

Application of Wavelets to Filtering and Analysis of
Self-Similar Signals

Karlton Edward Wirsing

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Master of Science
In
Electrical Engineering

Lamine M. Mili
Timothy Pratt
A. A. (Louis) Beex

March 21, 2014
Falls Church, Virginia

Keywords: Wavelet, Fractal, Self-Similarity, Hurst Exponent, Long Memory, Pink Noise,
Red Noise, White Noise, Daubechies Wavelet, Coiflet, Symlet, Discrete Wavelet
Transform, Stationary Wavelet Transform, Vanishing Moment, Threshold Function,
Hurst Exponent

Copyright © 2014 Karlton Edward Wirsing
All Rights Reserved

Copyright Release Information

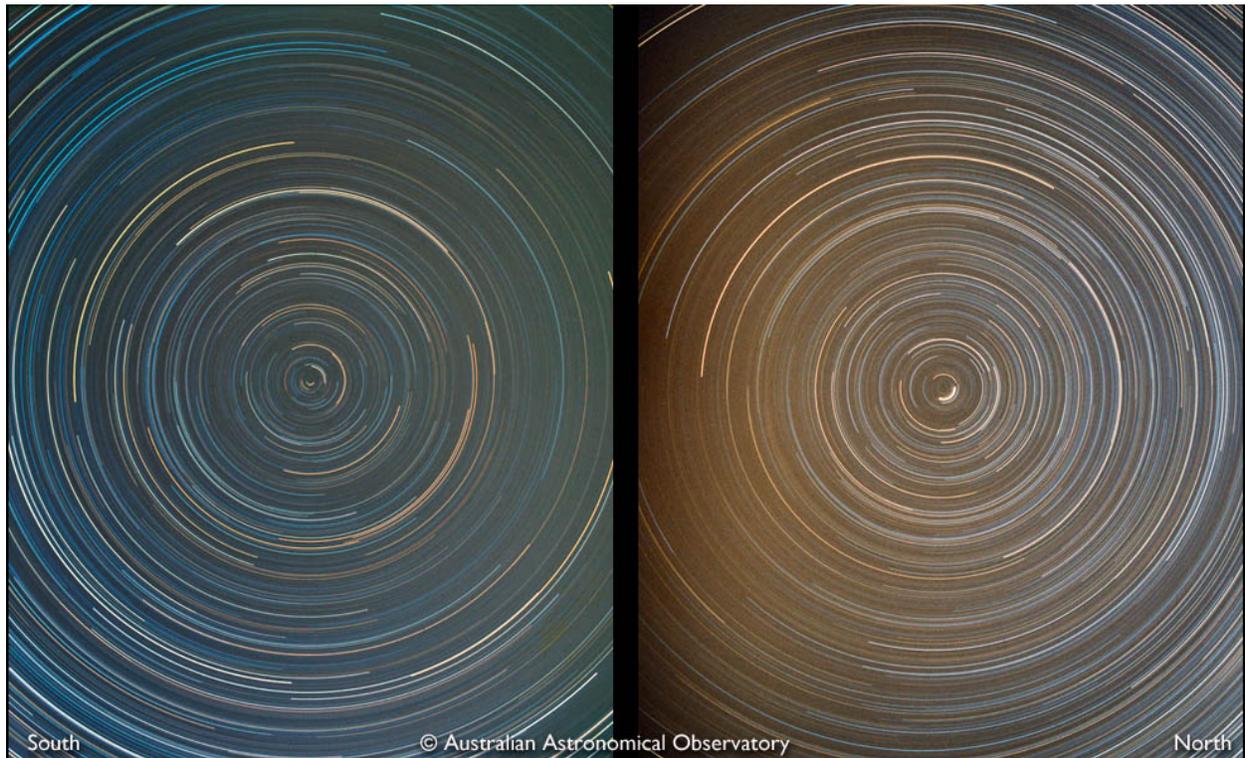


Figure 5-1: Pictures of the north and south celestial poles over several hours. The picture of the south celestial pole is at the Siding Spring Observatory in Australia, and the north celestial pole is at La Plama Observatory in the Canary Islands. Pictures © Australian Astronomical Observatory/David Malin Images [65]. Used with permission.

