Eco-Flow: Office Based Microclimates: Improving Thermal Comfort and HVAC Efficiency

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Objective

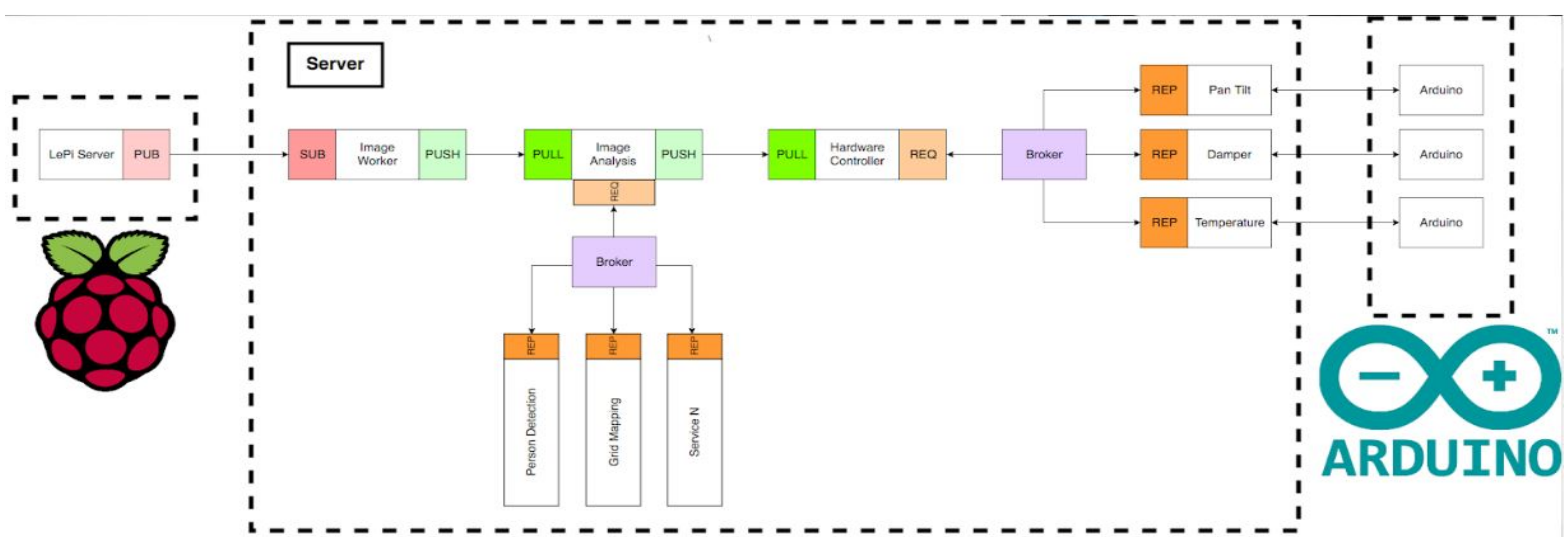
To provide a personalized microclimate for individual thermal comfort and reduce overall energy consumption in the HVAC industry.

Introduction

In the United States, the commercial industry consumes one point seven two trillion kilowatt hours of energy. 44% of this is from HVAC systems alone. This still results in over 750,000,000 kWh. As a progressive economy, it is surprising that we have not reduced energy consumption in the HVAC industry. We've recently pulled out of the Paris Climate Agreement, which makes it all the more important to invest in smarter, ecological solutions. What's more, HVAC systems do not tend to individual comfort in the work place, thereby wasting additional energy.

Eco-Flow is a highly effective system that will tend to individual requests for microclimates. By adding a microclimate, a user's immediate area can be tailored to suit them in a manner of ease. Eco-Flow embeds an HVAC system within every-day furniture. We create controllable, energy efficient heating and cooling that can target the users directly, thus allowing for customization of ideal comforts in a small area, rather than impacting a large area at the cost of more energy.

