

# **Investigation of Dynamic Ultrasound Reception in Bat Biosonar Using a Biomimetic Pinna Model**

Mittu Pannala

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

Doctor of Philosophy  
in  
Mechanical Engineering

Rolf Müller, Chair  
Javid Bayandor  
Alexander Leonessa  
Shashank Priya  
John Socha

November 1, 2013  
Blacksburg, Virginia

Keywords: bat biosonar, pinna deformation, biomimetic model,  
dynamic sensing, sensory coding capacity

Copyright 2013, Mittu Pannala


[Subject Areas](#)
[For Authors](#)
[About Us](#)

## Open-Access License

### No Permission Required

PLOS applies the [Creative Commons Attribution License \(CCAL\)](#) to all works we publish (read the [human-readable summary](#) or the [full license legal code](#)). Under the CCAL, authors retain ownership of the copyright for their article, but authors allow anyone to download, reuse, reprint, modify, distribute, and/or copy articles in PLOS journals, so long as the original authors and source are cited. **No permission is required from the authors or the publishers.**

In most cases, appropriate attribution can be provided by simply citing the original article (e.g., Kaltenbach LS et al. (2007) Huntingtin Interacting Proteins Are Genetic Modifiers of Neurodegeneration. *PLOS Genet* 3(5): e82. doi:10.1371/journal.pgen.0050082). If you plan to reuse is not part of a published article (e.g., a featured issue image), then please indicate the originator of the date of the journal in which the item appeared. For any reuse or redistribution of a work, you must also make clear the license was published.

This broad license was developed to facilitate open access to, and free use of, original works of all types. Applying this strategy will ensure your right to make your work freely and openly available. Learn more about [open access](#). For queries about the

Ambra 2.8.5 Managed Colocation provided  
by **Internet Systems Consortium**.

[Privacy Policy](#) | [Terms of Use](#) | [Advertise](#) | [Media Inquiries](#)

<b>Publications</b>	<b>pl</b>
PLOS Biology	<b>B</b>
PLOS Medicine	
PLOS Computational Biology	<b>C</b>
PLOS Currents	<b>S</b>
PLOS Genetics	
PLOS Pathogens	
PLOS ONE	
PLOS Neglected Tropical Diseases	



Mittu Pannala <[mittupannala@gmail.com](mailto:mittupannala@gmail.com)>

---

## Permission to reproduce an image from a paper

---

Hans Schneider <[drhschneider@netcologne.de](mailto:drhschneider@netcologne.de)>

Mon, Nov 11, 2013 at 11:58 AM

To: Mittu Pannala <[mpannala@vt.edu](mailto:mpannala@vt.edu)>

Dear Dr. Mittu Pannala,

thank you for your interest. You are permitted to reproduce Figure 3 (Abb. 3) from my publication "Die Ohrbewegungen der Hufeisennase (Chiroptera, Rhinolophidae) und der Mechanismus des Bildhörens", in case the publisher agrees as well.

Best wishes and good success for your graduation!

Prof. emeritus Dr. Hans Schneider

Institut für Zoologie

Universität Bonn

Poppelsdorfer Schloss

53115 Bonn, Germany

Tel.: +49-228-642106

E-Mail: [drhschneider@netcologne.de](mailto:drhschneider@netcologne.de)

---

**Von:** [mittupannala@gmail.com](mailto:mittupannala@gmail.com) [<mailto:mittupannala@gmail.com>] **Im Auftrag von** Mittu Pannala

**Gesendet:** Montag, 11. November 2013 15:37

**An:** Hans Schneider

**Betreff:** Permission to reproduce an image from a paper

Dear Dr. Schneider

I am Mittu Pannala, a graduating PhD student at Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

I would like to use the following figure in my Dissertation document. The figure is from the paper titled **"Die Ohrbewegungen der Hufeisenfledermaeuse (Chiroptera, Rhinolophidae) und der Mechanismus des Bildhoerens"**.

Figure 3 ("Abb. 3.")

Through this email, I would like to kindly request permission to reproduce this figure. As I use this picture, due credit and reference with the details about obtaining the copyright permission would be mentioned in the document. I have also requested permission from the publishers in a separate email.

Thankyou very much

--

Mittu Pannala  
Department of Mechanical Engineering  
Virginia Tech

## SPRINGER LICENSE TERMS AND CONDITIONS

Nov 12, 2013

This is a License Agreement between Mittu Pannala ("You") and Springer ("Springer") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by Springer, and the payment terms and conditions.

