Apr 28th, 12:00 AM - 12:00 AM

Mapping and Simulating Standing Wave Patterns in a Microwave Oven

Sana Ahmed

Mapping Standing Wave Patterns in a Microwave Oven

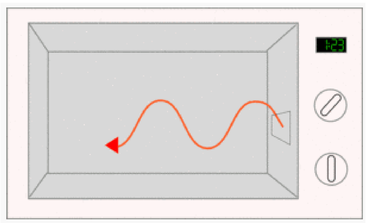
Department of Physics, Susquehanna University

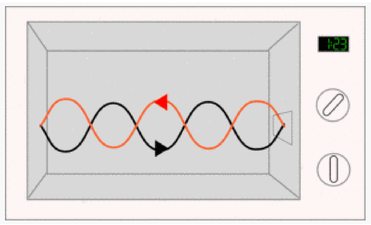
Sana Ahmed, Sami Zain, Mr. Everly, Dr. Zain

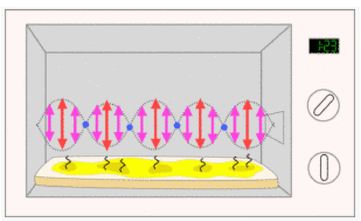
Abstract:

The goal of our project was to map and predict the standing wave patterns in a microwave oven cavity using experiments and computer simulations.

We used plexiglass sheets placed at five evenly spaced spots in the microwave cavity and a thermal camera to see the intensity of the antinodes. The thermal images that we gathered from those experiments became the basis of our computer simulations. We created a program to extract a three-dimensional representation of the thermal images. The 3D surfaces were then superimposed over each other as the plexiglass sheets were in the cavity. We are now able to map the standing wave patterns in the microwave oven cavity as a function of intensity.







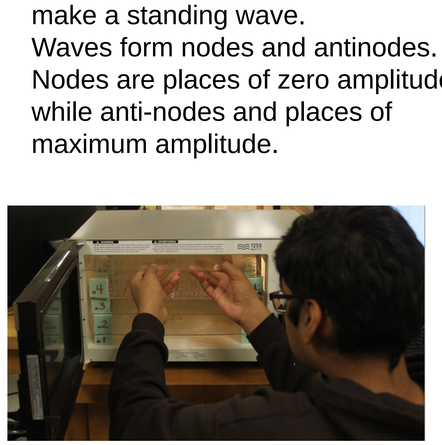
Background Analysis:

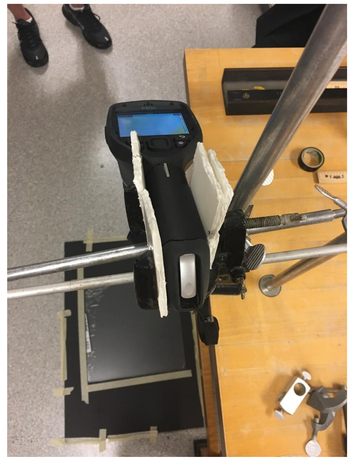
A microwave oven was used to find the speed of light using chocolate. By measuring the distance between chocolate melting points (the antinodes of the standing waves), and multiplying it by the frequency of the microwave, we hoped to find the speed of light.

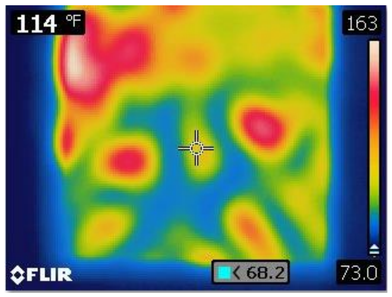
While conducting that experiment, we became curious about the patterns of the standing waves in the oven, as they seem to change with various object placed inside.

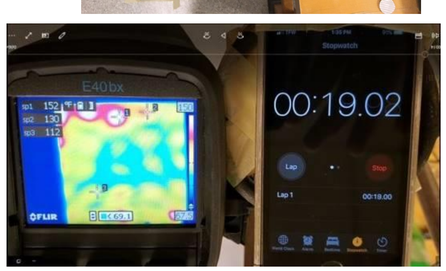
Concept:

A microwave oven is a machine that emits electromagnetic waves in the microwave range. When these waves get to the other side of the cavity they are reflected out of phase from the incoming wave. Many incoming and reflected waves together make a standing wave.
Waves form nodes and antinodes. Nodes are places of zero amplitude, while anti-nodes and places of maximum amplitude.







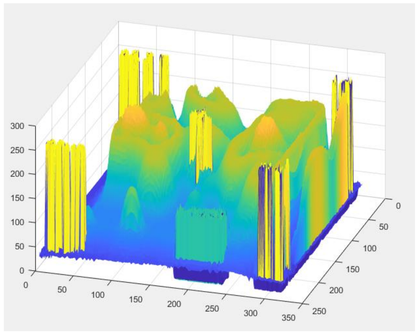


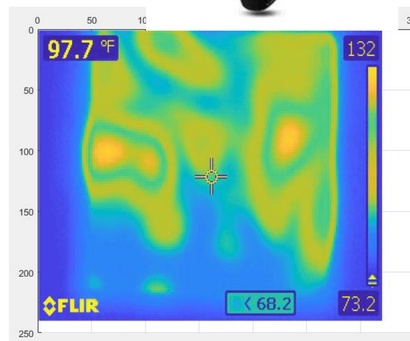
Process:

1. Ran initial testing with five plexiglass sheets together in the oven cavity to observe wave patterns with thermal camera. The patterns were the same for each level across each trial.
2. Created a program to analyze the color value of each pixel in an image. This was the first step in the process of creating the simulation of the thermal surface.
3. Conducted more trials to better understand the color shifts of the thermal camera. Found the ranges of temperature changes.
4. Wrote a program to create a 3D surface from the 2D thermal images we gathered.

Materials:

- Panasonic 2.2 Cu. Ft. 1250 W Stainless Steel Microwave Oven
- Flir E40bx Thermal Camera
- Matlab R2017a
- OPTIX 8-in x 10-in Clear Acrylic Sheet





Obstacles:

- Inexperience with thermal cameras.
- Our microwave overheated and became unusable.
- Lack of knowledge of Matlab.

Conclusion and Future Plans:

Mapping microwaves is not as easy as we first anticipated. Both the physical trials and the computer simulation brought up issues that we had to work to resolve. However, we found a way to successfully visualize the standing wave patterns as a function of heat intensity.

More testing has to be done, as we only mapped the wave pattern as it appears with five sheets together. Moving forward, we want to add more material into the cavity and observe how the wave pattern is affected by this increase of mass.