systems Sciences and Applications*, Int'l Institute for General Systems Studies, Inc., 1997. 467-71.
- Chen, G. R. and H. Ying. "BIBO Stability of Nonlinear Fuzzy PI Control Systems," *J. of Intell. & Fuzzy Sys.* 5 (1997): 245-56.
- Chen, G. R., J. Wang, and L. S. Shieh. "Interval Kalman Filtering," *IEEE Trans. on Aero. Elect. Sys.* 33 (1997): 250-59.
- Chen, G. R., P. Julian, and A. Desages. "Trajectory Tracking and Robust Stability for a Class of Time-Delayed Flexible-Joint Robot Manipulators," *Int'l J. of Control* 68 (1997): 259-76.
- Chen, G. R., Y. Chen, and H. Ogmen. "Identifying Chaotic Systems via a Wiener-Type Cascade Model," *IEEE Control Systems* 17 (1997): 29-36.
- Chui, C. K. and G. R. Chen. *Discrete H Optimization*. Springer-Verlag, 2nd edition, 1997.
- Dowell, M. and G. R. Chen. "Requirements for Planners for High-Level Monitoring and Control of Advanced Life Support Systems," *Proc. of Joint Conf. on Comput. & Intel. Sys.*, Durham, NC, March 2-5, 1997.
- Feng, F., L. S. Shieh, and G. R. Chen. "Model Conversions of Uncertain Linear Systems Using Interval Multipoint Pade Approximation," *Appl. Math. Model* 21 (1997): 233-44.
- Han, Z. and G. R. Chen. "Dynamic Right Coprime Factorization for Nonlinear Systems," *Nonlinear Analysis* 30 (1997): 3113-20.
- Hong, L., J. Cao, and G. R. Chen. "A Multiresolutional Approach to 3D Object Recognition," *Circ. Sys. Sign. Proc.* 16 (1997): 217-39.
- Hsu, Y. C. and G. R. Chen. "Design of a Fuzzy PD-Sliding Mode Adaptive Controller," *Proc. of Joint Conf. on Comput. & Intel. Sys.*, Durham, NC, March 2-5, 1997. 255-58.
- Hsu, Y. C., G. R. Chen, and E. Sanchez. "A Fuzzy PD Controller for Multi-Link Robot Control: Stability

Analysis," *Proc. of Int'l Conf. on Robot. Automa.*, Albuquerque, NM, April 20-25, 1997. 1412-17.

Hsu, Y. C., G. R. Chen, and H. Malki. "Fuzzy Logic and Neural Network Based Adaptive Controller Design," *Proc. of Int'l Conf. on Neural Networks*, Houston, TX, June 8-12, 1997. 1705-09.

Malki, H., D. Feigen span, D. Misir, and G. R. Chen. "Fuzzy PID Control of a Flexible-Joint Robot Arm with Uncertainties from Time-Varying Loads," *IEEE Trans. on Contr. Sys. Tech.* 5 (1997): 371-78.

Moiola, J. L., D. W. Berns, and G. R. Chen. "Feedback Control of Limit Cycle Amplitudes," *Proc. of IEEE Conf. on Decis. Contr.*, San Diego, Dec. 1997. 1479-85.

Moiola, J. L., D. W. Berns, G. R. Chen, and H. Ogmen. "Detecting Oscillations in Neural Networks via Frequency Domain Analysis," *Proc. of Int'l Conf. on Neural Networks*, Houston, TX, June 8-12, 1997. 669-74.

Siouris, G., G. R. Chen, and J. Wang. "Tracking an Incoming Ballistic Missile," *IEEE Trans. on Aero. Elect. Sys.* 33 (1997): 232-40.

Stotz, H. and G. R. Chen, "Fuzzy Logic Motion Control of a Multi-Link Robot Arm Model," *Proc. of the Engr & Arch. Symp.*, Prairie View, TX, Feb. 6-7, 1997. 167-71.

Wu, H., J. Lu, and G. R. Chen. "Recursive Filtering for Discrete-Time Nonlinear Systems," *Proc. of the Engr & Arch. Symp.*, Prairie View, TX, Feb. 6-7, 1997. 197-203.

Ying, H. and G. R. Chen. "Necessary Conditions for Some Typical Fuzzy Systems as Universal Approximators," *Automatica* 33 (1997): 1333-38.

Presentations

Chen, G. R. "Fuzzy Control Technology and its Applications in Petroleum Industry," lecture series, Jiangnan Petroleum Institute, P. R. China, June 26-July 3, 1997.

Funding

"Robust Optimal Digital Control of Uncertain Multi-Rate Sampled-Data Systems." Co-Investigator: L. S. Shieh; U. S. Army Research Grant Program, 1994-2001, \$180,000 + \$200,000.

"A Fuzzy Expert System for Fault Management of Water Supply and Recovery in the ALSS Project." Co-Investigator: J. Li; NASA-JSC, Intelligent Systems Division, 1995-1997, \$100,000.

"Ultrasound Measurement and Control System Development." Subcontract from UT Medical Branch at Galveston, 1996-1998, \$30,000.

"The Development of a Fuzzy-Logic-Based Approach for Smart Oil Recovery." Univ. of Houston Energy Laboratory, 1997, \$12,797.

"Improving Student Learning in Electro-Mechanical Systems." Co-Investigators: G. Reddy, K. Grigoriadis, and H. Malki; Univ. of Houston, 1997, \$10,000.

Investigative Team

UH PI: G. Ron Chen, Ph.D., Professor,
Department of Electrical and Computer
Engineering
gchen@uh.edu

JSC Co-PI: Jane T. Malin, Ph.D., Automation,
Robotics, and Simulation Division, SLSS
jmalin@gp301.jsc.nasa.gov

UH Post-doctoral Fellow: Mike Dowell, Ph.D.,
Electrical and Computer Engineering, completed
Aug. 1997

Ya-Chen Hsu, Ph.D., Electrical Engineering
Jialiang Lu, Ph.D., Electrical Engineering

[Contents](#)

ISSO -- Institute for Space Systems Operations
1997-1998 Annual Report