Radar/IR Based Avian Monitoring System for Wind Turbines

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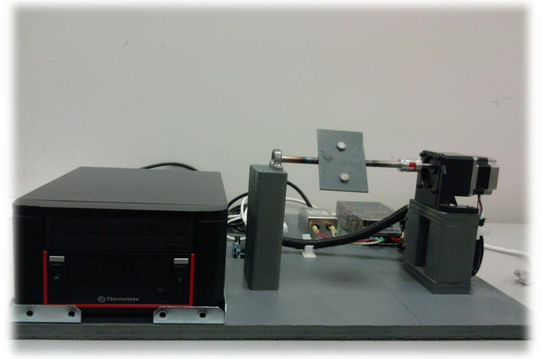
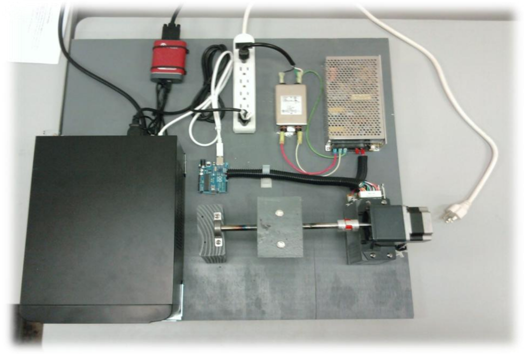
Introduction

According to the American Bird Conservancy, each wind turbine in the United States can kill up to 8 birds per year, culminating in the death of 10,000-40,000 birds each year across America.[1]. This leads to concern about the effect that wind turbines will have on the environment, particularly avian creates. Having the ability to monitor their habits will help to better understand what can be done to prevent the negative impact that wind turbines have and will have in the future.

Objective

A radar and IR based avian monitoring system for an offshore wind turbine application has been designed. The avian monitoring system is capable of capturing radar and IR data. The data is synchronized and sent to a remote computer via 3G system. The IR camera needs to be synchronized with the radar view from a remote location. The system was constructed and successfully tested for remote synchronization of radar and IR camera and transfer of data over the internet. The system is designed to monitor avian activity around offshore wind turbines.



