What would I do with a math degree? I don’t want to teach!

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Core Practices

The national standards propose that mathematical training provides for much more than just technical skills.

National Mathematics Standards

- **Mathematical Practice**
  Proficient students expect mathematics to make sense. They take an active stance in solving mathematical problems. When faced with a non-routine problem, they have the courage to plunge in and try something, and they have the procedural and conceptual tools to carry through. They are experimenters and inventors, and can adapt known strategies to new problems. They think strategically.

Attend to precision

Mathematically proficient students organize their own ideas in a way that can be communicated precisely to others, and they analyze and evaluate others' mathematical thinking and strategies noting the assumptions made. **They clarify definitions.** They state the meaning of the symbols they choose, are careful about specifying units of measure and labeling axes, and express their answers with an appropriate degree of precision. Rather than saying, "let *v* be speed and let *t* be time," they would say "let *v* be the speed in meters per second and let t be the elapsed time in seconds from a given starting time." They recognize that when someone says the population of the United States in June 2008 was 304,059,724, the last few digits indicate unwarranted precision.

Construct viable arguments

Mathematically proficient students understand and use stated assumptions, definitions and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They break things down into cases and can recognize and use counterexamples. **They use logic to justify their conclusions**, communicate them to others and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose.

Make sense of complex problems and persevere in solving them

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They consider analogous problems, try special cases and work on simpler forms. They evaluate their progress and change course if necessary. They try putting algebraic expressions into different forms or try changing the viewing window on their calculator to get the information they need. They look for correspondences between equations, verbal descriptions, tables, and graphs. They draw diagrams of relationships, graph data, search for regularity and trends, and construct mathematical models. They check their answers to problems using a different method, and they continually ask themselves, **"Does this make sense?"**

Look for and make use of structure

Mathematically proficient students look closely to discern a pattern. For example, in $x^2 + 5x + 6$ they can see the 5 as 2 + 3 and the 6 as 2 × 3. They recognize the significance of an existing line in a geometric figure and can add an auxiliary line to make the solution of a problem clear. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects. For example, by seeing $5 – 3(x – y)^2$ as 5 minus a positive number times a square, they see that it cannot be more than 5 for any real numbers x and y.

Look for and express regularity in repeated reasoning

Mathematically proficient students pay attention to repeated calculations as they carry them out, and look both for general algorithms and for shortcuts. For example, by paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, they might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in the way terms cancel in the expansions of $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x2 + x + 1)$ leads to the general formula for the sum of a geometric series. **As they work through the solution to a problem, proficient students maintain oversight of the process, while attending to the details.** They continually evaluate the reasonableness of their intermediate results.

Make strategic decisions about the use of technological tools

Mathematically proficient students consider the available tools when solving a mathematical problem, whether pencil and paper, ruler, protractor, graphing calculator, spreadsheet, computer algebra system, statistical package, or dynamic geometry software. They are familiar enough with all of these tools to make sound decisions about when each might be helpful. They use mathematical understanding and estimation strategically, attending to levels of precision, to ensure appropriate levels of approximation and to detect possible errors. **They are able to use these tools to explore and deepen their understanding of concepts.**

Mathematical Training for the Future

- Any employer would love to have these characteristics in an employee.
- Mathematical training does much more than teach arithmetic, algebra or geometry. It teaches the student a point of view.
- Should we expect less than these standards at the university level?
- In looking over your courses and curricula, I suggest keeping these course standards in mind.

What would I do with a math degree? I don't want to teach!

- If we are to increase the number of mathematics majors, we need to be able to answer this question.
- The education of faculty perhaps does not provide us with the background to answer this question.
- What is our educational path?

Typical Education Path

- BS in math, a minor in a variety of fields
- Graduate school-two-three years of basic course work, then focused research
- Faculty position-work hard to publish

- With this experience, how does one advise a student who does not intend to pursue an advanced degree in mathematics?

Applications of Mathematics

- What would one do with a BS in mathematics?
- Most of the math majors that I work with will not be pursuing graduate studies in the mathematical sciences.
- Nationwide fewer than 5% pursue graduate studies in math.
- The percentage of our graduates who pursue post-graduate studies has been over 25%.
- Other academic fields seek math majors.

Four UA Students Named Goldwater Scholars

The four UA students to be named Goldwater Scholars are (left to right) Stacy Marla Shiffler, Jennifer Sierchio, Beryl Jones and Troy J. Comi. (Photo courtesy of Leslie Johnston)

Each of the University of Arizona students nominated for the Goldwater Scholarship was selected for the award – a rarity for most institutions nationally.

Of the 278 scholarships awarded by the **Barry M. Goldwater Scholarship and Excellence in Education Foundation** for the 2010-2011 year, four of them were UA Honors College students.

