Automated Wildlife Watcher Proposal

ECE 445

Team #61
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1. Introduction

- Problem:

  Despite interests and concern over climate change and human development, there is actually very little data available about both the diversity and distribution of wildlife insects or avian pollinators. This is especially concerning when considering the myriad number of species that are poorly understood. How many are there? How do they live? What do they eat? What can be done to help further their numbers or have the least negative impact.

  It typically takes a lot of time and effort to survey wildlife populations, a more popular approach is to citizen science. By setting up feeding stations or flowering plants in private residences and documenting visiting species, we can gather a more complete picture of the ecological distribution and possible human impact on the local species. But this too is a limited approach as it depends on observers spending time outside and physically observing and document what they saw, a costly and arguably, ineffective method of data collection.

- Solution:

  We envision a wildlife camera that can keep a certain area of interest not only for a sustained period of time but also can track and follow any wildlife and zoom in for a more clear image or video of their behavior. This not only can relieve time spent for data gathering but also more precise information about suspected wildlife behavior with minimum human presence and interference, as well as some really nice photos and videos.

- Visual Aid:

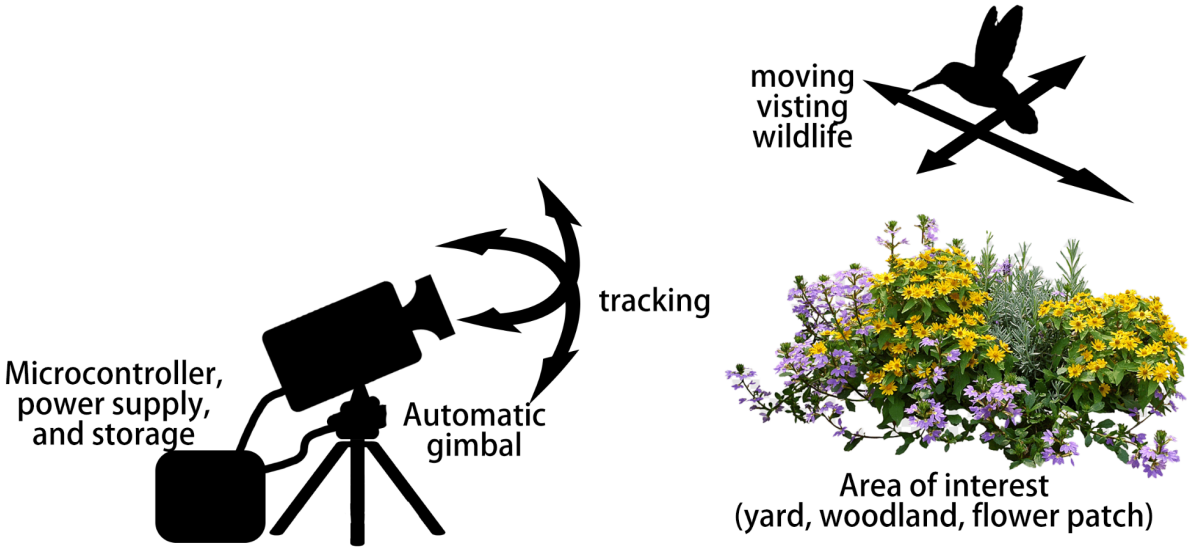


Figure 1
Source: Adapted from [1][2][3]

