Autonomous Light Air Vessels (ALAVs)

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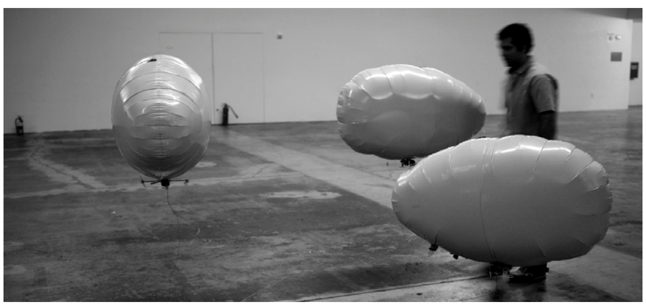
ABSTRACT

Through a defined research process we designed objects that behave and respond in specific ways and are part of a networked system that emphasizes autonomous and flocking behavior.

ALAVs are 3 flying objects that exist in a networked environment and communicate through assigned behaviors forming three scenarios: ALAV with a person, ALAV with other ALAVs, and ALAV alone.



We designed and integrated technology into working objects in an airborne environment. Rather than concepting speculative near future prototypes, the ALAVs are functioning objects. ALAVs are designed to behave and respond in specific ways. They are aware of each other and their surroundings and respond to people. The ALAVs reference flocking behavior to visualize and communicate the concept of unpredictably in environments. The ALAVs are autonomous objects that are in a continual search for activities represented by flocking and feeding. These parameters arose as a result of the possibilities of the provided technology. The technical constraints were translated into novel reinterpretations of a concept.

Categories and Subject Descriptors

B.B.7 [**Integrated Circuits**]: General; D.3.1 [**Programming Techniques**]: Miscellaneous*;* I.I.2 [**Artificial Intelligence**]: Robotics – *autonomous vehicles*

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General Terms

Algorithms, Performance, Design, Experimentation

Keywords

Blimps, SunSpots, Installation, Performance, Network.

1. ALAV SYSTEM

1. ALAVs Alone (autonomous): They are autonomous and roam to feed or to seek other members of the flock. Eagerly anticipating interaction, they project a nervous shout when alone for too long. This behavior represents their collective awareness.

The ALAVs have an algorithm that defines how they roam in search of people or food. They are autonomous with respect to their decision making process; they determine their path by controlling directional motors. Sometimes one strays from the flock. However, if after two minutes an ALAV has not interacted with anything, it makes a noise. This call is made by a cell phone vibrator resonating on their helium envelope.

2. ALAVs with other ALAVs (flocking): When not on the prowl for food, they constantly seek each other, yearning for attention. Within close proximity the ALAVs recognize another's presence and commence a flocking behavior. The behavior consists of ALAVs (2 or 3) spinning together and calling back and fourth between each other. The flocking behavior remains active for 30 seconds or until the ALAVs drift apart. The coherence of the system represents flocking as both near and remote proximity, since an ALAV is aware of the rest of its flock even when not in close range.

3. ALAVs with a Person (feeding): The ALAVs interact with people by feeding when they come into close range of food. Their hunger level is indicated by their hanging LED. If it is blue, people can approach them with food and they will feed, But if it is red, they are full and will not respond when approached. The feeding is activated when a person holding the food approaches an ALAV. You get its attention when it stops its current behavior and flutters its motors (cycling through them twice). It will begin feeding for ten seconds as long as the food remains close.

Feeding is indicated by three synchronized cues. 1. The ALAVs blue LED blinks 2. The light on the food blinks 3. The food vibrates (simulating eating out of ones hand). An ALAV will get full after feeding for around 10 seconds provided the person with the food remains close. This is indicated by its red LED: it will remain on for 15 more seconds, until it has digested the food. To complete the cycle its blue LED will turn on and the ALAV can be fed again.

2. RELATED WORK

Life Spacies (by Christa Sommerer & Laurent Mignonneau): *Life Spacies* enables visitors to integrate themselves into a world of artificial life organisms that react to the visitors body movement. The artificial life creatures also communicate with each other and so create an artificial universe. *Autonomous Minimalist Following In Three Dimensions: A Study with Small-Scale Dirigibles* (by Jason Welsby and Chris Melhuish): research of following and flocking behavior in three-dimensions using physical robots*.* *Flocking in Embedded Robotic Systems* (by Jim Pugh and Alcherio Martinoli): implementing flocking behavior on real robots and studying the system to determine what sensory information and behaviors are most important to robust flocking. Using algorithms that are inspired by flocking and shoaling phenomena in vertebrates.

