**Conference Specs**

* 6 pages max
* IEEE citations

Purpose statement should be tailored to this conference:

*“The conference aims to bring together scholars from different backgrounds to emphasize dissemination of ongoing research broadly in the fields of IOT, Electronics and Mechatronics.”*

🡪 “Energy harvesting & conversions” is our field

🡪 So, we should concentrate on the wireless devices part, but maybe not air quality

**Suggested page breakdown**

Abstract + introduction (2 pages)

Theory (1.5 page)

Numerical model (0.5 page, maybe a little more)

Discussion (1 page, maybe a little less)

Conclusion + bibliography (1 page)

Total: 6 pages

**Title**

~~A numerical model of temperatures in a tree stem~~

~~Exploring the viability of thermoelectric energy generation from a tree stem~~

A 2D numerical model of tree stem temperature (for…)

* Thermoelectric energy harvesting
* Forest fire prevention
* Air quality sensing

**Keywords**

Numerical model, tree stem, thermoelectricity, thermoelectric generator (TEG), energy harvesting, forest fire (?), Seebeck effect, Peltier cell (?)

*Are the keywords supposed to be alphabetical? These are just brainstormed for now.*

**Abstract/Summary**

(Revise this later to take out “we” statements)

The authors present a numerical model for the temperature differential within a tree stem. This model contributes to a proof of concept for the feasibility of using trees as an ambient power source. Live trees maintain a relatively constant internal temperature at homeostasis, so there is a temperature gradient between the core of the tree and the external environment. By the Seebeck effect - the buildup of an electric potential across a temperature gradient - a thermoelectric generator connected across this gradient could, in principle, be used to power low-power wireless devices for an indefinite period of time.

In this paper, we present a numerical model for the fluctuation of a tree’s internal temperature in a diurnal cycle. The horizontal cross-section of the tree is mapped to a polar coordinate grid. We simplify the model to 1D by taking height as a constant, then focusing the analysis at the optimal angle, where the temperature gradient is at the largest magnitude; for now, we assume this to be due south. Thus, we only consider the radial direction from core to bark.

The current work constitutes a work in progress, because the model still needs to be compared to experimental data for tree temperature and a sensitivity analysis has not been done. The COVID-19 pandemic has prevented us from getting field data on schedule. We also need experimental data for the input variables, but for now, we take educated guesses from current literature.

**Introduction**

[Some background about trees and heat transfer]

Applications of knowing tree temperature

* Being able to measure/predict the temperature gradient in trees is important for many fields of study
  + Optimal controlled conditions for growing trees
  + Wildfire prevention and performing controlled burns
  + Using trees as an ambient power source for wireless devices (that’s us)

**Theory**

Inputs (and where we get them from)

**Governing Equation**

We do 1 dimension

What is the name of our integration scheme?

Provide our equations 🡪 Latex from tree.pdf

**Numerical model**

Outputs

Things the user can specify

Here include table of values for different trees

Boundary assumptions?  
Wait, are we still doing a periodic stem center boundary? I read in Firestem2D that for numerical simplicity that isn’t necessary (see end of their “The FireStem2D Model” section)

Gaussian source terms

**Discussion**

We aren’t expert enough at the topic of heat transfer in trees to know a lot about what is missing from current literature and all the limitations/factors we aren’t considering. But we can start making a list.

**Conclusion**

**Bibliography**

IEEE Citation reference:

|  |  |
| --- | --- |
| **Journal article** | [4] J. U. Duncombe, "Infrared navigation - Part I: An assessment of feasability," *IEEE Trans. Electron. Devices*, vol. ED-11, pp. 34-39, Jan. 1959. |
| **eJournal (from database)** | [5] H. K. Edwards and V. Sridhar, "Analysis of software requirements engineering exercises in a global virtual team setup," *Journal of Global Information Management*, vol. 13, no. 2, p. 21+, April-June 2005. [Online]. Available: Academic OneFile, http://find.galegroup.com. [Accessed May 31, 2005]. |
| **eJournal (from internet)** | [6] A. Altun, "Understanding hypertext in the context of reading on the web: Language learners' experience," *Current Issues in Education*, vol. 6, no. 12, July 2003. [Online]. Available: http://cie.ed.asu.edu/volume6/number12/. [Accessed Dec. 2, 2004]. |
| **Chapter in book** | [2] L. Stein, “Random patterns,” in Computers and You, J. S. Brake, Ed. New York: Wiley, 1994, pp. 55-70. |