[65] D. Malin. (2012, December 3, 2013). *North and South celestial pole star trails*. Available: <http://tinyurl.com/star-trails-and-more>

Email Received from David Malin (david@davidmalin.com)
Date: 5/1/2014 1:06 AM
Subject: Re: North and South celestial pole star trails
To: Karlton Wirsing (wirsingk@acm.org)

Karlton

The AAO site images went off the air a few days ago. The observatory was transformed from an independent bi-national (Anglo-Australian) entity into an Australian Government funded body recently, and the images site, which I used to manage in retirement, is no longer accessible to people who have not been vetted. Vetting probably involves a lobotomy, so it will be a while before it reappears, though it will eventually.

However, you can find the image you mentioned (along with many other similar) on

<http://tinyurl.com/star-trails-and-more>

where you can download a ~800 x 2100 px version. If that's big enough for your thesis, please feel free to use it. The two preceding images (and aao2_08_6x6_10.jpg aao2_09_6x6_10.jpg) and are the components of this composite and are each 1200 px square, so feel free to use those instead.

Please credit the images "© Australian Astronomical Observatory/David Malin Images"

What's the title of your thesis, and how do these image fit?

Regards David Malin

On 1/05/2014 12:56 pm, Karlton Wirsing wrote:

I am a graduate student at Virginia Tech in the Electrical Engineering department and I was wondering if I could place your image of North and South celestial pole star trails in my Master's Thesis? I am not sure how copyright works versus fair use for that. The image was here: <http://www.aao.gov.au/images/captions/misc015.html>, but that page is no longer available. Thank you for your time.

Karlton Wirsing

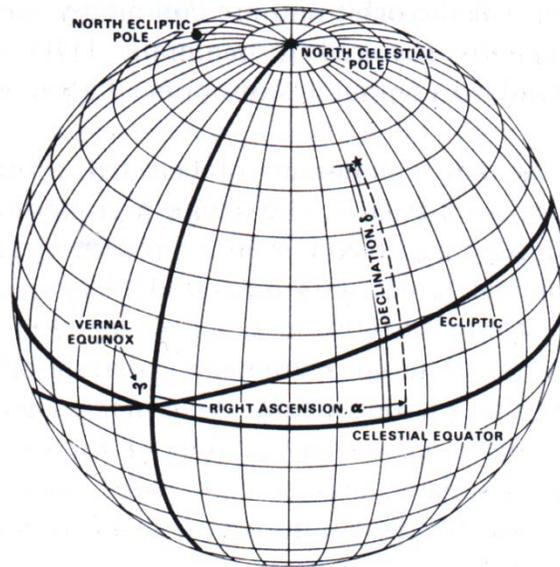


Figure 5-2: Diagram of the celestial sphere [64]. Used with permission.

[64] Computer Sciences Corporation. Attitude Systems Operation. and J. R. Wertz, *Spacecraft attitude determination and control*. Dordrecht ; Boston: Reidel, 1978.

According to (http://en.wikipedia.org/wiki/D._Reidel), “**D. Reidel** was an academic publishing company based in Dordrecht. It joined with Kluwer in the 1990s as Kluwer/Reidel, together being purchased by Cinven and Candover in 2003. Cinven and Candover also purchased Springer, merging the operations of all the publishers into one conglomerate, Springer Science+Business Media, from Spring of 2004. This conglomerate is now "the second largest commercial scholarly publisher in the world" after Elsevier.”