3. TECHNICAL DETAILS

3.1 SunSpots (http://www.sunspotworld.com)

How could we design something in an uncertain fluid environment with unknown outcomes? This was possible through the sponsorship of Sun Microsystems who donated instrumental technology (SunSpot system powered by Java). We used nature as an inspiration model to explore in depth the engineering of SunSpots and realized how the SunSpot can serve as a hub for a variety of external systems. We used design research to test the capabilities of the technology to fit into our framework.

3.2 Circuits

Our circuits included the following: auxiliary 3V lithium battery, 5 integrated circuits and motors, and 2N7000 transistors with 1M ohm resistors. Due to maneuverability efficiency (for example hovering) we used five independent motors to cover all directions. Eventually the SunSpot was incorporated with the motors and circuits to serve as a hub to control external components. The construction and circuits were refined to streamline weight, power, and efficiency.

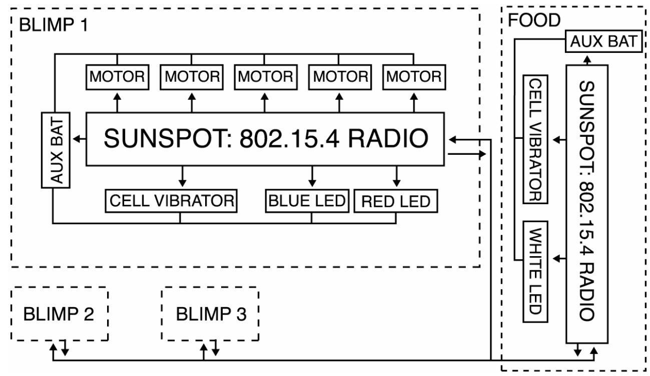
3.3 Software

We created a Java application designed to test and visualize the prototype's navigation capabilities using long-range radio communication to travel towards a specific location. Next we created a vehicle controller application. We used the laptop as a platform for controlling the ALAV's on board motors. It was designed to log our data so we could refine our final navigation algorithm. This was the most appropriate way to test the unpredictability of the ALAV's real world behavior.

3.4 Blimp and External Components

As a starting point, we hacked into existing RC blimp technology which included extensive buoyancy testing. For precision, we designed a laser cut balsa wood carriage suspended from the helium-filled envelope carriage to house the hardware. By using Rapid Prototyping techniques, we took as much handwork out of the process after we realized that even a minor variation in weight distribution can have significant ramifications on the performance of the ALAVs. After the model was complete, we started to build the necessary components to complete our scenarios: food, LEDs, and cellphone vibrator on the envelope. The vibrator resonates quickly through the helium envelope and results in a whaling call. The complete functioning system required fine-tuning the integration of the hardware and software.

Fig 1. Diagram



4. CONCLUSIONS

Our process is a unique approach to research that involves the designing of technologies into working objects. Using unpredictably to our advantage, it serves as a guide and learning tool. The ALAV system raises questions and issues regarding the integration of networked technology into various aspects of our everyday lives. It brings the capabilities of this emerging technology to life in a form that is accessible to an audience. Since everyone draws different associations from their own interactions, it becomes valuable to further a discussion of possible applications by building upon the system. The users are the public, academia, scientists and engineers. Research will continue into future interpretations of how to push networked technology into airborne object-based flocking environments.

Swarms of autonomously functioning vehicles could be deployed to carry out a prescribed mission and respond as a group to high-level management commands. We conceived the ALAV project as a platform to build upon based on people's interaction and emotional response to the system. The success of the existing project was its ability to captivate a wide audience. As a result, it communicated the idea of a networked environment with people co-habiting the same space as the ALAVs - an interactive system introducing people as part of the ecology. Our primary interests lie in further developing the relationship/dialogue between people and the flock of ALAVs.

5. ACKNOWLEDGMENTS

Bruce Hubbard, biologist and electrical engineering; Ewan Branda architect and software engineer; see www.alavs.com.

6. REFERENCES

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