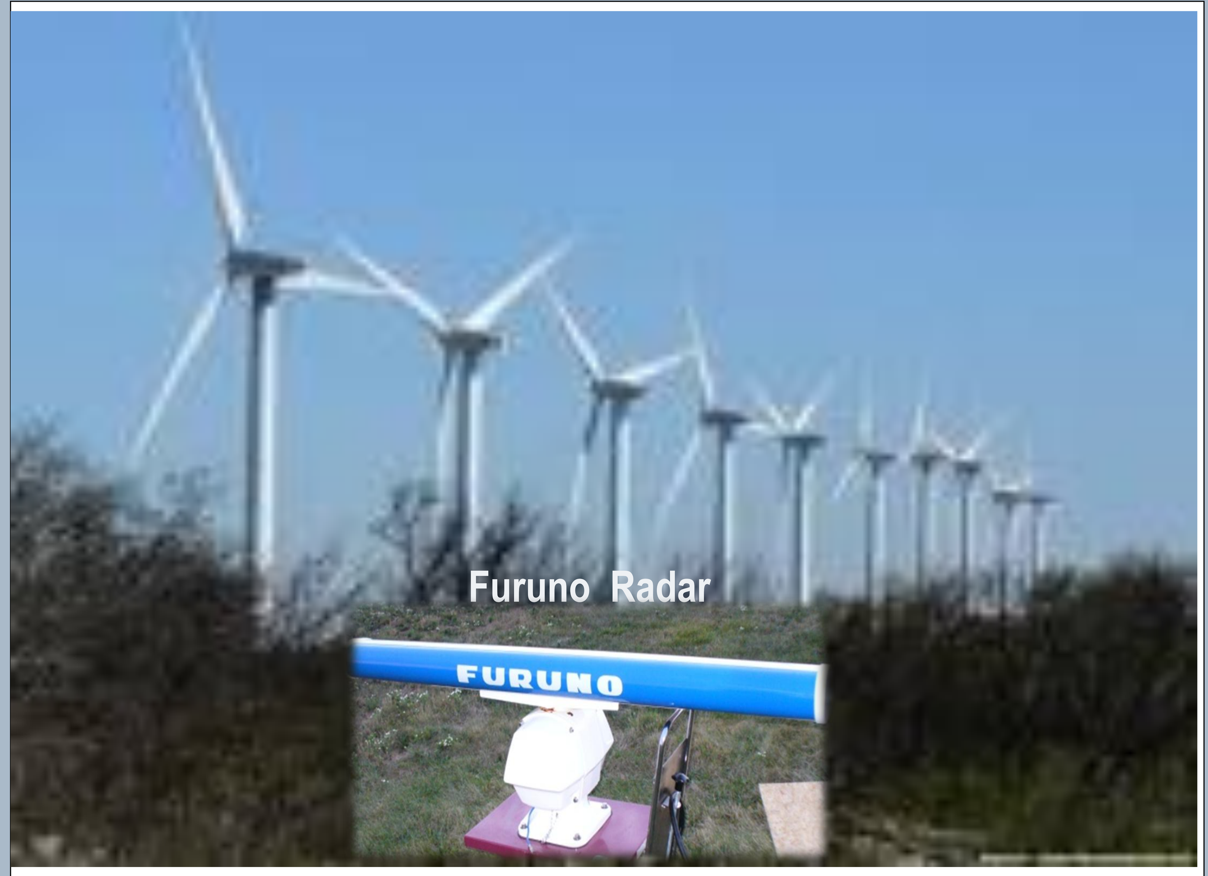


Materials

The components of this system include the embedded system, the motor and motor control for positioning the IR camera, the frame the motor was mounted on, and the capture cards used to interface between the IR camera and X-band radar to the embedded system. The embedded system holds the frame grabber for the IR camera which is installed in the PCI slot on its main board while the frame grabber for the radar is an external unit which is connected via USB. The IR camera positioning system consists of a motor, motor controller, and the mounting components. All of the system components are then mounted to the wooden system frame.