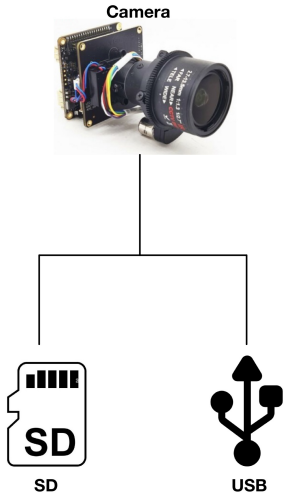


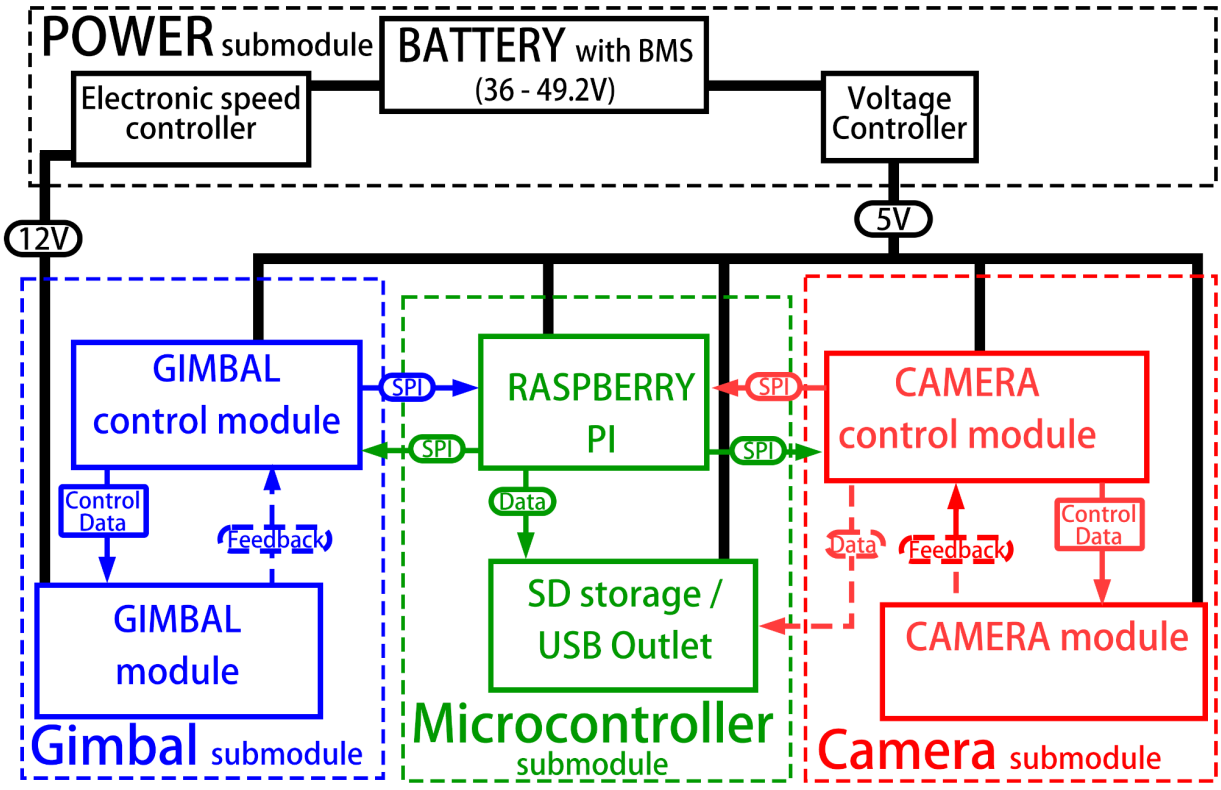
Figure 2: Storage of video and images
Source: Adapted from [4][5]

- High-level Requirements:

Camera can detect object entering its field of vision
Gimbal can adjust and track the object that is moving
The software will zooming the object and capture a photo or video

2. Design

- Block Diagram:



- Subsystem Overview:

Camera module: Camera module with a motion sensing algorithm reacts to dynamic objects (birds, insects, etc.). It has software implemented that is trained to recognize the objects in different directions. When a moving object is detected, the camera module will align and focus on a small area around the moving object and try to follow it using object tracking algorithms like YOLO, Faster R-CNN.

Gimbal: A gimbal consisting of a stepper motor is connected to the camera to stabilize and support it. Once the camera identifies the target object, the motor will turn the camera so that the target will stay within the camera range.

Microcontroller: The microcontroller on the customized PCB will be able to control a Raspberry Pi to receive the data from the camera module and send a signal to the mechanical system.

Power System: A power system consisting of battery, electronic speed controller and voltage regulator will be connected to the other subsystems, providing 12V for Gimbal Module, and 5V for Microcontroller Module and Camera Module.