Email Received from: “Koorevaar, Frank, Springer SBM NL” Frank.Koorevaar@springer.com

Date: 5/21/2014 10:11 AM

Subject: FW: TN 294820 FW: Books and software: Individual customers CA

To: Karlton Wirsing (wirsingk@acm.org)

Dear Mr. Wirsing,

Thank you for your request.

With reference to your request to reprint material in which Springer Science and Business Media control the copyright, our permission is granted free of charge and at the following conditions:

Springer material

- represents original material which does not carry references to other sources (if material in question refers with a credit to another source, authorization from that source is required as well);
- requires full credit [Springer and the original publisher/journal title, volume, year of publication, page, chapter/article title, name(s) of author(s), figure number(s), original copyright notice] to the publication in which the material was originally published, by adding; with kind permission from Springer Science+Business Media B.V.;
- may not be altered in any manner. Abbreviations, additions, deletions and/or any other alterations shall be made only with prior written authorization of the author and/or Springer Science + Business Media.
- may not be republished in Electronic Open Access.

This permission

- is non-exclusive.
- includes use in an electronic form: provided it's password protected, or on intranet or university's repository, including UMI (according to the definition at the Sherpa website: <http://www.sherpa.ac.uk/romeo/>), or CD-Rom/E-book,
- is subject to a courtesy information to the author (address is given with the article/chapter).
- is personal to you and may not be sublicensed, assigned, or transferred by you to any other person without Springer's written permission.
- is valid only when the conditions noted above are met.

Permission free of charge on this occasion does not prejudice any rights we might have to charge for reproduction of our copyrighted material in the future.

Kind regards,

—

Frank Koorevaar
Springer
Rights and Permissions

—

Van Godewijckstraat 30
3311 GX
Dordrecht
The Netherlands

—

frank.koorevaar@springer.com

+31 (0) 78 657 6630

www.springer.com

-----Original Message-----

From: Customer Service

Sent: Wednesday, May 21, 2014 8:59 AM

To: Permissions Europe/NL

Subject: TN 294820 FW: Books and software: Individual customers CA

-----Original Message-----

From: SpringerAlerts@springeronline.com
[<mailto:SpringerAlerts@springeronline.com>]
Sent: Wednesday, May 21, 2014 3:35 AM
To: orders-HD-individuals, SCSC
Subject: Books and software: Individual customers

INTERNAL NAME - Your Contact To Springer ORIGINAL URL -
<http://www.springer.com/contact?SGWID=0-40103-0-0-0>

Additional information

FORM OF ADDRESS - Mr.
ACADEMIC TITLE -
FIRST NAME - Karlton
MIDDLE NAME -
LAST NAME - Wirsing
EMAIL - wirsingk@acm.org
ORGANIZATION -
DEPARTMENT -
STREET - 10398 Bermuda LN
STREETNUMBER -
CITY - Manassas
ZIP CODE - 20109
STATE - Virginia
COUNTRY - USA

Title - Spacecraft attitude determination and control QUESTION - Spacecraft attitude determination and control was published by D. Reidel publishing in 1978. From what I read on the internet, D Reidel eventually merged to become Springer. I was wondering if I could use a scan of the figure in the work of the celestial sphere in my Master's Thesis.

Thank you.

