ESCAPE: Generating Energy from Movement

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Background

- Current animal tracking methods used in wildlife research today have limited battery life and unsophisticated power management
- Often requires recapturing and retagging an animal to further studies
- Personnel, traps, hounds, and access to range lands incur large costs per trip
- Risks injury or death to an animal depending on tranquilizer methods and stress
- Has the potential to alter an animal's behavior due to capture-related activities, acting accordingly to avoid recapture

Motivation

- Energy Scavenging Collar for Animal Physiology and Ecology (ESCAPE) seeks to extend collar battery life
- Combines with the previous iteration of the collar, ANIMA (Accelerometer Network Integrator for Mobile Animals) to provide sophisticated power management techniques
- The goal is to generate energy from an animal's movements to supplement the on-board battery
- This has the potential to extend the life of the collar's battery for up to a year, year-and-a-half at best
- Estimated cost savings are between $27,000-$45,000 a year
- Goal is to develop a testing rig to mimic various animal walking gaits to evaluate different ways to generate power (linear and rotary alternators)
- Quantitative measurements of energy extracted over time are used to assess performance and recommend a solution

Methods

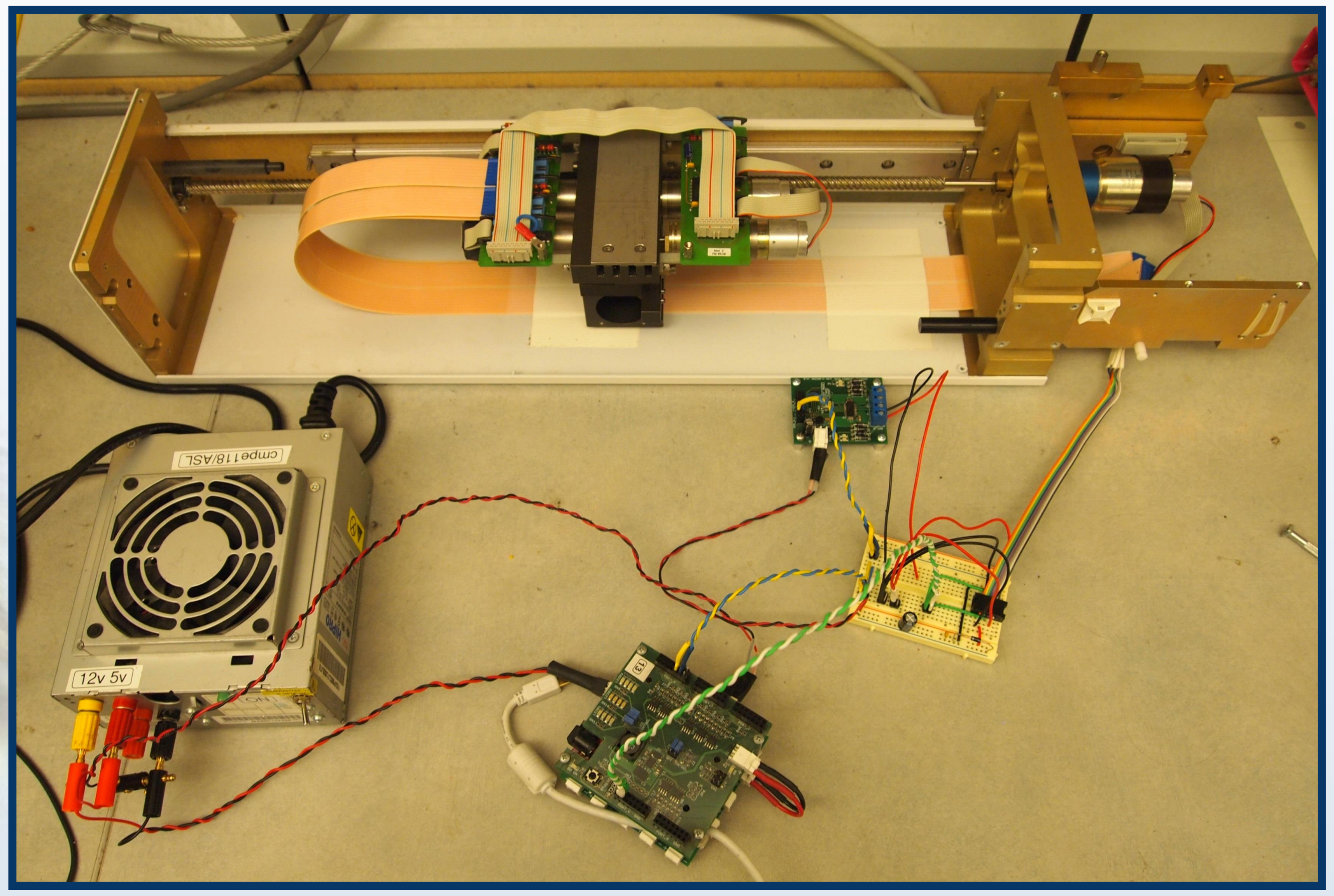

Figure 1: Full ESCAPE Testing Rig

- We wanted to create a one-dimensional testing rig for our initial analysis
- We did so by modifying an existing gantry, taking only the parts that we needed for our specific purposes and developing the rig from such
- We then designed a motor control circuit to power our DC motor
- An H-Bridge connected through a microcontroller handled frequency modulation and direction control, while the two separate channels on the incremental rotary encoder within the motor handled position control
- The position information was used to code an odometer module, measuring the current state of the encoder against the previous to increment or decrement a distance counter accordingly for amplitude modulation