"We typically have at least one, usually two and sometimes three students selected but in my recollection, this is the first time we've had all four selected," said Karna Walter, director of nationally competitive scholarships at the UA's **Honors College**.

Troy Comi : Comi, a senior, majors in chemistry, biochemistry, computer science, mathematics and molecular and cellular biology.

Beryl M. Jones : A triple major studying biochemistry and molecular biophysics, ecology and evolutionary biology and also molecular and cellular biology, Jones also has minors in chemistry and mathematics.

Stacy Marla Shiffler: A physics and applied mathematics major.

Jennifer Sierchio: A triple major in astronomy, physics and mathematics.

Dec 07, Message 1, no response

- William Velez wrote:

  Dear Stacy:

  I was going over enrollments for math 223 and I came across your name. I see that you did very well in this course and I congratulate you for your efforts. It appears that you are interested in physics. Have you ever thought of adding mathematics as another major? If you have any thought of pursuing an advanced degree in physics you will find that the undergraduate mathematics will be of tremendous assistance in that endeavor. After 254 you only need to take 7 more mathematics courses to complete the math major requirements. Here is a sample schedule that would allow you to complete the math major requirements in four years.

  S08: 254
  F08: 215
  S09: 323, 422
  F09: 454
  S10: 456
  F10: 413
  S11: 485

  If you would like to talk about these possibilities, send me a message and we can arrange to meet in my office. My office, Math 219, is part of the Math Center.

  Best. WYV

April 08, Message 2
Following my suggested schedule

- Quoting William Velez <velez@math.arizona.edu>:

  Dear Stacy:

  I see that you are enrolled in math 215 and 422 for the fall. I have revised the schedule to show you what would remain to have you complete the math major requirements.

  F09: 215, 422
  S10: 485, 323
  F10: 413, 454
  S11: 456

  Would you like to stop by and discuss the benefits of adding math as another major>

  WYV

October 08, Finally, a reply

- Dear Dr. Velez,

  Thank you for taking the time to contact me and send me a tentative schedule. I am considering declaring a math major, but I am going to wait and see how I do next semester with 215 and 422 and then make a decision. I want to be sure that I really enjoy math before I make any commitments. If I have any questions next semester I will certainly contact you.

  Thanks again for spending your time on this; it really is encouraging and helpful.

  Stacy Shiffler

My reply

- Great, I look forward to hearing from you. Since you are interested in mathematics, I would like to talk to you, even if you are not ready to declare the math major. The schedule that I sent you is but one of the options that are available for math majors. I would like to get a better idea as to you academic plans so that I can provide you with better advice.

  I am currently in Chicago and I won't be home until Wednesday. Could we talk next week? What times are you available on Thursday or Friday of next week?

  WYV

Finally, a math major

- Dear Dr. Velez,

  Would it be possible for me to come and speak to you about declaring a math major? I have considered what we discussed over the last few months, and I have a couple of questions. I could meet with you any afternoon except Wednesday, and if those times don't work, please let me know.

  Thanks!

  Stacy Shiffler

Most math majors will join the workforce

- Begin developing a sense of professionalism by having students create a resume.
- Internships with industry and national labs.
- http://www.dep.anl.gov/p_undergrad/
- Encourage students to minor in computer science or engineering.
- Career fairs on campus, visit them and talk to recruiters. Take students with you.

Internships

- http://www.nsf.gov/crssprgm/reu/reu_search.cfm

Message about summer internships

- Our department will be hosting a summer REU. The topic is computational photonics and students should have completed courses in differential equations and linear algebra. Here is the website for it: http://math.arizona.edu/~brio/Class/Summer09Info.html

  DO NOT REQUIRE MATH 323
  1. Central Michigan University: requires second semester calculus and linear algebra.
  2. Grand Valley State University: requires second semester calculus and linear algebra.
  3. University of Nebraska – Lincoln: calculus and differential equations
  4. University of Wisconsin-Eau Claire: completed two courses beyond calculus
  5. Wabash College: differential equations

  AVAILABLE FOR STUDENTS WHO ARE NOT US CITIZENS OR PERMANENT RESIDENTS
  1. Williams College (If funds are available)
  2. Worcester Polytechnic Institute (If funds are available)

  INTERNATIONAL COMPONENT
  1. IPAM: Institute for Pure and Applied Mathematics (China)
  2. Rutgers University - New Brunswick (Czeck Republic)

STUDENTS WHO GRADUATE IN MAY 09 MAY APPLY

1. IPAM: Institute for Pure and Applied Mathematics

ONE OF OUR PhDS IS INVOLVED

1. California State Polytechnic University, Pomona (Ben Leavit earned his PhD here)

MATHEMATICS EDUCATION

1. San Diego State University

THERE ARE AN INCREASING NUMBER OF REU SITES ON STATISTICS

1. California State Polytechnic University, Pomona
2. James Madison University
3. Oakland University
4. Rice University
5. Williams College
6. Worcester Polytechnic Institute

FINANCIAL MATHEMATICS

1. Lafayette College
2. University of Illinois
3. Worcester Polytechnic Institute

Profiles of math graduates.