Karlton Wirsing

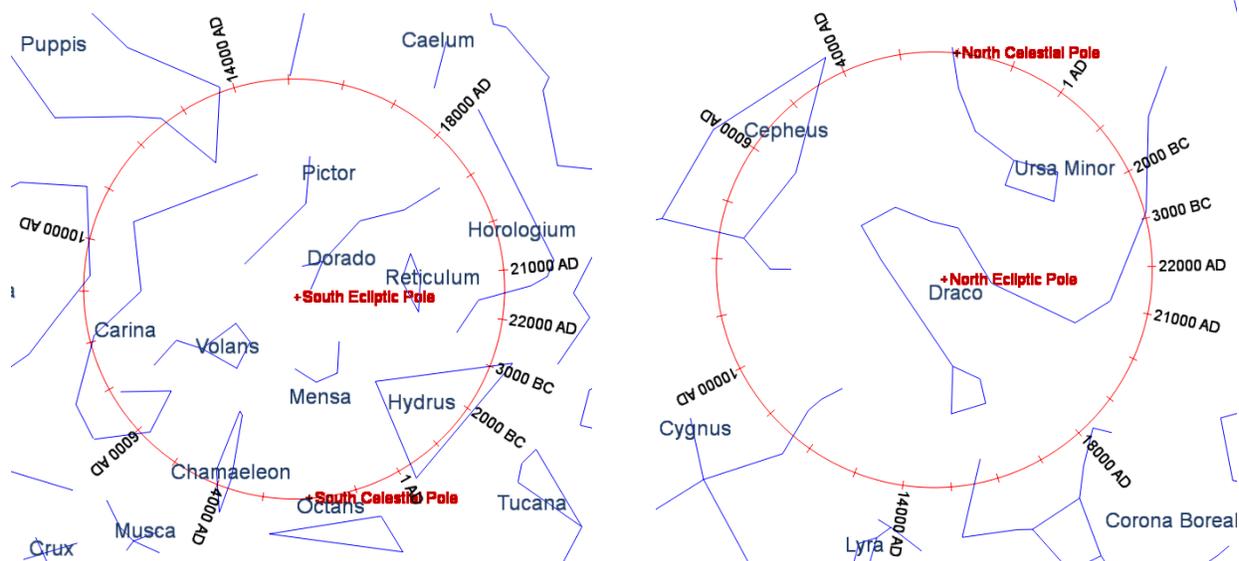


Figure 5-3: Picture of the precession of the south and north celestial poles around the ecliptic poles. The south celestial pole is on the left and the north celestial pole is on the right. Polaris is the current North Star; however this was not always the case. In 2850 BC, Thuban was the North Star. Image courtesy of Starry Night Education - www.starrynighteducation.com [66]. Used with permission.

[66] "Starry Night Professional," Pro Plus 6.0 ed: Simulation Curriculum Corp., 2009; www.starrynighteducation.com, e-mail: education@starrynighteducation.com.

Email Received from Keiron Smith (support@simcur.zendesk.com)
 Subject: [Simulation Curriculum Corp.] Re: Copyright Information
 Date: 5/26/2014 6:27 PM
 To: Karlton Wirsing (wirsingk@acm.org)

[Ticket #16170: Copyright Information](#)

Your request ([#16170](#)) has been updated.

To review the status of the request and add additional comments, follow the link below:
<http://support.simulationcurriculum.com/requests/16170>

You can also add a comment by replying to this email.

Keiron Smith, May 26 18:27:

Hi Karlton,

You have permission to use screenshots from Starry Night for non-commercial purposes, as long as you include the following credit:

"Image (or video) courtesy of Starry Night Education – www.starrynighteducation.com" adjacent to images and/or video in each and every instance of the image.

We also ask that you reference us using our web address (www.starrynighteducation.com) & email address (education@starrynighteducation.com) in the bibliography and reference sections of publications.

Note, this is only permission to use Starry Night graphics/images for non-profit publications.

If you wish to submit to or use Starry Night graphics/images in a commercial/for-profit publication like a newspaper/news website, etc, etc, then you must seek written consent from CEO Michael Goodman. Mr. Goodman can be reached here:

Michael Goodman
Simulation Curriculum Corp.
877-290-8256 (P)
952-935-4050 (F)
mgoodman@simcur.com

Keiron Smith
Starry Night & Sky Safari Software Support Team

Karlton Wirsing, May 20 21:22:

I was wondering if I could use these images from the Starry Night Professional software in my Masters thesis and what would be the appropriate citation? I am a licensed user.
Karlton Wirsing

Attachment(s)
[fdibdgha.png](#)
[jcjihgie.png](#)

This email is a service from Simulation Curriculum Corp..