Embedded System

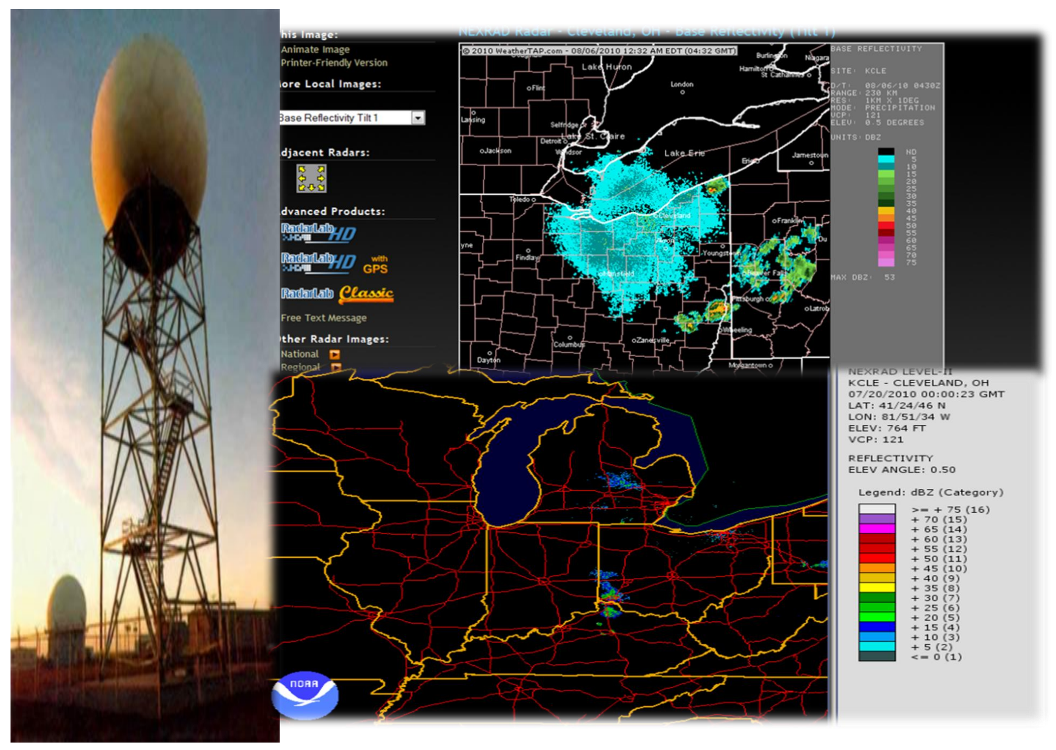
IR Camera



Method

The system operates by capturing the video signals from the IR camera and radar into their respective frame grabbers. These frame grabbers then take the video and record it into files that can be broken into multiple frames. These cards also allow live viewing of the video signals. The files can then be copied to a remote computer automatically via an FTP server and client.

The IR camera is rotated using a stepper motor. The motor is interfaced through the Arduino to the embedded system, where rotation commands can be sent either locally or remotely through a UDP server and client.

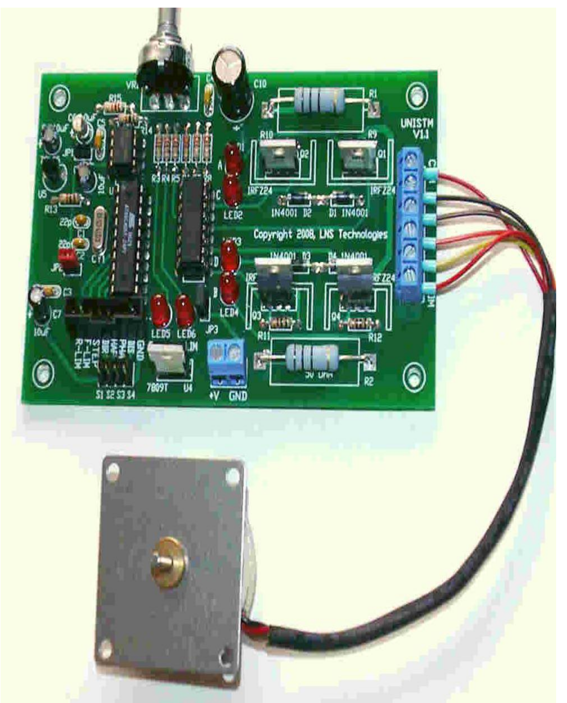


Mechanical Design

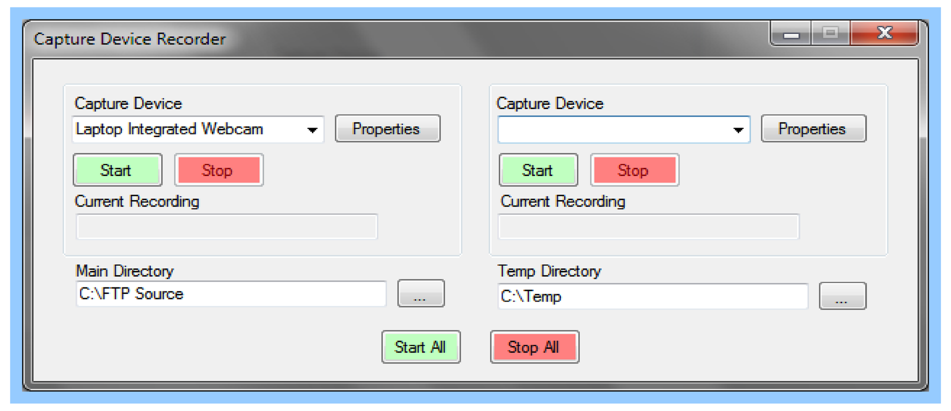
The mechanical aspects of this project involved designing an apparatus to mount the S-19 IR camera on that would provide adequate holding torque for stabilization and allow for a rotation range of at least 180 degrees. The rotation is achieved by using a stepper motor that is user controlled via input to the Arduino Uno microcontroller. The optimal stepper motor size was determined using torque calculations based on the camera weight and its lever arm.

