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FINDING ELECTROMAGNETIC FIELDS AND WAVES FROM THE HEART AND BODY

Looking into the electric and magnetic field that is produced by the heart, finding the theoretical electromagnetic wave that made from each beat

For many years, people have been using electrodes to find their heart rate. This is measured through the electric pulses that are produced by the heart. The devices used today outside of the electrocardiogram (ECG), are not accurate because they use a Photoplethysmography (PPG) sensor. In short, this sensor is very good for sitting still but not good while a person is moving. An ECG sensor is not ideal because a person would have to be wired up and the PPG sensor is not accurate. Since we need an improvement, a device that could track a heart rate without theoretically touching someone would be a very dynamic piece of new technology.

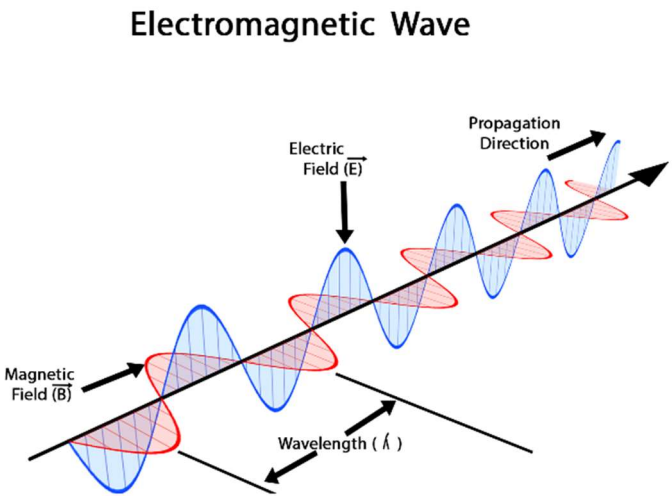

Figure 1: A look at the coupled magnetic and electric field and how they coincide to make an electromagnetic wave from https://www.toppr.com/guides/physics/communication-systems/propagation-of-electromagnetic-waves/

Background

Studies show that each pulse of a heart creates and dissipates an electric field, and basic physics says that every changing electric field is coupled with a magnetic field. This being said, a magnetic field with a perpendicular electric field creates an electromagnetic field and therefore an electromagnetic wave is produced. (Figure1) If that was a lot of information, the heart should produce an EM wave (not discovered yet with our technology). If the heart emits these waves, we can theoretically create a sensor that traces the wave's frequencies. During the off beat you should get no emission and during the on beat there should be a frequency of a wave much like infrared waves. Tracking the emissions as a beat, one could have a wireless heart rate monitor.

An Outside Relating Study

A study was conducted in August 2020 about the effects of a cell phone on heart rate variability. Heart rate variability is the average variation between subsequent heart beats, heart rate variability is regulated by the autonomic nervous system that is involved with the bodies potential emissions of electromagnetic waves. The study found that when a person is exposed to a cell phone their heart rate variability decreased in both normal-weight and obese normotensive medical students. If your heart rate variability is decreased, it would show a sign of stress to the body and heart. If your phone produces a certain electromagnetic wave that disrupts the hearts usual electromagnetic field, then the heart would have to work harder to create its normal electromagnetic field making it eventually pump slower like any other overworked muscle. This being said, your heart has to emit an electromagnetic wave because the only reason your heart would slow down and become more infrequent is because of stress to the heart.

Application

We can see that the concept of an electromagnetic field is very viable and that the presents of such a wave that we can track is there to be measured. If the wave is there, however, how can someone measure it? A rectenna can be used as a perfect receptor for the hearts electromagnetic wave. (Figure 2) The block diagram receives the electromagnetic wave from the source that will take the received wave and increase or decrease the voltage across the load based on the frequency of the wave.

What is the frequency of the electromagnetic wave that comes from the heart and does it differ from onbeat to offbeat? The magnetic field provided by the heart starts at 0T on an offbeat and ends at 13nT on an onbeat. This being said then, using Maxwell's equations and Faraday's equation the electric field starts at 0 V/m and goes to 2.1 mV/m. This will give a frequency of around 150 THz as a frequency and that would make the wave an infrared wave.

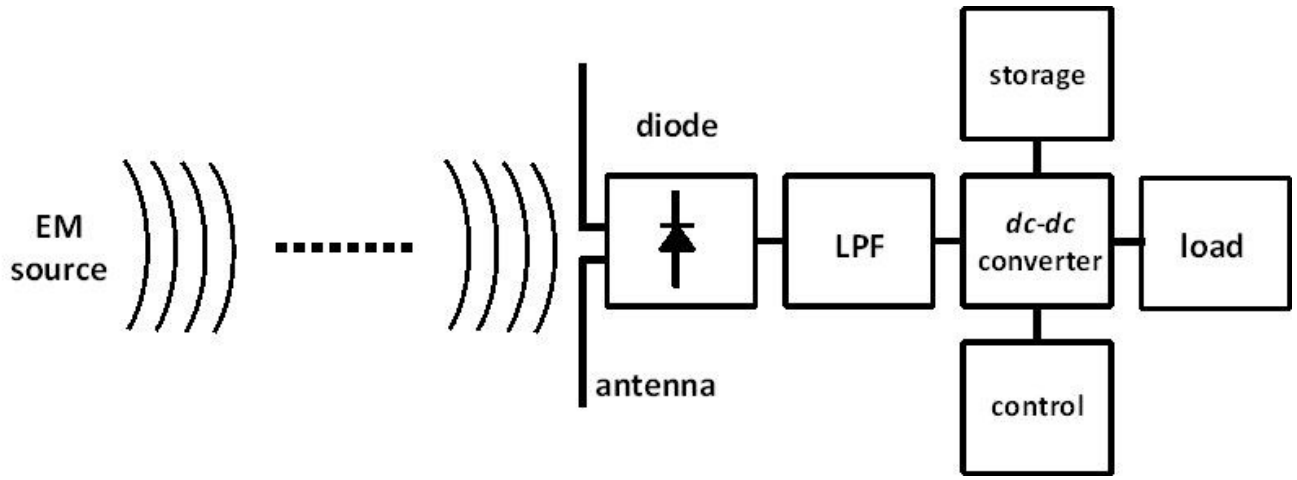

Figure 2 : The block diagram shown above shows an electromagnetic wave receptor or rectenna from https://www.intechopen.com/books/ict-energy-concepts-towards-zero-power-information-and-communication-technology/electromagnetic-radiation-energy-harvesting-the-rectenna-based-approach

Conclusion

As seen above, concept that there are electromagnetic waves coming from the body and that they can be recorded is not a far out thought. The thought that no person has ever had an idea about this form of heart rate capture can sound weird because of the simplicity of the idea. This is a possible study that could make a breakthrough in the bio-electrics field. Considering that this has not been researched yet and the facts provided are based on no direct paper, rather subsequent papers. The connections between the article provided and the topic give the idea a great deal of validity. The diagram in Figure 2 shows that this system would only have to measure the change in the load current and the only things needed are known electromagnetic waves to get benchmark current measurements. The wireless heartrate sensor will give people and hospitals everywhere a simple and easy way to track their heart rate and maybe catch a heart attack before it happens.

References

1. M. Alassiri, A. Alanazi, H. Aldera, S. A. Alqahtani, A. S. Alraddadi, M. S. Alberreet, A. I. Alhussaini, Y. Alotaibi, M. A. Alkhateeb, and A. S. Shatoor, “Exposure to cell phones reduces heart rate variability in both normal-weight and obese normotensive medical students,” *Explore*, vol. 16, no. 4, pp. 264–270, 2020.