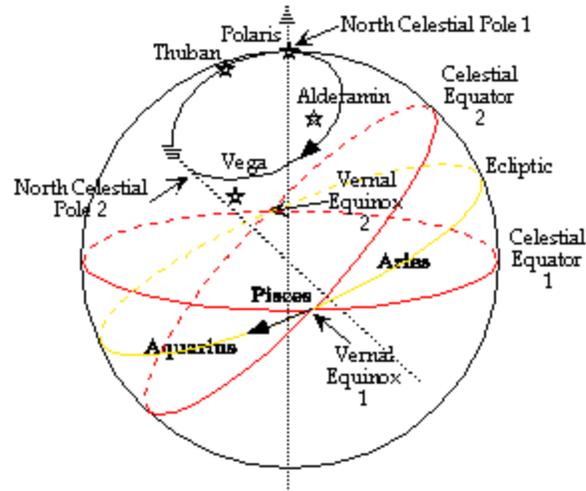


Figure 5-4: Effect of the precession of the celestial sphere. As the celestial poles change, so does the celestial equator. The ecliptic remains constant. North Celestial Pole 1 is the current celestial pole, and North Celestial Pole 2 will be the celestial pole in the future [67]. Image courtesy of Scott Anderson. Used with permission.

[67] S. R. Anderson. (2002, December 4, 2013). *Introduction to Astronomy*. Available: http://www.opencourse.info/astronomy/introduction/03.motion_earth/

Email Received from Scott R. C. Anderson (srca@mindspring.com)

Date: 5/21/2014 9:10 PM

To: Karlton Wirsing (wirsingk@acm.org)

Yes! Can I ask the subject?

Scott R. Anderson, Ph.D.
srca@mindspring.com

On Wednesday, May 21, 2014 6:46 PM MT, Karlton Wirsing <wirsingk@acm.org> wrote:

I was wondering if I could use this image as part of my Master's thesis? Thank you.

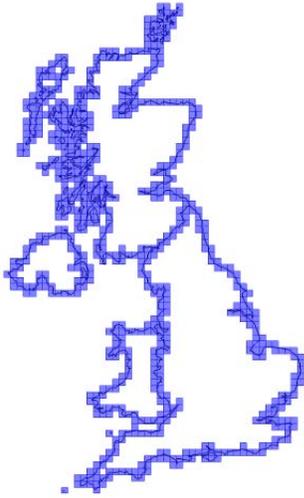


Figure 5-5: Great Britain covered by boxes with side length of 2^4 .

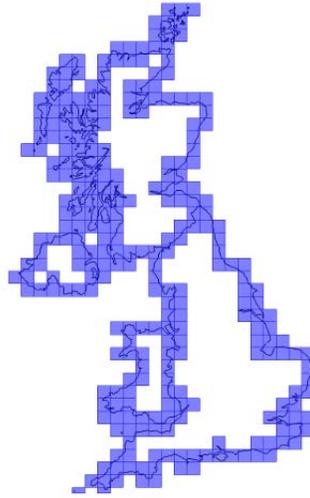


Figure 5-6: Great Britain covered by boxes with side length of 2^5 .

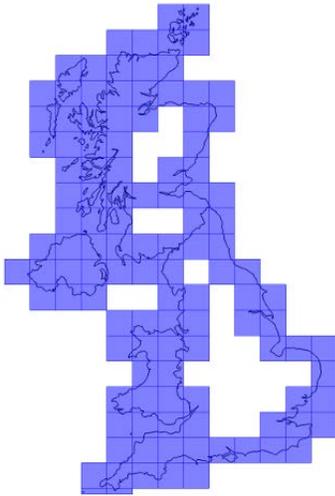


Figure 5-7: Great Britain covered by boxes with side length of 2^6 .

