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Novel Geometric Representation for 1D Model of Arterial Blood Pulse Wave Reflection

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*Abstract*— This electronic document is a “live” template. The various components of your paper [title, text, heads, etc.] are already defined on the style sheet, as illustrated by the portions given in this document.

# INTRODUCTION

Blood pressure is critical in accurately characterizing cardiovascular diseases and correctly diagnosing patients with such diseases in clinical settings. Measured blood pulse pressure waves, however, are a generated by a complex system of arterial blood propagation that cannot be investigated through simple pressure-band measurement, which is known to be extremely error prone. Mathematical modeling of blood pulse pressure wave propagation through the arterial system has therefore become increasingly important in extracting important diagnostic information, such as arterial distensibility. One constituent phenomenon of blood pressure for which there remains inadequate modelling is blood pulse wave reflection, specifically at arterial bifurcations. Thus far, wave reflections have been modeled without consideration of bifurcations, the primary producer of wave reflections, by using 1D geometric representations of inter-branching arterial segments. In such representations, reflections are caused by irregularities such as aneurisms or stenosis. At these irregularities the incident wave is split into two components, one forward moving and the other backward moving. This process is described by *transmission* and *reflection* coefficients, dictating how the incident wave is separated. The measured wave form can be determined by storing the coefficients of each wave split in a kind of wave *propagation history.* Such a representation, however, is insufficient for modeling the full arterial system, and, further, does not lend itself to efficient algorithms for traversing propagation histories.

# Structure

First, this paper gives a full description the novel geometric tree representation of the arterial system, detailing how propagation history is stored as well as the proposed algorithm for determining effective reflected waves. Next, results are given, both using a simplified full binary tree and using a more realistic tree generated from in-vivo arterial segment length data. Finally, the limitations of this model are discussed as well as directions for further research on its basis.

# Model Exposition

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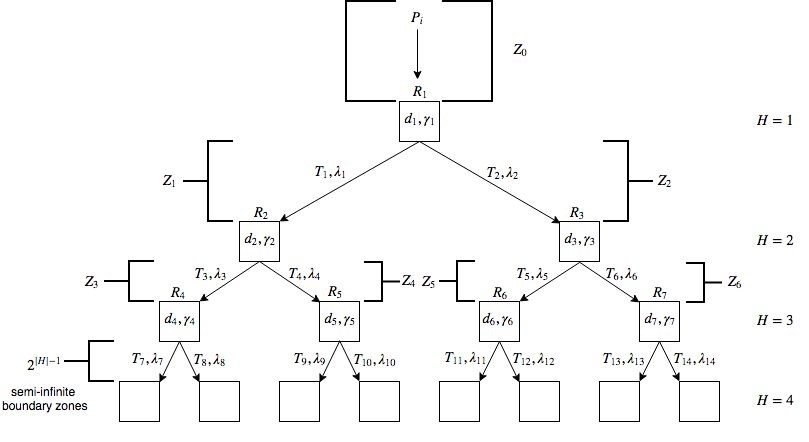


Figure 1: Geometric Tree Representation of Arterial System with Seven Branchings

The general form of the system detailed in

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

## B. Units

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
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* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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* There is no period after the “et” in the Latin abbreviation “et al.”.
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An excellent style manual for science writers is [7].

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1. Table Type Styles

| Table Head | Table Column Head | | |
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| Table column subhead | Subhead | Subhead |
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a. Sample of a Table footnote. (Table footnote)

1. Example of a figure caption. *(figure caption)*

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To have non-visible rules on your frame, use the MSWord “Format” pull-down menu, select Text Box > Colors and Lines to choose No Fill and No Line.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K.”

# Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Appendix

Appendixes should appear before the acknowledgment.

Acknowledgment

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R. B. G.) thanks . . .” Instead, try “R. B. G. thanks”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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