The flexibility of the Tower System peripheral interface will only require minor adjustments in the *Communicator* hardware and software to incorporate any proprietary wireless technologies that may be used in commercially available ECG systems.

V. Conclusions and Future Directions

A high degree of accuracy was achieved in predicting atrial arrhythmia in 8 patients using only an external ECG when we used an ANN neural network with 10 hidden neurons with a back propagation algorithm.

Future work involves extracting information from the EGM that compliments the information of the surface ECG and implementing these algorithms on hardware. In addition we plan to explore the benefits of using the VCG representation by converting both the ECG and the EGM signals into the VCG format, VCG_{EGM} and VCG_{ECG} respectively, to see if this improves decision making of the learning system [13].

Acknowledgment

This research was supported in part by Jabil Inc., NSF Grant IIP-1217306, the Florida 21st Century Scholars program and the Florida High Tech Corridor Matching Grants Research Program.

References

[1] A. Kadish, "Heart Failure Devices: Implantable Cardioverter-Defibrillators and Biventricular Pacing Therapy," *Circulation*, vol. 111, no. 24, pp. 3327–3335, Jun. 2005.

[2] J. A. Warren, R. D. Dreher, R. V. Jaworski, J. J. Putzke, and R. J. Russie, "Implantable cardioverter defibrillators," *Proceedings of the IEEE*, vol. 84, no. 3, pp. 468–479, Mar. 1996.

[3] S. Farrugia, H. Yee, and P. Nickolls, "Neural network classification of intracardiac ECG's," in *IEEE International Joint Conference on Neural Networks*, pp. 1278–1283.

[4] C. M. Bishop, *Pattern recognition and machine learning*. New York: Springer, 2006.

[5] I. Witten, E. Frank, and M. Hall, *Data Mining: Practical Machine Learning Tools and Techniques*, Third. Morgan Kaufmann.

[6] Y. Fukuoka, M. Fukuhara, and A. Ishida, "Stress assessment based on ECG using neural networks," in *Proceedings of the 18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 1996. Bridging Disciplines for Biomedicine*, 1996, vol. 5, pp. 1802–1803 vol.5.

[7] I. A. Tarmizi, S. S. N. A. S. Hassan, and W. P. W. Ibrahim, "A journal of real peak recognition of electrocardiogram (ECG) signals using neural network," in *2012 Second International Conference on Digital Information and Communication Technology and it's Applications (DICTAP)*, 2012, pp. 504–509.

[8] F. Poree, A. Kachenoura, G. Carrault, R. D. Molin, P. Mabo, and A. I. Hernandez, "Surface Electrocardiogram Reconstruction From Intracardiac Electrograms Using a Dynamic Time Delay Artificial Neural Network," *IEEE Transactions on Biomedical Engineering*, vol. 60, no. 1, pp. 106–114, Jan. 2013.

[9] Y. Suzuki, "Self-organizing QRS-wave recognition in ECG using neural networks," *IEEE Transactions on Neural Networks*, vol. 6, no. 6, pp. 1469–1477, Nov. 1995.

[10] *Comprehensive electrocardiology: theory and practice in health and disease*, 1st ed. New York: Pergamon Press, 1989.

[11] A. L. Goldberger, L. A. N. Amaral, L. Glass, J. M. Hausdorff, P. C. Ivanov, R. G. Mark, J. E. Mietus, G. B. Moody, C.-K. Peng, and H. E. Stanley, "PhysioBank, PhysioToolkit, and PhysioNet : Components of a New Research Resource for Complex Physiologic Signals," *Circulation*, vol. 101, no. 23, pp. e215–e220, Jun. 2000.

[12] S. Haykin, *Neural Networks: A Comprehensive Foundation*, 1st ed. Upper Saddle River, NJ, USA: Prentice Hall PTR, 1994.

[13] G. S. Mendenhall, "Implantable and surface electrocardiography: complementary technologies," *Journal of Electrocardiology*, vol. 43, no. 6, pp. 619–623, Nov. 2010.