- AMS started a program about 5 years ago requesting departments to create profiles of their graduates who did not pursue postgraduate studies in math.
- http://math.arizona.edu/ugprogram/prospective/alumniprofiles.html
- Contact graduates and maintain communication.
- Create profiles of your own graduates.

Local situation

- Understand where your graduates are going.
- Connect them to research projects on campus.
- Have a dedicated faculty member direct students towards summer REUs and internships.
- http://www.scied.science.doe.gov/scied/fast/project_desc_2010.html
- Idaho

ORISE and ORAU

- http://see.orau.org/Listing.aspx?Type=Undergrad

American Society for Engineering Education

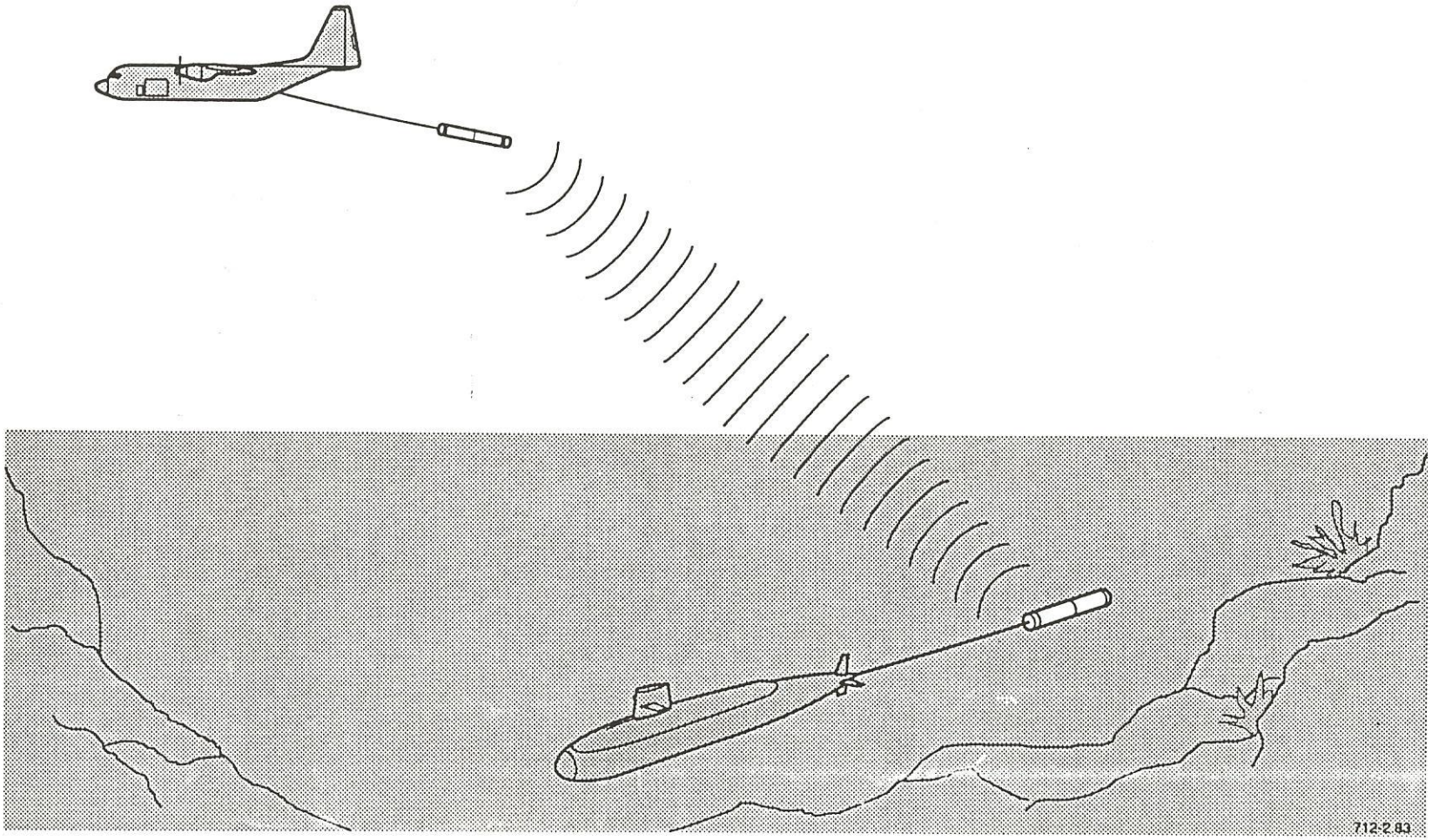
- http://www.asee.org/about-us

- My own experiences in applied math
- Intern at Bell Labs
- Sandia National Laboratories
- Command and Control of Atomic Weapons Systems
- Back to Academia
- ASEE

NOSC

Navy Problem

Maintain Communications Between Command Authorities and Submarines Under Hostile Conditions



US005495496A

United States Patent [19]

Bond et al.

