# ECG Simulator

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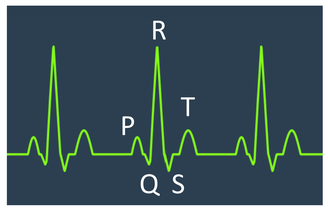
## Project Summary

Heart disease is a prominent issue in Kern County. Kern County has the fourth highest number of deaths by heart disease. Nurses in Kern Medical train to learn and recognize patterns that may indicate common heart diseases. In training, they simulate common diseases for the nurses to learn, but they cannot physically print the rhythms they generate, so they currently use pre-printed results. The goal of this project was to create an ECG simulator that can generate the common diseases they need to learn and print the waves it just generated. The ECG simulator allows them to change the signal of each wave depending on the parameters.

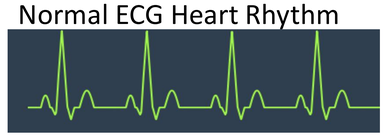



## Fourier Analysis

ECG waves are comprised of a P wave, T wave, and QRS complex. Fourier analysis is used to reduce these waves to sinusoidal functions that accurately represent the waves.

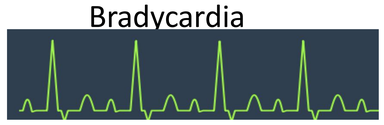
## Methodology

Normal ECG Heart Rhythm

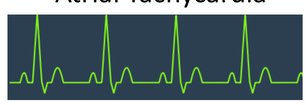


Sinus Arrythmia

Bradycardia



Atrial Tachycardia



$$f_{P,T,U}(x) = \frac{a_0}{2} + \sum_{n=1} \propto a_n \cos\left(\frac{n\pi x}{l}\right)$$

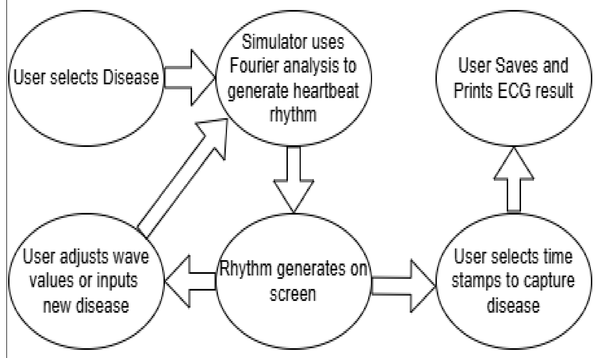
$$f_{Q,QRS,S}(x) = \frac{a_0}{2} + \sum_{n=1} \propto a_n \cos\left(\frac{n\pi x}{l}\right)$$

$$f_{ECG}(x) = f_Q(x) + f_{QRS}(x) + f_S(x) + f_P(x) + f_T(x) + f_U(x)$$

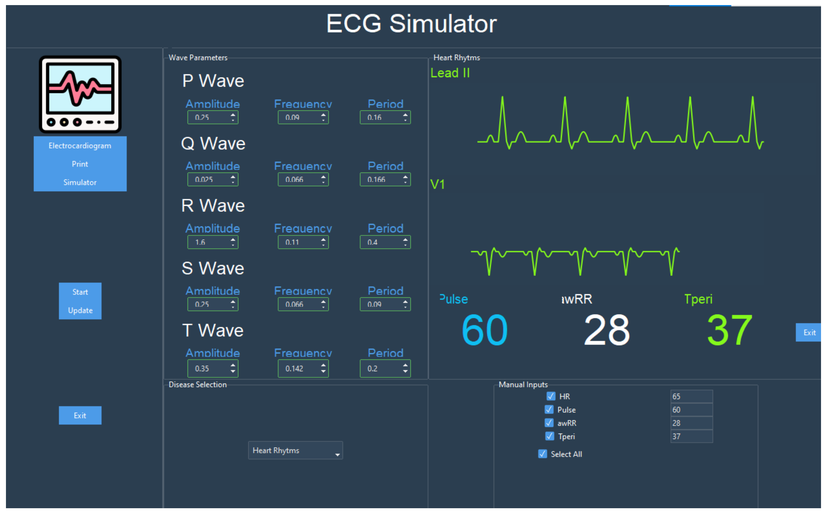
## Technology

Python, Tkinter, matplotlib, Bootstrap

## Usage Flowchart




## Main Screen



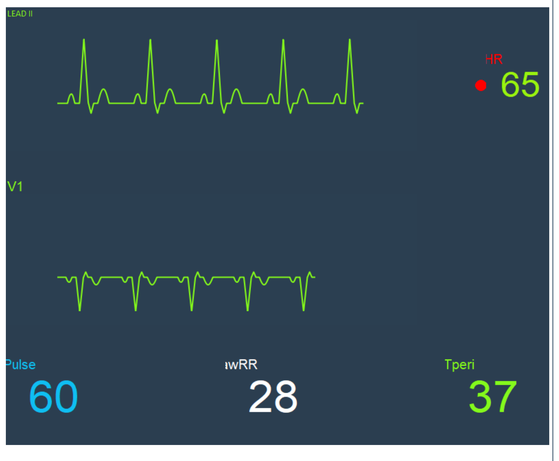

This is the screen used to generate the disease and adjust the parameters as needed. The GUI is used as a control center to create waves that can resemble a live patient who came in with heart problems.

## ECG Screen

The right side of the main screen is a preview of the secondary screen.

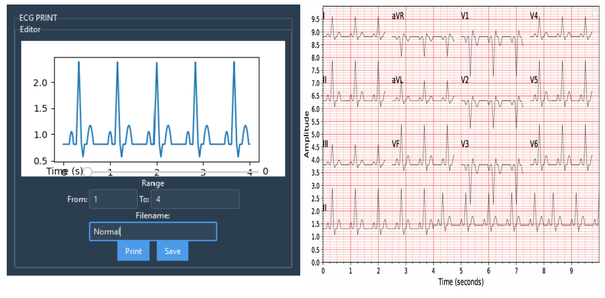
It is important to have two terminals to allow the users to visually see the changes. They can alter the waves independently of each other. As some diseases can be displayed with no P wave or a shorter R wave.

The heart rate is displayed alongside the lead II signal and can be increased or decreased as needed.




The ECG signal is animated based on the data points that were created by following the methodology from above. The updates are shown on the display once the wave returns to the left most part of the screen.

## Print Result Sample




By selecting "Print" from the Main Screen, the user can select a start and end time to capture results from the generated signal to save or print.