OUR TEAM’S PAPERS

C. P. de Souza, F. B. S. Carvalho, F. A. N. Silva, H. A. Andrade, and N. de V. Silva, “On Harvesting Energy from Tree Trunks for Environmental Monitoring,” *????*.

N. T. Purcell, J. D. Stevens, E. Carlson, G. Boyer, and O. R. Baiocchi, “Harvesting Energy from Tree Trunks,” *????.*

REFERENCES WE HAVE USED A LOT

B. E. Potter and J. A. Andresen, “A Finite-Difference Model of Temperatures and Heat Flow within a Tree Stem,” *Canadian Journal of Forest Research*, vol. 32, no. 3, pp. 548–555, 2002.

E. K. Chatziefstratiou, et al., “FireStem2D – A Two-Dimensional Heat Transfer Model for Simulating Tree Stem Injury in Fires,” *PLoS ONE*, vol. 8, no. 7, p.e70110, July 2013.

CITED IN OUR TEAM’S PAPERS

B. R. Helliker and S. L. Richter, “Subtropical to boreal convergence of tree-leaf temperatures,” *Nature*, vol. 454, July 2008. [Online.] Available: Academic OneFile, <http://find.galegroup.com>. [Accessed July 21, 2020].

C. P. Souza, F. B. S. Carvalho, F. A. N. Silva, H. A. Andrade, N. d. V. Silva, O. Baiocchi, and I. Muller, “On Harvesting ̈ Energy from Tree Trunks for Environmental Monitoring,” International Journal of Distributed Sensor Networks, 6 2016. [Online]. Available: <https://doi.org/10.1155/2016/9383765>

M. Ali, L. Albasha, and N. Qaddoumi, “RF energy harvesting for autonomous wireless sensor networks,” in 2013 8th International Conference on Design & Technology of Integrated Systems in Nanoscale Era (DTIS). IEEE, 3 2013, pp. 78–81. [Online]. Available: http://ieeexplore.ieee.org/document/6527782/

APPEARED IN TREE.PDF

D. Yan, F. P. Dawson, M. Pugh, and A. A. El-Deib, “Time-Dependent Finite-Volume Model of Thermoelectric Devices,” *IEEE Transactions on Industry Applications*, vol. 50, no. 1, pp. 600-608, 2014.

W. Bownman, “Sapwood temperature gradients between lower stems and the crown do not influence estimates of stand-level stem CO2 efflux,” *Tree Physiology*, vol. 28, no. 10, pp. 1553-1559, August 2008. [Online]. Available: <https://academic.oup.com/treephys/article/28/10/1553/1647174>. [Accessed July 21, 2020].

J. Chen, J. F. Franklin, T. A. Spies, “An empirical model for predicting diurnal air-temperature gradients from edge into old-growth Douglas-fir forest,” *Ecological Modeling*, vol. 67, no. 2, pp. 179-198, 1993.

S. Tanja, et al., “Air temperature triggers the recovery of evergreen boreal forest photosynthesis in spring,” *Global Change Biology*, vol. 9, pp. 1410-1426, 2003.

S. Linge, H. P. Langtangen, “Diffusion Equations,” in Finite Difference Computing with PDEs, *not sure how to complete this citation*

Other stuff I can’t figure out how to cite

In Github: 10\_part3.pdf

**Questions to expect at poster Q/A**

* Does putting in the sensor spike hurt the tree? 🡪 ???? no clue