CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Computer Vision Bird Identification for Smart Bird Feeder	
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Project Overview:

Birds have fascinated us throughout history. Many of us take great joy in attracting and feeding wild birds around our homes. Over 50 million people in the United States alone spend billions of dollars annually on the activity. As a hobby, feeding wild birds is now second only to gardening. Bird lovers are thrilled by the variety of birds that visit their yards, and proper identification of species is important not only for personal satisfaction, but because accuracy is important when contributing bird count information to bird conservation, citizen-science initiatives such as Cornell University's Project Feeder Watch. But while the popularity of backyard bird feeding has grown enormously, how we view and enjoy our backyard birds hasn't changed much in generations.

With limited time to view their feeders, many bird enthusiasts can only know a small sample of the birds that visit and may have trouble identifying some birds. The goal of the pEEp Feeder is to bring backyard bird feeding into the modern age by combining IOT technologies with artificial intelligence to create a revolutionary new way to experience back-yard birds. Our pEEp smart feeder will be equipped with an internet connected camera that allows real-time viewing and image processing via smart software. The pEEp camera will capture images of feeding birds and AI techniques will identify the species. Feeder owners can then receive updates and images to see what birds have visited, along with other information/data.

Initially, we will development an AI model able to accurately identify bird species from images. Ultimately, the goal is to have the pEEp feeder *automatically* identify *individual* visiting birds. This capability would present avian researchers with a valuable tool for tracking specific birds across time and migratory routes. It would also kindle a more intimate and personal connection to our backyard birds and may lead to increased participation in citizen-science, conservation and education efforts.

In particular, the envisioned product is a web app that serves as an end-user interface to the pEEp camera. Some specific aims and features on the project include:

Phase 0: Minimum Viable Product.

- Able to take in pictures of birds (representative of pics taken by pEEpcam) with date/time information and display them in chronological order in the GUI.
- Has fully trained AI module that can be given a pic and will classify from among three different species (list to be determined). At this basic level, can assume that pics are mostly "ideal" in terms of framing/lighting.
- Tools for managing the training set and training parameters for the AI module, e.g.:
    - Ability to load a raw training set, i.e., large set of bird images
    - Ability for admin expert to quickly flip through those pics and classify into the target classes
    - Ability to save/import/export fully classified training sets.
- Streamlined workflow for training the AI, loading resulting module into the webapp for testing.
- A mechanism for evaluating/scoring the accuracy of classification.

Phase 1: A complete and usable product

- A more refined GUI, tested on prototypical beta end-user group
- More powerful classifier, specifically able to succeed on bird images that are non-ideal in terms of framing/lighting.
- Ability to configure any number of classification categories (i.e., more than three bird species)
- Mechanism for continual improvement: admins can review all classified images and "correct" mis-classifications. These expert-classified images become part of revised/growing training set.
- Allow users to flag mis-classified images; these are queued for admin/expert review.
- GUI tools to allow end-users better insight into their bird visitors, e.g.:
    - graphical (e.g. pie chart) of species observed in some time period.
    - ability to set/change time period in graphical tool, e.g., zoom in/out in timescale.
    - Nicer dashboard view that gives summary data for last 24 hours, last week, last month, last year
- Ability for user to specify which bird species should be tracked/counted/reported on.

Phase 2: Extra features that would be cool (stretch goals)

- Actual connection to the pEEp-cam birdfeeder hardware device to access incoming images.
- Ability to share "reports" of bird visitors with friends by email, Facebook, Twitter.
- Ability to export detailed chronological statistics in a tabular format, e.g., for posting to national repositories to support scientific analysis.

In this time of pandemic and for the foreseeable future, many people are looking for entertainment and engagement in and around the relative safety of their own homes. With proper implementation, I believe the pEEp Feeder concept can not only provide an opportunity for this type of at-home fulfillment but can also be a significant tool for public engagement in citizen-science and conservation efforts. An accurate AI bird identification tool will be invaluable toward these efforts.

Knowledge, skills, and expertise required for this project:

- Web and or Android coding skills
- An understanding of Machine Learning/Computer Vision

Equipment Requirements:

- There should be no software required other than a development platform and software/tools freely available online.
- Sponsor will provide team with the current pEEp web app code (not currently very smart) if requested.
- If the team chooses to develop the app interface in android, android TV boxes will be provided for on-device testing.

Software and other Deliverables:

- The web application as described above, deployed on a platform of the client's choice, and tested successfully with real data. Must include a complete and clear User Manual for configuring and operating the software.
- Final Report must include a section reporting on accuracy if species ID achieved by the AI implementation, and discussion of findings related to accuracy versus size/nature of training set.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, Bitbucket, or some other version control repository and as a physical archive on a USB drive.