LARGE AREA REMOTE VIDEO MONITORING USING MULTIPLE WIRELESS MOTION SENSORS

Principal Investigators: William H. Powers, Jr., Henry P. Lentz
PixController, Inc., Export, PA

INTRODUCTION OF CURRENT VIDEO RECORDING TECHNOLOGY

Using motion detection video recording systems, or "video camera traps" as they are commonly called, have been a very successful tool in capturing video of various forms of warm-blooded animals. Using a Passive InfraRed (PIR) motion detector, which detects warm targets in motion over ambient background temperature, is a proven and reliable means of detecting warm-blooded animals. A stationary target or a target not moving can not be detected. The target must also have a warmer surface temperature than the ambient background in order to be detected. This ensures surrounding vegetation, falling leaves, or branches will not trigger the motion sensor. Video recording systems such as this (*See Figure 1*) can be deployed in remote areas and left for weeks to months at a time to record what ever walks by.

Tradition "video camera traps" use commercially made video camcorders which are controlled via a motion sensor to power on the camcorder and start the camcorder recording when it detects motion. The system can be set to record as long as the animal is present within the motion detection area, or for a pre-set recording time. After the animal walks out of the motion sensing area or the pre-set time expires, the camcorder will be powered down. The electronics and video camcorder are housed in a waterproof case. A recording system such as this was recently used to capture the first-ever video of Borneo Rhino by the WWF, which made International news in April of 2007. (*See Figure 2)*

While this type of technology has been very successful in capturing elusive and rare forms of wildlife, it has limitations such as a small detection area and only a single camera angle from which to capture video. We are proposing to develop a motion-based video system with multiple wireless motion sensors, in which a video camera can be controlled to move and zoom as the target animal moves within a given area.

Figure 1
Video Camera Trap System

Figure 2
First ever Borneo Rhino video capture with a video camera trap

BASIC OVERVIEW OF THE VIDEO SYSTEM COMPONENTS

In the spring of 2007 PixController, Inc. released a multi-functional wireless Radio Frequency (RF) controller board (*See Figure 3*). This new controller works in conjunction with the popular X10 wireless PIR motion sensors (*See Figure 4*) manufactured by X10, Inc. This motion sensor was selected because:

- Small unit size
- Inexpensive to purchase
- Long battery life
- Rugged waterproof housing

The X10 wireless motion sensors transmit a wireless RF command signal to the PixController RF receiver controller when a motion event is detected. The motion sensor can be configured to send one of 256 unique unit ID addresses

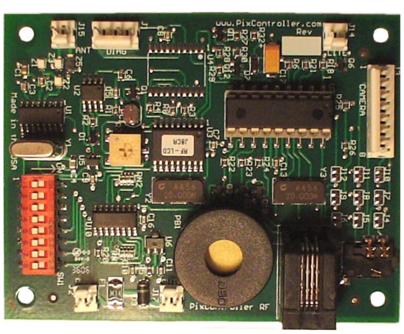

Figure 3
PixController RF Controller Board

Figure 4
X10 Wireless PIR Sensor

At the heart of the PixController RF board is a microcontroller, which is a scaled down version of the microprocessor commonly used in today's personal computers. Microcontrollers are ideal for this type of application since they use little power to operate and are specifically designed to control hardware devices. Several interfacing ports are designed into the PixController RF board including RS-232 serial, LANC port for controlling Sony/Canon video camcorders, J-LIP port for controlling JVC video camcorders, direct-wire interface port for controlling various digital and 35mm cameras, and Digital Video Recorder (DVR) interface. The RF board also includes control outputs for lights and IR LED arrays.

The type of video camera that will be used for this project will be a commercially made Pan-Tilt-Zoom (PTZ) video camera (*See Figure 5*). Camera movement will be controlled via an RS-232 serial interface port from the PixController RF board. Each X10 wireless PIR sensor's position will be calibrated by positioning the PTZ video camera for the location of each sensor and storing the PTZ position. Up to 256 PTZ positions can be stored, with one position for each X10 wireless PIR motion sensor. Each motion sensor in turn will be configured with unique address ID.

Figure 5
Pan-Tilt-Zoom (PTZ) Video Camera

When the X10 wireless motion sensor in the field is triggered, it will send a wireless RF command and address ID back to the PixController RF board. The PixController RF board will read the RF command and ID, and position the PTZ video camera in the appropriate direction for the triggering motion sensor. The video signal from the PTZ video camera can then be recorded to a host of recording devices such a high quality MiniDV tapes or DVR devices attached to the PixController RF board. (*See Figure 6*)

