## Practical Blind Demodulation: Theory and Design

John R. Treichler and C. Richard Johnson, Jr.

• Abstract: While blind demodulation (including equalization) was born as a niche application, the explosion over the last several years of multipoint and broadcast communication systems has revealed the broad utility of this technology. The first blind equalization algorithms (to move beyond decision-directed adaptation) were developed approximately 2 decades ago. The first commercial products are now little more than a decade old. A variety of large and small companies are currently developing blind demodulators for a variety of emerging communication systems, including high definition televisions and CDMA systems for mobile users. This tutorial will provide an overview of (i) design issues resolved in producing blind demodulators and (ii) published behavior theory on the constant modulus algorithm as a blind equalizer. These two segments will each will run for approximately 90 minutes. There will be videotapes of (a) working gear and (b) Matlab-based demos of blind equalization algorithms. This tutorial is a byproduct of two recent invited papers appearing in the October 1998 special issue of the Proceedings of the IEEE on blind system identification and estimation: J. R. Treichler, et al., "Practical Blind Demodulators for High-Order QAM Signals" and C. R. Johnson, Jr., et al., "Blind Equalization Using the Constant Modulus Criterion: A Review".

## • Outline

- Design Issues (Treichler)
  - \* Classical design of QAM demodulators
  - \* Blind acquisition in data transmission systems
  - \* System design issues for blind demodulation
  - \* Hardware and firmware implementations of blind QAM demodulators

- CMA Behavior Theory (Johnson)

- \* Fractionally-spaced equalizer design
- \* Constant modulus cost function as proxy for mean squared error
- $\ast\,$  Robustness properties of equalizers based on the constant modulus algorithm
- \* Extensions, open problems and research areas

## • Speaker's Biographies

- John Treichler (Fellow, IEEE) was born in Velasco, TX, in 1947. He received the B.A. and M.S. degrees in electrical engineering from Rice University, Houston, TX, in 1970 and the Ph.D. degree in electrical engineering from Stanford University, Stanford, CA, in 1977. From 1970 to 1974, he was in the U.S. Navy and spent the next three years at Stanford University. From 1977 to 1983, he was employed with ARGOSystems, Inc., Sunnyvale, CA. He is currently the Senior Scientist at Applied Signal Technology, Inc., Sunnyvale, CA. He has served as a Lecturer at Stanford and spent the 1983-84 academic year at Cornell University as an Associate Professor in the School of Electrical Engineering. His current interests are in the area of digital and adaptive signal processing, particularly as applied to communication problems.
- C. Richard Johnson, Jr. (Fellow, IEEE) was born in Macon, GA, in 1950. He received the B.E.E. from the Georgia Institute of Technology, Atlanta, GA, in 1973. He received the Ph.D. degree in electrical engineering with minors in engineering-economic systems and art history from Stanford University, Stanford, CA, in 1977. From 1977 to 1981, he was an Assistant Professor in the School of Electrical Engineering at Virginia Polytechnic Institute and State University, Blacksburg, VA. In 1981 he joined the faculty of Cornell University, Ithaca, NY, where he is currently a Professor of Electrical Engineering and a member of the Graduate Field of Applied Mathematics. His current research interest is in adaptive parameter estimation theory, which is useful in applications of digital signal processing to telecommunication systems.

## • URLs

- Dr. Treichler's company's web page is located at http://www.appsig.com.
- Professor Johnson's research group's web page is located at http://backhoe.ee.cornell.edu/BERG/.