2. Semi-annual report

Göksel Keskin (goksel.keskin@ttk.elte.hu)

Doctoral School of Physics

Supervisor: Dr Mate Nagy

Ph.D. Thesis title: Designing and Creating a Proto-type Semi-Autonomous Bird Inspired UAV for Bird Tracking and Filming

1. Introduction

In my second semester, according to my research proposal, the main goal was to analyse GPS recordings of discovering the gliding part of the immigration flight. On the other hand, I participated in the selection of model gliders for my group and also in a collaborative project at the Department of Ethology. Also, my courses were parallel to assist my research topic.

2. Research

I've been working on a large data set that consisted of GPS records collected in collaboration with my supervisor and also by different research groups. The main purpose of this data set to compare soaring flight among bird species. The white stork (*Ciconia ciconia*) dataset contains high-resolution data that make it possible to find out the glide polar of the storks individually and as an average. During migration, storks perform different flight styles such as taking-off, gliding, soaring, flapping. Since gliding flight in birds is generally observed in a straight line, the curvature has been calculated to avoid the analysis of segments with too many turns [1].

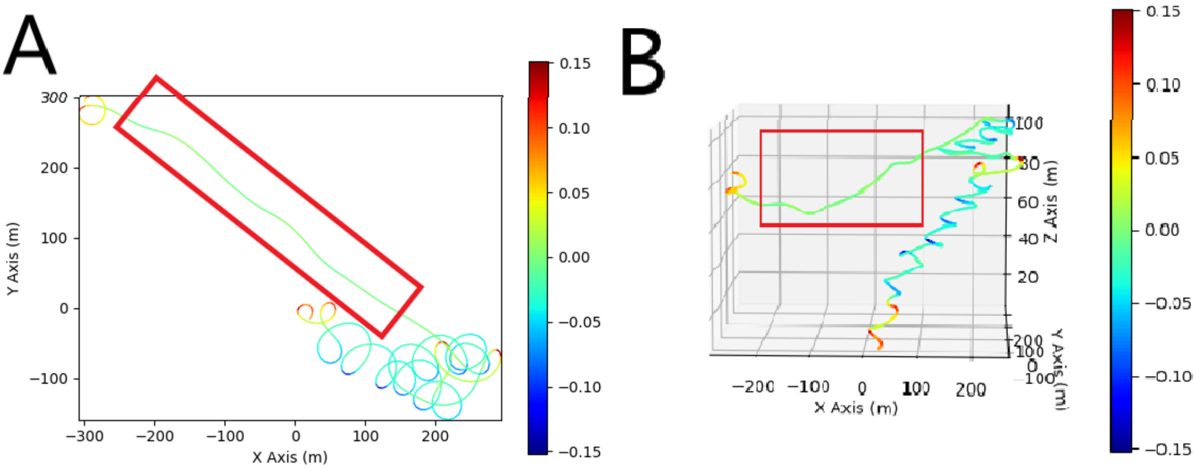

Figure 1. The horizontal path curvature, κ, is shown by colour-coded. **A**. 2D visualization shows us, curvature is close to 0 during the straight gliding (can be seen inside the red frame) flight while larger than 0.1 in thermal circling. **B.** 3D visualization provides us proof of unpowered gliding flight. Loss in altitude can be observed in the red frame, which means after gaining altitude by thermals, the stork glides to another thermal without consuming energy.

The next step after the calculation of the curvature value was to find out the most commonly used horizontal speed relative to the vertical speed which is sink speed in gliding flight. This method first applied to individuals who performed the most frequent gliding flight among storks tagged. Also, these individuals have been selected from birds that completed the migration on the same route.

The effective glide polar curve was created from the average vertical velocity for every 0.5 m/s increments of horizontal velocity. For the effective polar curve, a parabola fitted between the calculated points of average vertical speed [2].