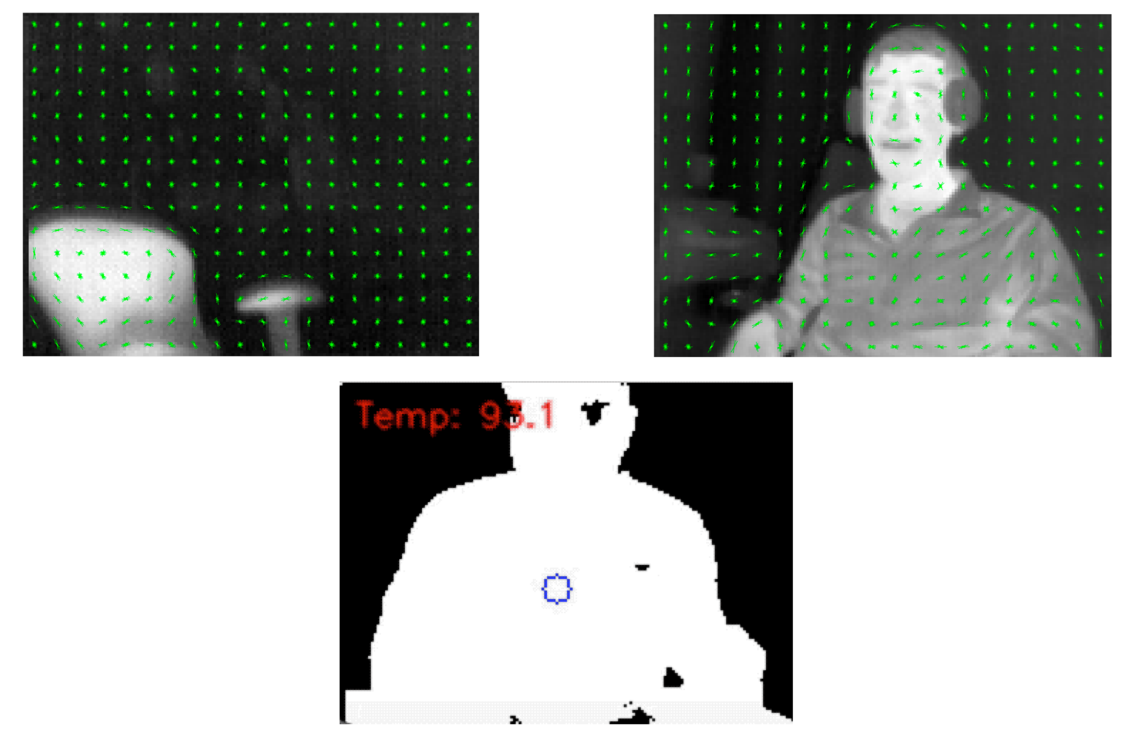
System Architecture



Methods

Machine Learning

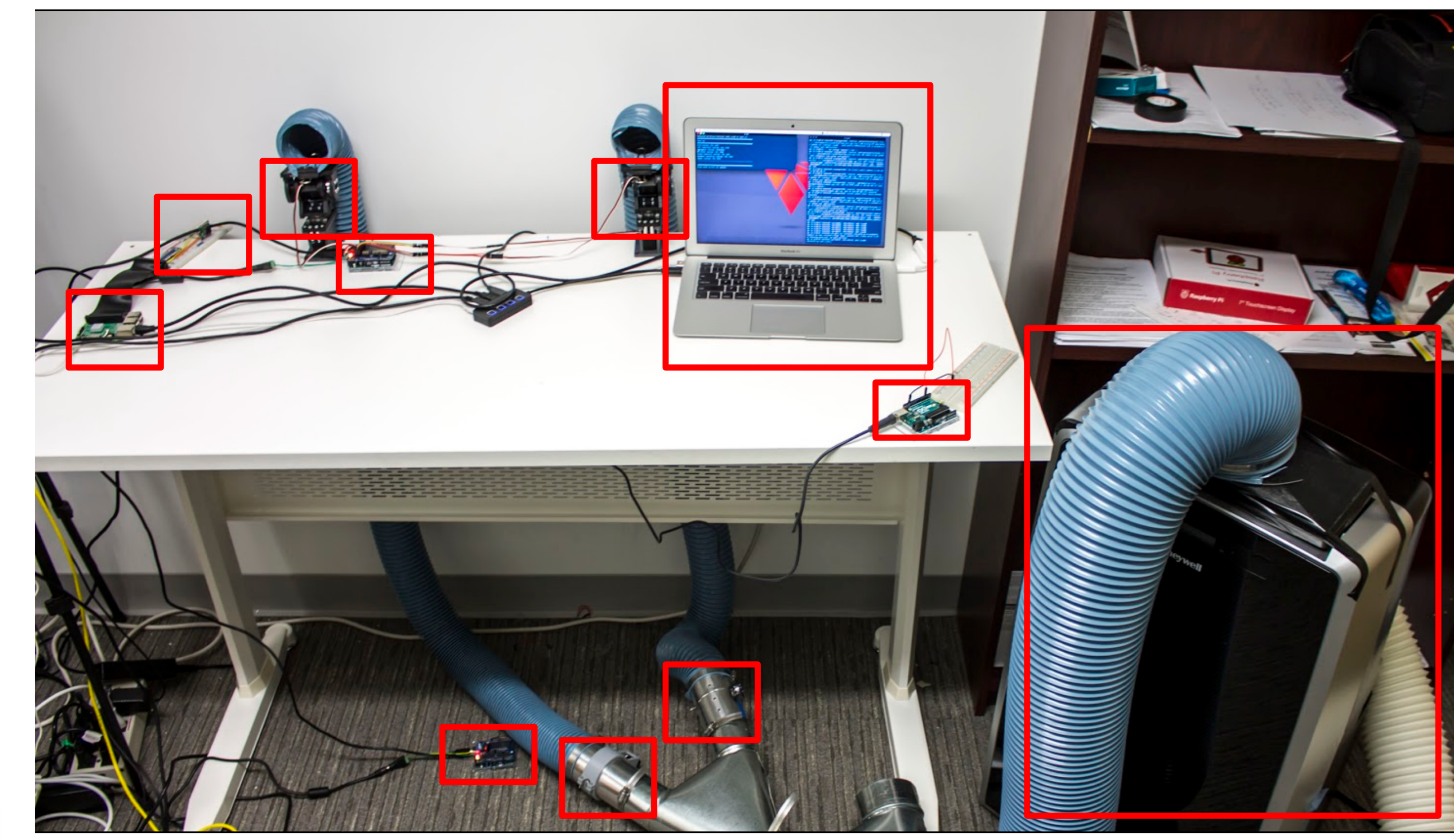
Support Vector Machine (SVM) with Histogram of Oriented Gradients(HOG). We use HOG as a feature descriptor. We trained the SVM on images with humans sitting in front of a desk and on scenes without them.



Position Detection

We do thresholding to receive only warm components of an image and then we get the largest warm connected component to get the position of the human. From there we are able to receive the surface temperature of objects within in the frame of the human and the central moment to determine how and where the thermal endpoints should be directed. This architecture pattern helps the system operate reliably. Components can be killed and spawned allowing the system to have the ability to have less points of failure.

System Design



Thermal Interaction

- IR Emitter – Customizes temperature, fan speed, heat/cool mode.
- Damper – Controls airflow of air from HVAC.
- Pan-Tilt – Sets direction of airflow.

Energy Saving

- IR Emitter – Controls HVAC state – it will switch off without user presence
- Damper – Decides which side to direct airflow to user
- Pan-Tilt – Always ensures delivered air is localized to the user.

Discussion & Future Directions

Increasing Efficiency

Our current build is complete, but it can be made into something much more efficient. The project can further cool or heat an individual at a pace that conserves more energy. This will require more research and experimentation, such as determining how long a person takes before they are cooled to their preferred temperature, what temperature said individual prefers –how to programmatically determine a psychological choice in terms of thermal comfort.

End-Goal

As discussed. The goal is maximize thermal comfort and minimize power consumption. By continuing development in this area it is possible to have a significant impact in the current HVAC ecosystem.