# Tracking Bed Bug Movement in the Presence of $CO_2$ using Computer Vision

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## Abstract

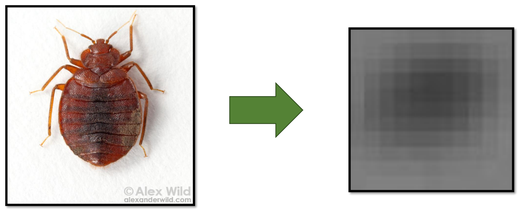
Modern aerospace systems need a new approach for swarm consensus that is distributed, operates with local knowledge, and uses simple agents. The overarching goal of our research was to advance our understanding of bed bug behavior and use this understanding to improve performance of aerospace swarms. The first step is to understand individual bed bug response to stimuli ($CO_2$, heat, light) and individual neural characteristics, before considering group dynamics. The objective of this research was to establish a collaboration between biologists and engineers at ERAU to design and implement a test platform to enable new data collection for individual bed bug movement. This collaboration began by examining individual bed bug response to $CO_2$ concentration. Our central hypothesis is that if we record bed bug response to $CO_2$ exposure, then we will be able to improve our understanding of collective decision making because the bed bugs coordinate their response to environmental conditions.

## Research Question

How can computer vision be used to automate the data collection process for the current bed bug research at Embry-Riddle's Prescott, AZ campus?

## Purpose

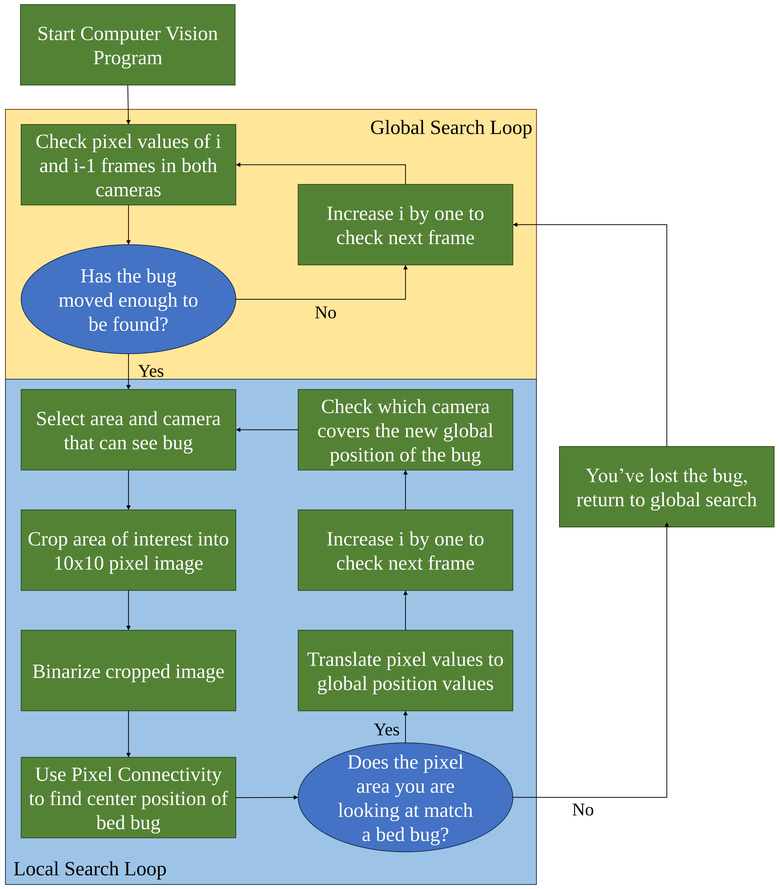
- Design a computer vision solution to identify, track, and log bed bug position, velocity, orientation, and frame data.
- Process logged attitude data to analyze and categorize individual bed bug responses to $CO_2$ stimuli.