**All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.**

License Number	3266631220041
License date	Nov 12, 2013
Licensed content publisher	Springer
Licensed content publication	Zeitschrift für vergleichende Physiologie
Licensed content title	Die Ohrbewegungen der Hufeisenfledermäuse (Chiroptera, Rhinolophidae) und der Mechanismus des Bildhörens
Licensed content author	Hans Schneider
Licensed content date	Jan 1, 1960
Volume number	44
Issue number	1
Type of Use	Thesis/Dissertation
Portion	Figures
Author of this Springer article	No
Order reference number	
Title of your thesis / dissertation	Investigation of Dynamic Ultrasound Reception in Bat Biosonar Using a Biomimetic Pinna Model
Expected completion date	Nov 2013
Estimated size(pages)	84
Total	0.00 USD
Terms and Conditions	

### Introduction

The publisher for this copyrighted material is Springer Science + Business Media. By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the Billing and Payment terms and conditions established by Copyright Clearance Center, Inc. ("CCC"), at the time that you opened your Rightslink account and that are available at any time at <http://myaccount.copyright.com>).

### Limited License

With reference to your request to reprint in your thesis material on which Springer Science and Business Media control the copyright, permission is granted, free of charge, for the use indicated in your enquiry.

Licenses are for one-time use only with a maximum distribution equal to the number that you identified in the licensing process.

This License includes use in an electronic form, provided its password protected or on the university's intranet or repository, including UMI (according to the definition at the Sherpa website: <http://www.sherpa.ac.uk/romeo/>). For any other electronic use, please contact Springer at ([permissions.dordrecht@springer.com](mailto:permissions.dordrecht@springer.com) or [permissions.heidelberg@springer.com](mailto:permissions.heidelberg@springer.com)).

The material can only be used for the purpose of defending your thesis, and with a maximum of 100 extra copies in paper.

Although Springer holds copyright to the material and is entitled to negotiate on rights, this license is only valid, subject to a courtesy information to the author (address is given with the article/chapter) and provided it concerns original material which does not carry references to other sources (if material in question appears with credit to another source, authorization from that source is required as well).

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.

### Altering/Modifying Material: Not Permitted

You may not alter or modify the material in any manner. Abbreviations, additions, deletions and/or any other alterations shall be made only with prior written authorization of the author(s) and/or Springer Science + Business Media. (Please contact Springer at ([permissions.dordrecht@springer.com](mailto:permissions.dordrecht@springer.com) or [permissions.heidelberg@springer.com](mailto:permissions.heidelberg@springer.com)))

### Reservation of Rights

Springer Science + Business Media reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

### Copyright Notice:Disclaimer

You must include the following copyright and permission notice in connection with any reproduction of the licensed material: "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) is given to the publication in which the material was originally published, by adding; with kind permission from Springer Science and Business Media"

Warranties: None

Example 1: Springer Science + Business Media makes no representations or warranties with respect to the licensed material.

Example 2: Springer Science + Business Media makes no representations or warranties with respect to the licensed material and adopts on its own behalf the limitations and disclaimers established by CCC on its behalf in its Billing and Payment terms and conditions for this licensing transaction.

#### Indemnity

You hereby indemnify and agree to hold harmless Springer Science + Business Media and CCC, and their respective officers, directors, employees and agents, from and against any and all claims arising out of your use of the licensed material other than as specifically authorized pursuant to this license.

#### No Transfer of License

This license is personal to you and may not be sublicensed, assigned, or transferred by you to any other person without Springer Science + Business Media's written permission.

#### No Amendment Except in Writing

This license may not be amended except in a writing signed by both parties (or, in the case of Springer Science + Business Media, by CCC on Springer Science + Business Media's behalf).

#### Objection to Contrary Terms

Springer Science + Business Media hereby objects to any terms contained in any purchase order, acknowledgment, check endorsement or other writing prepared by you, which terms are inconsistent with these terms and conditions or CCC's Billing and Payment terms and conditions. These terms and conditions, together with CCC's Billing and Payment terms and conditions (which are incorporated herein), comprise the entire agreement between you and Springer Science + Business Media (and CCC) concerning this licensing transaction. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall control.

