



Hawai'i Natural Energy Institute Research Highlights

Energy Efficiency & Transportation

Using Computer Vision to Measure Human Movement

OBJECTIVE AND SIGNIFICANCE: The objective of Computer Vision is to develop a process to anonymously measure human flow patterns, dwell times, dwell location, occupant spacing, and other metrics for the purpose of optimizing space utilization and energy management. The technology will allow users to associate foot traffic and movement patterns with specific areas of a facility in order to achieve optimal flow patterns. It can also be used to identify areas in which energy systems can be ramped down or turned off when not in use.

BACKGROUND: HNEI and its collaborators, MKThink (MKT) and RoundhouseOne (RH1), have been exploring the optimization of space and human flow to maximize energy efficiency, while maintaining comfort conditions. This collaboration has developed a series of cost-effective, readily deployable technologies to monitor indoor and outdoor environmental conditions in order to achieve indoor comfort.

Expanding on that work, MKT and RH1 has developed a process known as “Computer Vision,” which monitors the human element of a space. The Computer Vision technology uses a video camera and on premise processing to anonymously track human movement by assigning temporary digital markers to each individual within the range of the camera. The digitized data extracted from each image frame is sent via cellular modem to a central server for additional processing. It is then processed and mapped without storing or saving the images. This process assures absolute anonymity for those in the camera’s range.

A recent deployment of the Air Angel, the outdoor data collection platform, at the Bishop Museum is one of several pilot installations in Hawai'i and California to test the Computer Vision technology in different conditions. The Air Angel is a self-contained trailer integrating solar PV, environmental, communication, and Computer Vision sensing technologies to detect human activity, record the number of people, dwell time, dwell location, physical separation within its detection range, all completely anonymous without storing or using any personally identifiable information. When fully rolled out, Computer Vision can be deployed anywhere where human flow

patterns, dwell times, and densities can help clients make operational decisions based on those factors.



Figure 1. The Air Angel at Bishop Museum in Honolulu.

PROJECT STATUS/RESULTS: The first Hawai'i deployment was rolled out as a functioning outdoor display at Bishop Museum in April 2021. Data is currently being collected and will be released weekly until the end of the project. This project will continue until December 2021.

Reports document on brief contacts and extended contacts, interior and exterior, reporting by time-of-day, by location, group size and distance. Figures 2 through 4 (on the following page) illustrate three of the several reporting images. Figure 2 summarizes dwell time in an interior zone; figure 3 details number of extended contacts (> 5 sec.), proximity and duration in an interior zone; and figure 4 details number of brief contacts (< 5 sec.) and duration in an exterior zone.

TIME IN TARGET

IN TARGET
During the operating time period observed, you were within your target performance for SAFETY 74.6% of the time.

[See Reference Page for metrics and thresholds covered by this report]

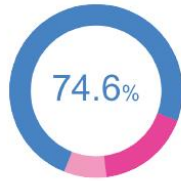


Fig. 01

EXTENDED
During the operating time period observed, you were outside of your target performance for SAFETY 17.5% of the time.

BRIEF
During the operating time period observed, you were at the boundary of your target performance for SAFETY 7.9% of the time.

CONTACT DETAILS BRIEF

BRIEF
These contacts lasted less than < 5 secs

SUMMARY STATS

Unique Contacts	Avg. Distance	Avg. Duration
8319	3.5 ft	2.8 sec



Fig. 09

OF OPERATING TIME

Fig. 10

BY LOCATION

IN TARGET
Target performance was observed in 96.2% of your space where OCCUPANCY was observed.

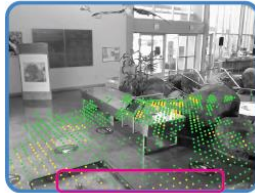


Fig. 02

EXTENDED
Extended contacts were clustered in 1 primary location.

BRIEF
Brief contacts were also clustered in 1 primary location.

BY TIME OF DAY

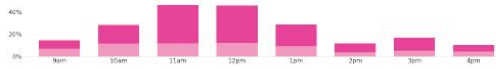


Fig. 03

BRIEF
65% of boundary performance was observed between 9am-1pm.

EXTENDED
66% of extended performance was observed between 9am-1pm.

Figure 2. Sample report informing the duration of contacts by time of day for June 28, 2021.

CONTACT DETAILS EXTENDED



Fig. 06

OF OPERATING TIME

EXTENDED
These contacts lasted more than > 5 secs

SUMMARY STATS

Unique Contacts	Avg. Distance	Avg. Duration	Max Duration
14087	2.61 ft	9.05 sec	2min 34sec

Fig. 07

CONTACTS BY LOCATION



Fig. 08

Figure 3. Sample report for Central Gallery interior zone, contacts > 5 sec for June 28, 2021.

CONTACTS BY LOCATION

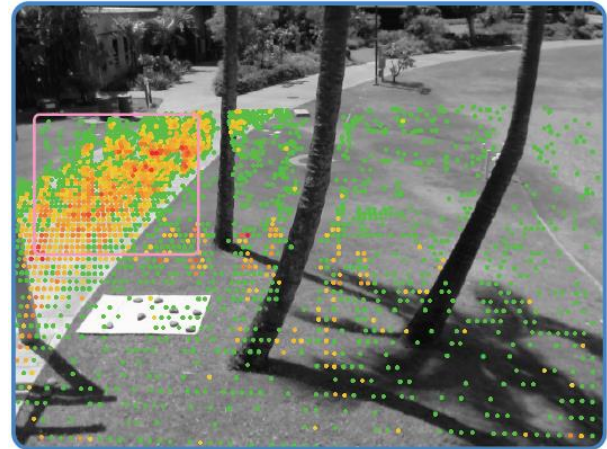


Fig. 11

Figure 4. Sample report for exterior zones for contacts < 5 sec. for June 28, 2021.

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