About

This is a document detailing how the new Velocity Curve formulation behaves under extreme conditions. After the meeting Jan 16, 2023.

📑 Nomenclature

We define certain words we use throughout the formulation & analysis. Note that not all the variables are documented (e.g. Track Error Boundary is assumed to be a familiar nomenclature for the reader)

Constants (User-defined)

- V_nom: Nominal Velocity (Cruise speed)
- V_max: Maximum Velocity (Physically possible by the vehicle)
- V_path: Desired speed on the path (in the direction of unit path tangent)
- V_approach_min: Desired minimum approach speed orthogonal to the path

Time-varying

- V_approach: Speed to approach path in the orthogonal direction when track error is at infinity
- V_orth: Orthogonal velocity component to the path
- V_parallel: Parallel velocity component to the path

Special Rules

- V_path is set to be V_nom for a fixed-wing. Whereas for a multicopter it can take any value within the feasible range.
- V_gnd: Ground speed of the vehicle (defines track error boundary for TJ derivations)

🥷 Extreme Conditions

Here are the variables we will be varying:

- **V_nom: Nominal Velocity (Cruise speed)**
- **V_path: Desired speed on the path (in the direction of unit path tangent)**
- **V_approach_min: Desired minimum approach speed orthogonal to the path**
- **V_g: Ground speed of the vehicle (currently)**

V_path < max(V_nom, V_approach_min)

This is only relevant for a multicopter, where we reach a speed lower than the maximum speed between nominal speed & minimum approaching speed.

In this case, the first version of the cartesian v_approach_min algorithm should behave in a cartesian-decoupled velocity-ramp in starting from max(V_nom, V_approach_min) value, orthogonal to the path.

⚗️ Algorithms

TJ NPFG Cartesian V_approach_min

- **V_approach** = max(V_nom, V_approach_min, V_path)
- Track_error_boundary = V_approach * time_constant
- If V_path >= V_approach
    - Follow NPFG logic, with V_nom = V_path
- Else
    - Ramp-in velocity as sine & cosine of look-ahead-angle formulation

✅ Results

Summarized in: 12_VelocityCurveFormulation_230123