#### Jurisdiction

All disputes that may arise in connection with this present License, or the breach thereof, shall be settled exclusively by arbitration, to be held in The Netherlands, in accordance with Dutch law, and to be conducted under the Rules of the 'Netherlands Arbitrage Instituut' (Netherlands Institute of Arbitration).**OR:**

**All disputes that may arise in connection with this present License, or the breach thereof, shall be settled exclusively by arbitration, to be held in the Federal Republic of Germany, in accordance with German law.**

#### Other terms and conditions:

**v1.3**

**If you would like to pay for this license now, please remit this license along with your payment made payable to "COPYRIGHT CLEARANCE CENTER" otherwise you will be invoiced within 48 hours of the license date. Payment should be in the form of a check or money order referencing your account number and this invoice number RLNK501157583.**

**Once you receive your invoice for this order, you may pay your invoice by credit card. Please follow instructions provided at that time.**

**Make Payment To:**

**Copyright Clearance Center**

**Dept 001**

**P.O. Box 843006**

**Boston, MA 02284-3006**

**For suggestions or comments regarding this order, contact RightsLink Customer Support: [customercare@copyright.com](mailto:customercare@copyright.com) or +1-877-622-5543 (toll free in the US) or +1-978-646-2777.**

**Gratis licenses (referencing \$0 in the Total field) are free. Please retain this printable license for your reference. No payment is required.**

---

---



Ref : BB/463088/PAP/302673

**Assignment of copyright - IOP Publishing Limited**

1. IOP Publishing Limited ("IOP") agrees to publish:

**Manuscript Title:** Interplay of static and dynamic features in biomimetic smart ears (**the Article**) written by

**Names of all Authors:** Mittu Pannala, Sajjad Meymand, Rolf Mueller (**the Named Authors**)

in the following journal: Bioinspiration & Biomimetics (**the Journal**)

2. Transfer of Copyright Agreement

2.1 On acceptance for publication the undersigned author(s) ("Author") of the Article assigns exclusively to IOP worldwide copyright in the Article for the full term and for all media and formats in all material published as part of the Article, which expression includes but is not limited to the text, abstract, tables, figures, graphs, video abstracts and other multimedia content but excludes any other item referred to as supplementary material.

2.2 If any of the Named Authors are Government employees, on acceptance for publication the Author shall grant IOP a royalty free exclusive licence for the full term of copyright for all media and formats to do in relation to the Article all acts restricted by copyright worldwide.

2.3 On acceptance for publication the Author shall grant IOP a royalty free non-exclusive licence for the full term of copyright for all media and formats to do in relation to any supplementary material deemed to be part of the Article all acts restricted by copyright worldwide.

3. Author Rights

3.1 IOP grants the Named Authors the rights specified in 3.2 and 3.3. All such rights must be exercised for non-commercial purposes, if possible should display citation information and IOP's copyright notice, and for electronic use best efforts must be made to include a link to the on-line abstract in the Journal. Exercise of the rights in 3.3 additionally must not use the final published IOP format but the Named Author's own format (which may include amendments made following peer review).

3.2 The rights are:

3.2.1 To make copies of the Article (all or part) for teaching purposes;

3.2.2 To include the Article (all or part) in a research thesis or dissertation;

3.2.3 To make oral presentation of the Article (all or part) and to include a summary and/or highlights of it in papers distributed at such presentations or in conference proceedings; and

3.2.4 All proprietary rights other than copyright.

3.3 The additional rights are to:

3.3.1 Use the Article (all or part) without modification in personal compilations or publications of a Named Author's own works (provided not created by third party publisher);

3.3.2 Include the Article (all or part) on a Named Author's own personal web site;

3.3.3 Include the Article (all or part) on web sites of the Institution (including its repository) where a Named Author worked when research for the Article was carried out; and

3.3.4 No sooner than 12 months after publication to include the Article (all or part) on third party web sites including e-print servers, but not on other publisher's web sites.

**Signature**

In signing this Agreement the Author represents and warrants that the Article is the original work of the Named Authors, it has not been published previously in any form (other than as permitted under clause 3.2.2 which fact has been notified to IOP Publishing Ltd in writing), all Named Authors have participated sufficiently in the conception and writing of the Article, have received the final version of the Article, agree to its submission and take responsibility for it, and submission has been approved as necessary by the authorities at the establishment where the research was carried out.

The Author warrants that he/she signs this Agreement as authorised agent for all Named Authors and has the full power to enter into this Agreement and to make the grants it contains, that the Article has not been and will not be submitted to another publisher prior to withdrawal or rejection, it does not infringe any third party rights, it contains nothing libellous or unlawful, all factual statements are to the best of the Author's knowledge true or based on valid research conducted according to accepted norms, and all required permissions have been obtained in writing.

