Analamp

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Abstract
AnaLamp, inspired by the Pixar short Luxo Jr, is a smart lamp that serves as a desk assistant and companion. It utilizes IOT technology, image capture, and physical computing to improve the experience of working at and away from a desk. Its features include: Automatic position adjustments to follow the movement of hands around a desk for focused precision hand work, remote occupancy detection and viewing of studio that can be used to locate forgotten or missing objects.

Introduction
At this time, tech companies are working to improve office workflows within the realm of the screen. Software such as word, pages, and Google Drive help us create, while applications such as Slack and Messenger allows us to communicate with one another. However, little time and effort has been invested into exploring how technology could improve the experience of sitting at a desk on an environmental level or within a public working space with interesting dichotomies between personal privacy and shared spaces.This is the goal of AnaLamp, a smart lamp engineered towards improving the desk environment. It does this through performing tasks that would otherwise be difficult carry out, such as locating whether or not

an object has been left at one's desk, and serving as a source of entertainment and joy in what can sometimes be a dull environment. The whimsical and overt nature of the lamp is also an interaction design aspect that explores a possible response to the critique of IoT and ubiquitous computing.

Context

With the advent of IoT devices and interest in creating hybrid digital and physical spaces, smart devices such as this one could soon find their way into our everyday life. With this in mind, we explored what a smart lamp assistance could potentially look like. In addition to technological feasibility of creating such a device, we explored what type of functionalities might be useful for such a product and the possible social affordances it offers.

Lamp Movement

The lamp is controlled by three servo motors, one at the middle linkage of the lamp and two more linking the head to the body. The motor at the middle linkage controls the vertical rotation of the lamp's upper body like a mechanical tendon, while the motors connected to the head control its vertical and horizontal rotations by directly replacing rotation points with servo centers. These motors are controlled through a servo hat connected to a raspberry Pi all tucked into a custom designed case that connects to the bottom of the lamp and can rotate the hardware and wires out of view. In order to secure the servo motors to the lamp, we replaced the existing hinges with our own 3D printed versions built to hold the servo motors. This allowed us to integrate the servos into the lamp while allowing it to maintain some of its aesthetic qualities.

In the remote web and mobile control mode for the lamp, angle information sent to the servo motors are generated from the user's interaction with an HTML online interface. The interface's animated graphics are constructed using a Javascript library called p5.js. This interface allows users to pinpoint a single target location for the lamp to aim it's 'sight' at and calculates the the necessary angles accordingly. These angles are then sent through to a IoT backend called shiftr.io. A python library called paho Mqtt interfaces with dynamic servers and databases allows the python programs on the pi to retrieve the angles from shiftr to various classes within the raspberry pi. Finally, the pi sends this information, translated into pulse width modulations, to the individuals servo motors that move the lamp.

Too many threads, inherent mechanical latency and race conditions meant that the interface had to be more selective with when and how many messages it published to shiftr. The webpage currently works with a slower frame rate and sends individual variable angles one at a time.

corners are picked out to identify the tips of the fingers and the gaps between them. This is used to infer their general shape.

Social Affordance of Animated Lamp driven Surveillance

People are uncomfortable with passive constant surveillance. The possible scrutiny, loss of control and privacy is often brought up as general critique to ubiquitous computing and IoT. In workspace wherein ideas of personal privacy and the public nature of a studio or common space is have an interesting dichotomy, the lamp offers a unique social affordance over traditional security cameras, bugs or other passive surveillance. A hypothetical designer can check to see who is in studio when he opens his phone to his desk lamp's camera feed or if he activates the occupancy detection mode of the lamp which returns how many 'occupants' it has found. That said, the point of the lamp is not to make the most efficient and accurate occupant detection system. The overt animated scanning the lamp does is immediately obvious to occupants within the room. Their privacy is easily ensured if they wish to have it because the lamp can only 'see' in one direction at a time and doesn't move particularly fast; it is easy to avoid and allows a more fluid social dynamic to exist.

Face Tracking

AnaLamp uses the Haar Cascade classification method in order to detect a user's face. This object detection method uses a large pool of labeled images to compose a feature set that can then be referenced to identify similar objects in an image. For our purposes, we used a preprocessed xml file designed by intel to to identify frontal faces that matched within a predefined scale. This was used to implement a face tracking mode for AnaLamp, adjusting the orientation of the lamp to follow a user. Alternatively, this can be extended to detect other objects in the image (watch, phone, computer). Generating new cascade xml files can be completed by uploading an image containing an object of interest from the web app for processing.

Hand Gesture Tracking

In order to implement an adaptive skin filter for hand detection, we used the face detection method described in the previous section. Once we identified a face in the image, we selected a sub-region of the face with the most skin (below the eyes) to calculate the distribution of hue across the user's skin. This gave us an expected mapping for the user's skin tone that we then back projected into a threshold for determining which part of the image to consider skin for a particular individual. Once this information was gather, the lamp repositioned itself illuminate the desk (where the user would place their hands). This threshold was then applied to the frames of a desk, allowing them to be distinguished from an background on which they are placed. Once the hands are distinguished, corners are picked out to identify the tips of the fingers and the gaps between them. This is used to infer their general shape.

Occupancy Detection

In order to detect whether or not someone else is in the room, AnaLamp's camera captures an initial frame, and then uses that as a reference for all consecutive frames. When comparing to frames, AnaLamp creates a mask that maps out the change in value for each pixel. The program then detects regions of change. If these regions are large enough to eclipse a the given threshold, the room's state is defined as occupied.

Conclusion

While this is an initial exploration, we believe believe that the concept of a smart lamp could have many more functionalities in the future. This current iteration is more focused on functional sensing and the application of the sensed information has not yet been refined in the form of more joyful, emotive animation. The rest left to do is in the design of the interactions and animation. Smart objects, such as this one, which serve a range of purposes, could become increasingly common within work and professional spaces, though in this concept we strive for technology that feels more human and personal. Therefore, we would like to eventually use this model to evaluate the desirability of these features and brainstorm additional functionalities.

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