## Hypothesis

*If* implement machine vision in the processing of bed bug video tracking *then* we can rapidly increase our ability to track, study, and understand bed bug movement *because* we can automate time intensive data collection.

## Computer Vision Feedback Loop




## Bedbug Finding Algorithm

**Question:** Which camera has the best chance at finding the bed bug?

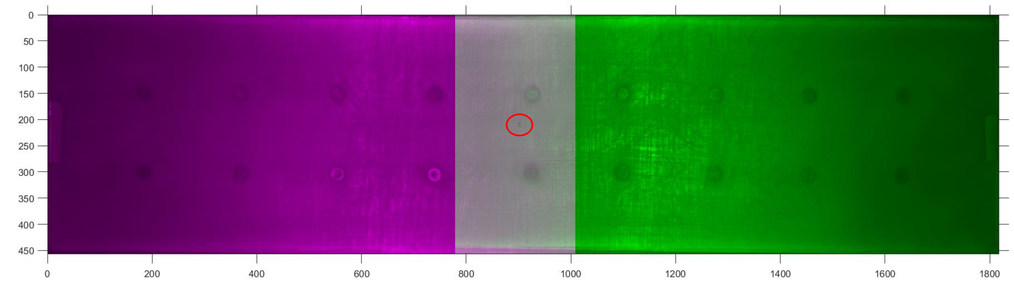



*Figure 1: Fused Left and Right Camera Images*

**Question:** How to find position of the bed bug in image?

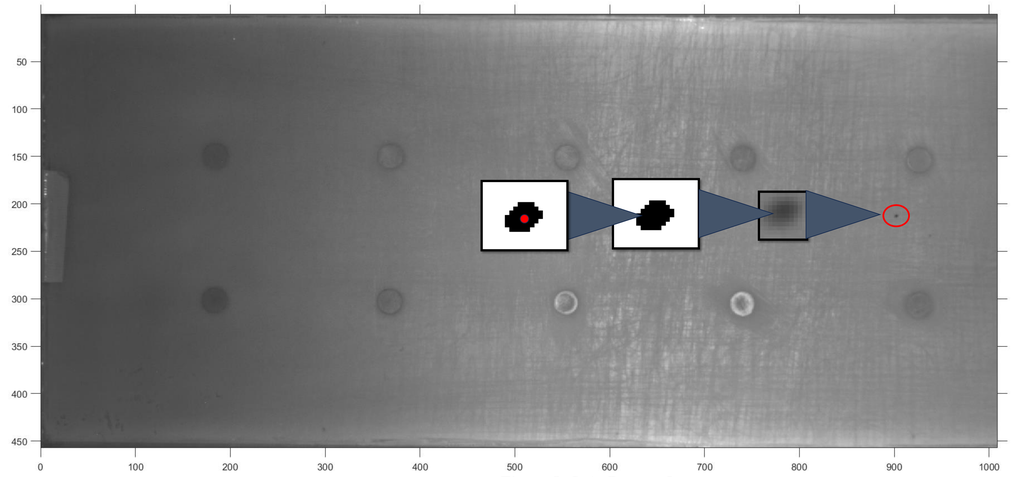



*Figure 2: Left Camera Image*

## Problems Faced

- Average pixel width of bed bug is only 5 pixels
- Image wide Binarization results in noisy images
- Use of NIR, two-camera, system produced large amounts of data that MATLAB could not record without loosing large amounts of frames or data.
- Use of Streampix 'sequence' file format led to problems adapting seq file format into images in MATLAB (barcode images)
- Acquiring a reliable foreground mask for blob detection (basically the flickering of light off the testbed, interference of user when lifting the lid)
- Use of blob size to limit impact of flickering light.
- Dark colors of the testbed near the edges, and near the left region of the testbed.

## Conclusion

- A total of 30 control videos and 45 test videos have been processed to date.
  - Around 900 minutes of video processed
  - Roughly 1.35 million frames of data
- Each video takes roughly 20-30 minutes to process, depending on video length and computing resources availability.

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