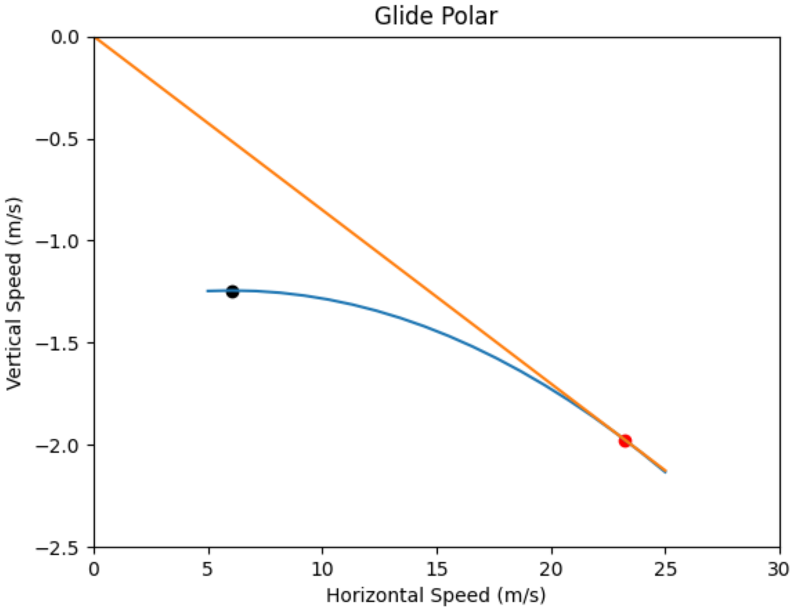

Figure 2. The glide polar curve gives us information about flight performance. The glide ratio equal to the maximum lift-drag ratio is marked as the red point where the tangent line from the origin touches the parabola. The black point shows us the minimum sinking rate where storks lose less altitude.

The intersection point of a tangent line from the origin to the parabola gives the maximum lift-drag ratio equals to the glide ratio. The minimum sink rate is shown as a black point. The derivation of such polar curve from real flight track is important as birds utilise benefits of morphing their wings.

According to the research plan, glide polar of other bird species that data set is available will be created. The glide polar will be used to find out in thermal horizontal velocity and climb rate graph. Then all the flight performance results of the birds will compare with each other.

Besides analysing the GPS data set, I worked on selecting the first prototype of an R/C (Radio control) model glider which is an important research aim for the MTA-ELTE 'Lendület' Collective Behaviour Research Group. This glider will be the first step towards an autonomous robotic glider that can perform formation flight with wild birds. Besides this research with the fixed-wing glider, I also joined another research project that fits very well the scope of my PhD research plan. In this project, working with my supervisor, his collaborators and a professional falconer, we aim to explore the possibilities of raptor’s behaviour in close proximity to drones. The first initial step is a training of a Harris hawk that would grab a prey hanging from a rope carried by rotary-wing drones (to habituate the bird to the noise produced by the drone). This outcome of such training will serve as a proof-of-concept for our further research plan regarding the flight of bird(s) and drone(s). In this project, I was able to benefit from my previous experience as a trained drone pilot.

In collaboration with Dr. Attila Andics research group at the Department of Ethology, I also started working in a project (partially as part of my courses) that is focusing to assess individual variation in (family) pigs’ response to novel environment and objects based on their locomotor activity measured using a motion sensor device and object exploration scores.

3. Study Activity

Biophysics I (biophys1f20ex)

I joined this class gain more in-depth knowledge in physics, as my main background is biology. Understanding intermolecular and intercellular physics is also helpful to work on flight locomotion of bird flight.

Theoretical evolutionary biology (FIZ/3/005E)

The evolution of multicellular organisms and the branching of animals brings many clues to the flight of birds. Arboreal and cursorial theory can be scrutinized better with the help of this class.

Integrated research methods in ethology (BIO/02/06E)

My research topic is highly correlated to the behaviour of birds. Learning research methods to solve birds' behaviour guide me to step forward in my research.

4. References

1 Nagy M, Couzin ID, Fiedler W, Wikelski M, Flack A. 2018 Synchronization, coordination and collective sensing during thermalling flight of freely migrating white storks. Phil. Trans. R. Soc. B 373: 20170011. http://dx.doi.org/10.1098/rstb.2017.0011

2 Ákos Z, Nagy M, Vicsek T. 2008 Comparing bird and human soaring strategies. Proceedings of the National Academy of Sciences,105 (11) 4139-4143. Doi: 10.1073/pnas.0707711105