- Subsystem Requirements:

Camera module: The camera module returns in-time videos to the microcontroller. It will align and zoom in certain objects according to signals from the microcontroller.

Requirement 1: The camera must be able to auto-focus.
Requirement 2: The camera must be controlled by the microcontroller to align and zoom in curtain moving objects

Gimbal: The stepper motor is used to rotate the camera in 360 degrees horizontally. It will support the camera at the designed height to capture the target object.

Requirement 1: The rpm of the gimbal motor must be controlled in a specific range to reduce the effect of motion blur and keep the target object within the camera range at the same time.
Requirement 2: The gimbal structure must be stable enough to protect the camera from environmental issues (blowing wind).

Microcontroller: The microcontroller, chosen to be Raspberry Pi, controls both the gimbal and the camera module. It communicates with the gimbal and the camera module through SPI(Serial Peripheral Interface).

Requirement 1: The microcontroller takes the input video/images from the camera module and uses object tracking algorithms to find the moving path of the object.
Requirement 2: The microcontroller will recognize the specific object using machine learning algorithms.
Requirement 3: The microcontroller uses the path to calculate the moving angle for the gimbal to follow the object.

Power System: A battery pack with BMS will be the primary voltage source. An electronic speed controller is required to control and regulate the speed of the motor in gimbal. A voltage regulator is used to regulate the DC voltages required from the microcontroller and camera modules.

Requirement 1: The supplied voltages for the gimbal, microcontroller and camera modules must be 12V +/- 5% and 5V +/- 5% respectively.

- Tolerance Analysis:

  - ➢ The microcontroller could be the part with the most difficulty to implement. The camera should be able to track the object, but the object may not stay at the center of the screen, and the gimbal's rotate rate may be complex to calculate when the moving object changes its velocity or direction.
  - ➢ We accept if the gimbal's rotation causes incoherence and jitter in the video. We also accept if the moving object is not in the center all the time. (The gimbal will calibrate slowly)

3. Ethics and Safety

- Ethics

  As UIUC engineering students, we have read and made ourselves familiar with the IEEE code and ACM code. According to part II in the IEEE code[6], we treat everyone fairly and with respect. This group is open to everyone's ideas and will try our best to avoid injuring others by false actions or any other physical or abuse abuses. In 1.3 of the ACM code[7], we should follow the principle to be honest. Copying other sources without citation is not allowed. In our project, we may use the open source code to help us build our algorithm. We will pay attention to sources used throughout the progress so that every source is cited in documentation. When there are questions or uncertainty related to ethical issues, we will seek help from TAs and professors.

- Safety

  Everyone should complete the safety training to obtain lab access. The working schedule will be planned so that no one will work in the lab alone. When there is a case that requires the use of utilizing certain battery chemistries or to work with high voltages, the member should complete additional training.

4. References

[1] PNGITEM. *Garden Flowers png images*. Accessed: Feb 9, 2023. [Online Image] Available: https://www.pngwing.com/en/search?q=garden+Flowers

[2] CLIPARTIX. *Hummingbird Clipart*. Accessed: Feb 9, 2023. [Online Image] Available: https://clipartix.com/hummingbird-clipart-image-31490/

[3] PNGITEM. *Video Camera Graphic*. Accessed: Feb 9, 2023. [Online Image] Available: https://www.pngitem.com/middle/hmhhoih_video-camera-graphic-png-png-download-camera-filmadora/

[4] Alamy. *SD card icon on white background*. Accessed: Feb 9, 2023. [Online Image] Available: https://www.alamy.com/sd-card-icon-on-white-background-storage-microchip-sign-micro-sd-symbol-flat-style-image434136652.html

[5] Flaticon. *USB Symbol*. Accessed: Feb 9, 2023. [Online Image] Available: https://www.flaticon.com/free-icon/usb-symbol_64172

[6] "IEEE code of Ethics," IEEE. Accessed: Feb 9, 2023. [Online] Available: https://www.ieee.org/about/corporate/governance/p7-8.html

[7] "ACM Code of Ethics and Professional Conduct," ACM. Accessed: Feb 9, 2023. [Online] Available: https://www.acm.org/code-of-ethics