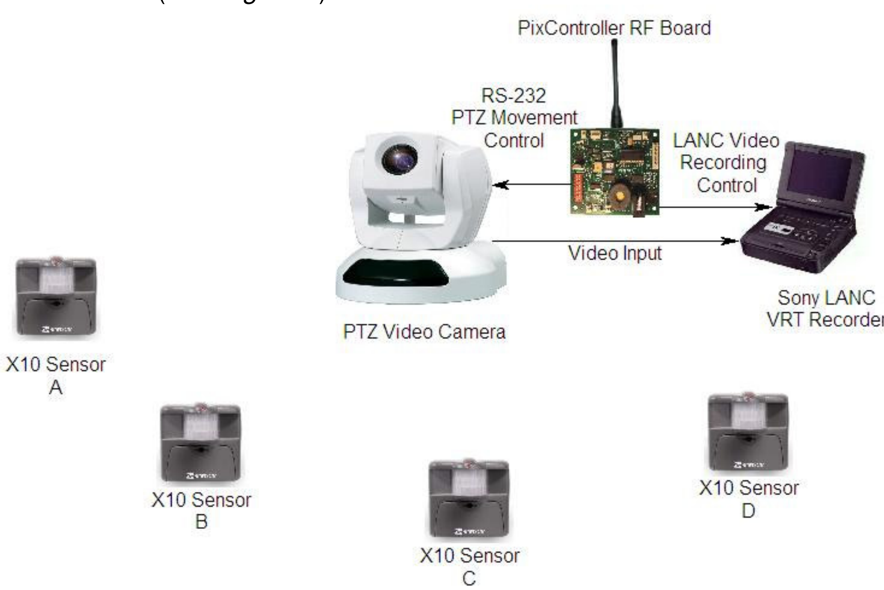

Figure 7

UNDERSTANDING THE X10 RF DATA TRANSMISSION FORMAT

Understanding the X10 data format was the first hurdle we had to overcome when interfacing the PixController RF board with the X10 motion sensors. The X10 wireless PIR motion sensor sends data using Amplitude Shift Keying (ASK) of data on a 310MHz carrier in the U.S. (418MHz or 433.92MHz in Europe). The PixController RF receiver board detects the 310MHz signal, demodulates it (i.e. removes the 310MHz carrier), and sends the demodulated data pulses as a stream to a decoder. The decoder on the PixController RF board is a separate, mission-specific PIC microcontroller. (See Figure 7)

Each X10 PIR sensor can be setup to send out a unique ID address,consistsing of a 'House' plus a 'Unit' code. There are 16 'House codes' (A to P) and 16 'Unit codes' (1 to 16). Each House code has 16 Unit codes, which provides for 256 possible ID addresses.

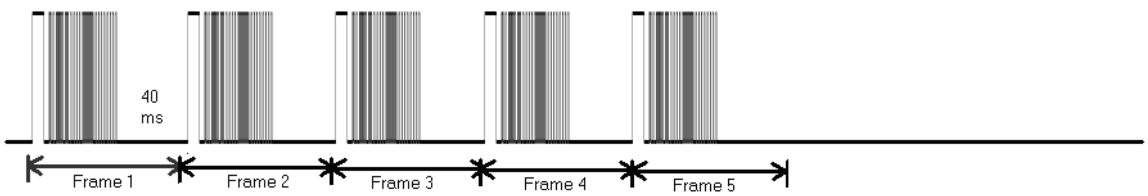

Figure 7

Amplitude Shift Keying Data Format

The House Code and Unit Code sent by the X10 motion sensor default to House Code “A” and Unit Code “1” a from the factory; they can be changed to any combination of House Code and Unit code using the pushbuttons in the motion sensor. In practice, different combination can be used for multiple camera locations, pre-triggering, sequencing, and other specific applications.

RF ANTENNA DESIGN CONSIDERATIONS

The X10 receiver embedded in the PixController RF board is essentially an AM radio which is tuned to the 310 MHz transmission frequency of the X10 motion sensors. In order to accurately decode the data stream contained in the X10 transmission and sound antenna design is required. This is complicated by extremely low transmission power (a small fraction of a watt), and the need for compact and inconspicuous packaging at the camera.

We have worked with two basic antenna designs: quarter-wave monopole and coil. The monopole, simply a whip, rod, or wire cut to the correct length (about 9 inches), gives solid performance. Typically 100 foot range is easily attained, and we’ve seen as much as 200 feet with good line of sight. The downside of this type of antenna is that it often needs to be mounted outside the case, which can pose a challenge for packaging.

The coil antenna is simply a length of wire wound around an object such as a ballpoint pen. When the pen is removed, the coil is completed. The coil is usually good for at least 50 foot range and sometimes more, and is attractive because it can be kept inside the case.

In the future we plan to experiment with more complex antenna configurations – such as dipole, yagi, and co-phasing – in order to explore the limits of X10 transmission range.

SUMMARY

A large-area video monitoring system using a single camera, triggered and directed by multiple motion sensors, is under development.

The building blocks include off-the-shelf PTZ cameras, wireless motion sensors, and proven PixController control hardware, along with new, specialized firmware being developed for the application.

In the short term, a deployable prototype will be put in the field for testing under various environmental conditions and with different sensor topologies.

Ultimately, a robust and manufacturable product will be made available to researchers for routine use.