Electrical Design

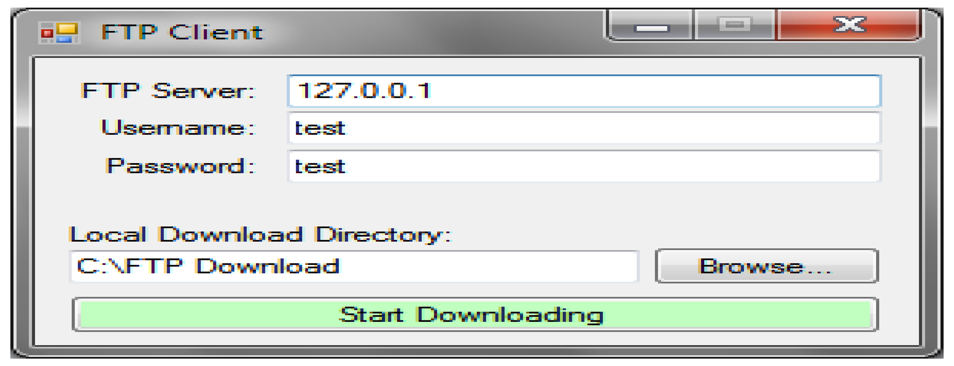
The major electrical design element of this project was the motion control of a stepper motor to accurately position the IR camera at a requested angle. Our design accomplished this using a microcontroller and motor driver to supply signals to the stepper motor.



Software Design



(1)



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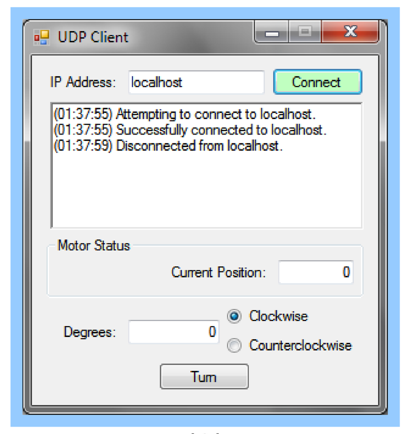

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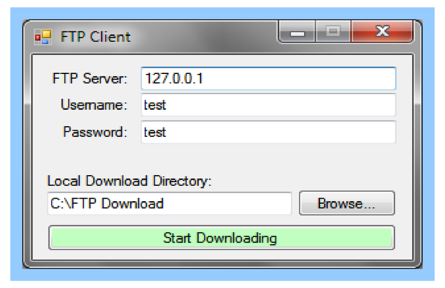

(4)

Software interface performs: (1) capture video signals and create video files from the frame grabber cards, (2) FTP file transfer client (3) control the IR camera motor, (4) download the captured video files from the embedded system to the remote computer.

The motor controlling software consists of a server run on the embedded system and any number of clients that connect through remote computers. The video capture software allows capture from two sources simultaneously. The FTP Client connects from a remote computer to the embedded system, which runs a free FTP server, FileZilla.

Results

- Used frame grabbers to capture separate video feeds
- Time stamped video for synchronization
- Created FTP client to download video files to a remote computer
- Used a stepper motor to obtain IR camera positioning accuracy within 1 degree
- Created UDP server and client software for remote positioning of the IR camera

Conclusion

The avian monitoring system consists of an IR camera and marine X-band radar interfaced with an embedded system for video capture and wireless transmission to a remote computer. It is our hope that this prototype can help with future research on the affect that wind turbines have on the avian wildlife population.

References

[1] "American Bird Conservancy's Wind Energy Policy." (2007) American Bird Conservancy. [Online] Available: http://www.abcbirds.org/abcprograms/policy/collisions/wind_policy.html

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[3] S. A. Gauthreaux, Jr. and J.W. Livingston. Monitoring bird migration with a fixed-beam radar and a thermal-imaging camera. *J. Field Ornithol.* 77(3):319-328, 2006.

Acknowledgement

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