Laser-Based Insect Eradicator

ELECTRICAL & COMPUTER ENGINEERING

PHOTONIC SENTRY

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Introduction

The Photonic Fence (PF) is a laser-based insect monitoring and eradication system designed to selectively kill mosquitos and other pests.

The objective of this project is to classify irregularities in the PF's current tracking system and develop a target isolation algorithm that addresses those issues.

System Overview

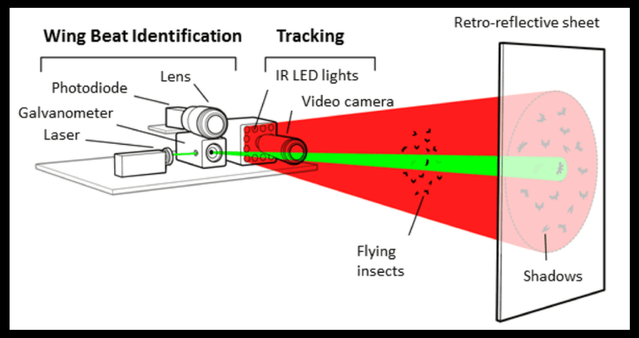

Figure 1: System level operation of the PF unit [1]

- A binary threshold is applied to distinguish between foreground (insects) and background (retroreflector).
- The Coarse Tracking subsystem scans the retroreflector region for potential targets.
- The Fine Tracking subsystem uses a steerable optic to track and dose targets.

Trace Classifier

System traces are parsed in three stages:

1. Identification of thresholding discrepancies
2. Frame by frame analysis of foreground components to detect tracking issues
3. Validation of potential misclassifications

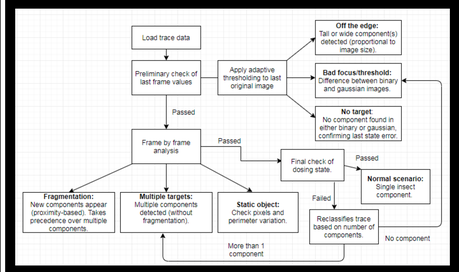

Figure 2: Flowchart of the classifier

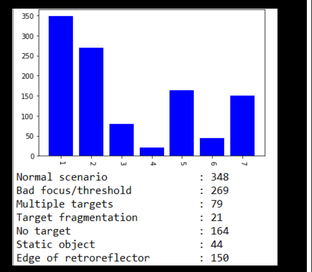

Figure 3: Classification results of 1075 samples

Target Isolation

The algorithm processes grayscale images from the Fine Tracking subsystem and outputs the coordinates of the intended target.

- Adaptive thresholding is applied to account for variations in lighting across the retroreflector.
- Image moments are calculated to find the centroids of foreground components.
- The output centroid is selected by predicting the trajectory of the target's path.

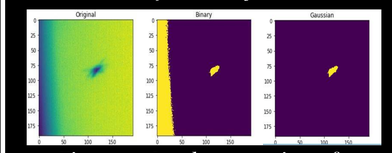

Figure 4: Implementation of adaptive Gaussian thresholding

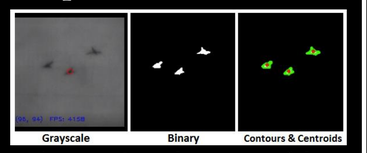

Figure 5: Sample output of the algorithm

Discussion

The following improvements were made By pipelining the target isolation algorithm:

- The PF correctly tracks the target when multiple insects are in the frame.
- The number of errors caused by non-uniform lighting conditions is significantly reduced.

Future challenges include:

- Improving the accuracy of the adaptive threshold.
- Optimizing the runtime of the algorithm.

Conclusion

Our classifier was successful in identifying and tabulating irregularities in the PF's tracking system.

The most common tracking errors could be attributed to poor image thresholding and the presence of multiple targets.

A tracking algorithm was successfully implemented to tackle both issues via adaptive thresholding and trajectory prediction.

References

[1] Mullen, E. R., Rutschman, P., Pegram, N., Patt, J. M., and Adamczyk, J. J. (2016). Laser system for identification, tracking, and control of flying insects. Optics express, 24(11), 11828–11838.