[11] **Patent Number: 5,495,496**

[45] **Date of Patent: Feb. 27, 1996**

[54] **METHOD AND APPARATUS FOR SUPPRESSING LINEAR AMPLITUDE INTERFERENCE FROM BANDSPREAD COMMUNICATION SIGNALS**

[75] Inventors: **James W. Bond**, San Diego, Calif.; **Williams Velez**, Tuscon, Ariz.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy**, Washington, D.C.

[21] Appl. No.: **766,605**

[22] Filed: **Sep. 26, 1991**

[51] **Int. Cl.**[6] **H04B 1/69**

[52] **U.S. Cl.** **375/200**; 375/208

[58] **Field of Search** 375/1, 200, 208; 380/34

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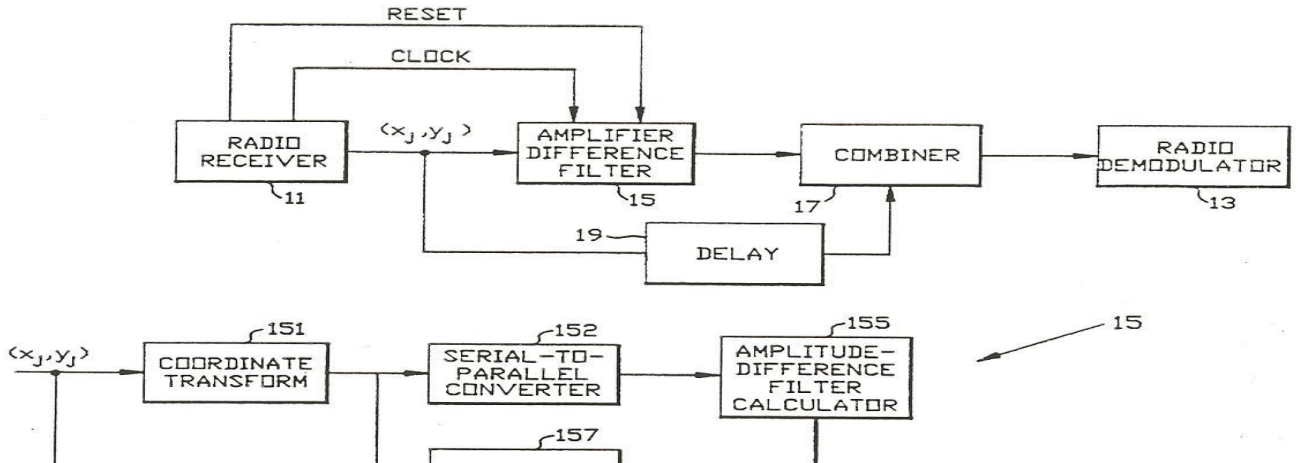
Primary Examiner—Salvatore Cangialosi

Attorney, Agent, or Firm—Harvey Fendelman; Thomas Glenn Keough

[57] **ABSTRACT**

A method and apparatus are provided for suppressing linear amplitude interference (e.g., on-off interference) from a sequence of bandspread communication signals generated by a radio receiver. Each sample is defined as a vector having signal and interference vector components. The interference vector component is such that the amplitude of the interference: 1) is essentially linear, and 2) dominates the signal component. To suppress the linear amplitude interference, a pseudo second derivative is obtained for each sample based upon the current, previous and subsequent sample amplitudes. The pseudo second derivative for each current sample is transformed into a corresponding pseudo second derivative vector based on a symmetric sampling of pseudo second derivatives from previous and subsequent received signal samples. All terms of each corresponding pseudo second derivative vector are summed and averaged to generate a corresponding average enhanced signal gain for each sample. Each corresponding average enhanced signal gain is multiplied by a normalized vector approximately parallel to the corresponding sample's interference vector component. This estimates the signal vector component that is parallel to the interference vector component for each sample as an indication of the desired communication signal. The method and apparatus are effective whenever the amplitude of the interference vector components is approximately linear over the time that the interference is present.

12 Claims, 4 Drawing Sheets



Final Thoughts

- My own limited experience is that mathematics applied in the real world is undergraduate level mathematics.
- Our mathematics majors have more than just knowledge, they have problem-solving skills.
- Our responsibility as mathematicians and educators is to make students aware of the importance of mathematical training.