All Named Authors assert their moral rights.

Author's signature... *Mittu Pannala* ...Date... *02/11/2013* ...

Signature on behalf of Institution.....Date.....

Note that if the Article was prepared as part of a Named Author's duties for their institution this Agreement must be signed by their institution as Author. Further, if there are several Named Authors it should be signed by one author in a representative capacity. If all Named Authors are employees of the US Government and the Article was prepared as part of their duties the Article is not eligible for copyright and one of the Named Authors should sign below to confirm this fact. If at least one of the Named Authors is not a US Government employee the above should be signed.

I ..... (print name ..... ) confirm that all Named Authors are employees of the US Government and the Article was prepared as part of their duties and consequently the Article is not eligible for copyright.

Please return ALL of this form as soon as possible to IOP Publishing Ltd, Temple Circus, Temple Way, BRISTOL BS1 6HG, UK. (Journal fax: +44 (0) 1179200734)

Acoustical Society of America  
Suite 1N01, 2 Huntington Quadrangle, Melville, NY 11747-4502  
(516) 576-2360; asa@aip.org

## Transfer of Copyright Agreement

Authors who submit manuscripts for any of the publications of the Acoustical Society of America (ASA) are required to read this document and to take appropriate actions during electronic submission. The Society desires the right to disseminate material which it publishes to the fullest extent and desires the right to restrict publication by third parties who might illegally profit from the investments that the ASA has made in its publications. To insure that this is possible and to conform with U.S. copyright laws, it is desirable that the copyright be held by the Society. Electronic signature certifying agreement and acknowledgment that the corresponding author has read this document constitute a transfer of copyright, to the fullest extent of which the author is authorized to do so.

The implied transfer of copyright is for the original article that is being submitted and subsequent, if necessary, errata, and the abstract forming part thereof, the transfer being to the Acoustical Society of America for the full term thereof throughout the world, subject to the Author Rights (described below) and to acceptance of the Article for publication. The transfer of copyright includes all material to be published as part of the Article (in any medium), including but not limited to tables, figures, graphs, movies, and other multimedia files. Given that the author has the authority to transfer such copyright, the ASA shall have the right to register copyright to the Article in its name as claimant, whether separately or as part of the journal issue or other medium in which the Article is included.

The terms of the transfer agreement are such that the author(s) are reserved certain rights to additionally disseminate the work via outlets other than those of the Acoustical Society of America. These rights are as follows:

1. All proprietary rights other than copyright, such as patent rights.
2. The right, six or more months after publication by the ASA, to post copies of the article as published on the author(s) institutional internet web sites or on governmental web sites, to whatever extent is required by the author(s) institution or by whoever funded the research reported in the paper. The author also has the sole right to grant any other category of third party the right to republish fragments of the paper, but not the entire paper. (If any such third party seeks to republish the entire paper, the ASA will grant them permission only if there is clear evidence that the author approves of the republication. The authority to make the decision is reserved by the ASA. The granting of such permissions is administered by the Office of Rights and Permissions of the American Institute of Physics on behalf of the Acoustical Society of America.) Any such republication must give a complete citation to the article originally published by the ASA and must describe any modifications that have been made to the original.
3. The right, after publication by the ASA, to use all or part of the article, including the ASA-formatted version, in personal compilations or other publications of the author's own works, including the author's personal web pages, and to make copies of all or part of the article for the author's use for lecture or classroom purposes. Any such use must give a complete citation to the article and describe any modifications that have been made to the original. Any such use that purports to be the original ASA article must be identical to the ASA-formatted version. Any electronic posting of the article must include a link to the on-line publication of the article.
4. If the article has been prepared by an employee within the scope of his or her employment, the employer shall have the right to make copies of the article for the employer's own internal use. If the article was prepared under a U.S. Government contract, the government shall have the rights under the copyright to the extent required by the contract.

The author(s) agree that, insofar as they are permitted to transfer copyright, all copies of the article or abstract shall include a copyright notice in the ASA's name. The author(s) represent and warrant that the article is original with them, that it does not infringe any copyright or other rights in any other work, or violate any other rights. If the work is such that governmental laws forbid it to be copyrighted, and that it is free for open dissemination, then the author's electronic signature attests to such being the case. If there is more than one author, then the corresponding author's electronic signature attests to that individual having the authorization to sign for and on behalf of all the other authors.