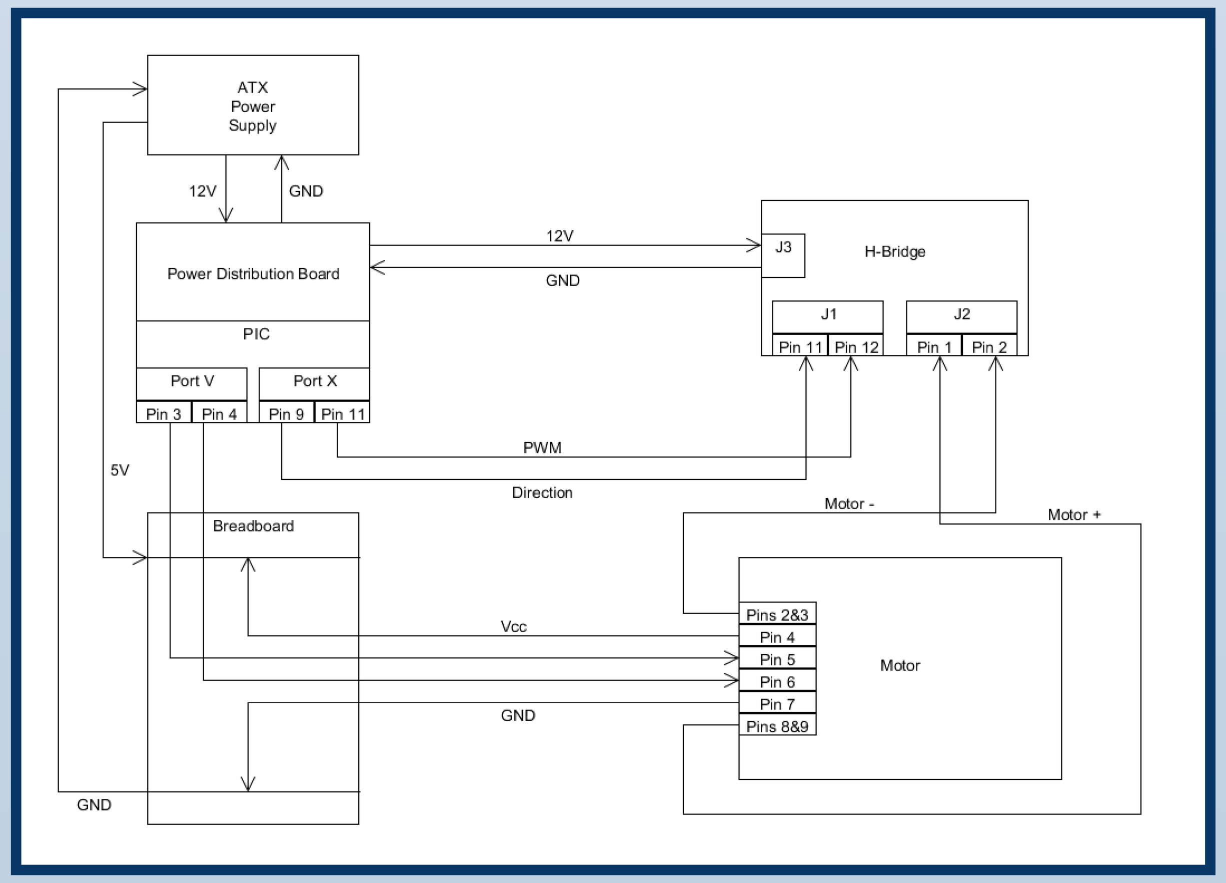

Figure 2: Motor Control Circuit Block Diagram

Results

```
void __ISR(_CHANGE_NOTICE_VECTOR, ipl2) ChangeNotice_Handler(void) {
    printf("ssss");
    INTDisableInterrupts();
    // clear the mismatch condition
    mPORTBRead();
    // clear the interrupt flag
    mCNClearIntFlag();
    asm ("nop");

    current_state = IO_PortsReadPort(PORTV) & (PIN3 | PIN4);

    direction = (prev_state & PIN3)^((current_state & PIN4) >> 1);

    if (direction)
        count++;
    else
        count--;

    prev_state = current_state;

    INTEnableInterrupts();
}
```

Figure 3: Software Framework for the Odometer Module

- We were able to successfully design and develop the hardware component of the rig
- We successfully communicated with the rotary encoders in the motor and laid a software framework for individuals working on this project in the future to modify at their will to obtain desired results

Future Work

- We hope to modify our software framework to mirror different animal walking gaits
- Primary focus will initially be on wolves
- Wolves and other canids have predictable movement patterns
- Can easily test the collar on different size dogs to measure the effects of size and weight on performance after preliminary tests on the rig
- The two alternators will be connected to a capacitor and voltage increase over time measured, similar to the circuit that will be present on the collar

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2. Graduate student, Department of Computer Engineering, University of California, Santa Cruz
3. Faculty advisor, Department of Computer Engineering, University of California, Santa Cruz

Background image edit from http://itsdura.deviantart.com/art/PNG-Wolf-202552184, original image from http://www.flickr.com/photos/dennis_matheson/3260507529/