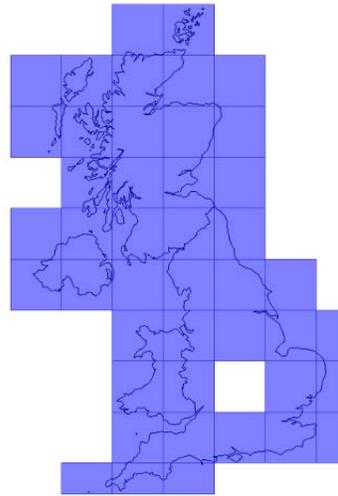


Figure 5-8: Great Britain covered by boxes with side length of 2^7 .

[72] d-maps.com. (2013). *Outline of United Kingdom of Great Britain and Northern Ireland*. Available: http://www.d-maps.com/carte.php?num_car=14447&lang=en

Email Received from d-maps.com (webmaster@d-maps.com)

Subject: Re: Copyright Use

Date: 5/22/2014 5:42 AM

To: Karlton Wirsing (wirsingk@acm.org)

Hi Karlton

Of course you can, my maps are made for that !

Just for my curiosity : it is a thesis about what ?

Daniel Dalet
d-maps.com
Digne (France)

Le 22/05/2014 03:08, Karlton Wirsing a écrit :

Can I use this map in my Master's thesis?

http://www.d-maps.com/carte.php?num_car=14447&lang=en

And possibly this map?

http://d-maps.com/carte.php?num_car=12683&lang=en

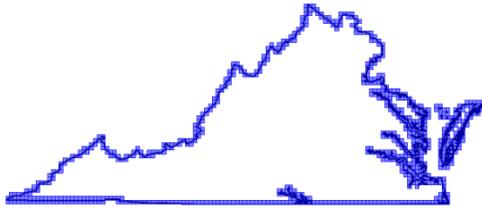


Figure 5-9: Virginia covered by boxes with side length of 2^3 .

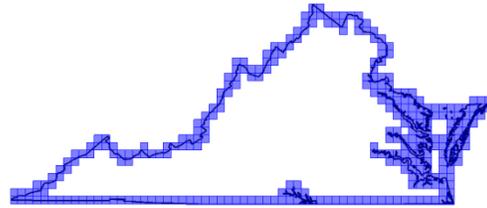


Figure 5-10: Virginia covered by boxes with side length of 2^4 .

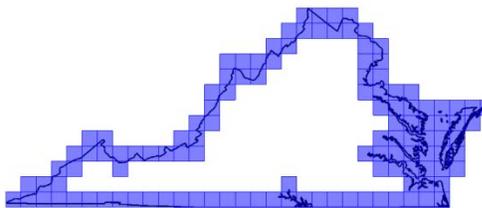


Figure 5-11: Virginia covered by boxes with side length of 2^5 .

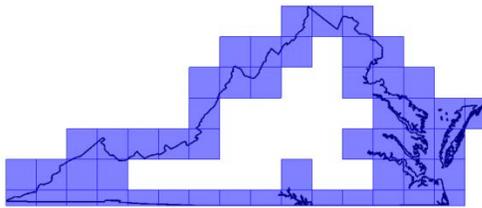


Figure 5-12: Virginia covered by boxes with side length of 2^6 .

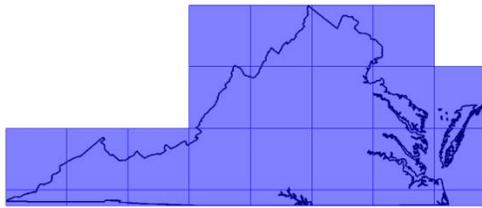


Figure 5-13: Virginia covered by boxes with side length of 2^7 .

[73] Facts.co. (January 5, 2014). *Blank Map of Virginia*. Available: <http://facts.co/virginia/virginiablankmap.png>

File no longer available at that url and no contact information is given. Since it is based on a map, it is assumed to be in the public domain.