Progetto Aerodinamica dell'Ala Rotante

- FUNZIONE ELICA INTUBATA - SPINTA TOTALE

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1 Algorithm

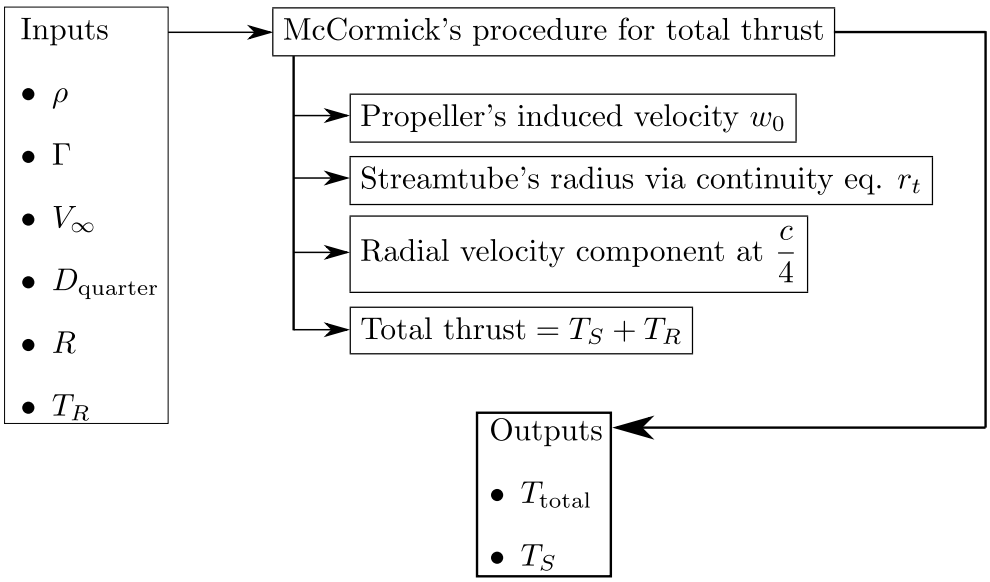

Figure 1 - 1: Flow diagram of the function `elica_intubata.m` with inputs and outputs.

In this brief document, we will describe the algorithm of the function `elica_intubata.m` based on the semi - empirical method proposed by McCormick. A simplified flow diagram for the code is shown in 1 - 1.

1.1 Inputs

The function accepts the following inputs:

- flow density ρ;
- ring vortex circulation Γ;
- stream velocity V_∞;
- quarter diameter D_{quarter};
- duct's radius R;
- free rotor's thrust T_R.

1.2 Outputs

The function generates the following outputs:

- total thrust T_{total};
- shroud thrust T_S.

1.3 Use of the function

This function must be used in conjunction with another program that provides ring vortex circulation and, thus, the isolated rotor's thrust.

2 Code listing

```
%% \elica_intubata.m
%  \brief:  A function that calculates total thrust of a ducted propeller.
%   It generates a vector with total thrust and shroud thrust as output.
%  \author: Claudio Mirabella, Christian Salzano
%  \version: 1.04
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%
% ================================================================================
% |Name         : elica_intubata.m                                                 |
% |Author       : Claudio Mirabella, Christian Salzano                             |
% |               University of Naples Federico II.                                |
% |Version      : 1.04                                                             |
% |Date         : 25/11/2020                                                       |
% |Modified     : 11/01/2021                                                       |
% |Description  : A function that calculates total thrust of a ducted propeller.   |
% |               It generates a vector with total thrust and shroud thrust as output.|
% |Reference    : Lezioni di Aerodinamica dell'Ala Rotante                         |
% |Input        :                                                                  |
% |               (rho) = Density                                                  |
% |               (Gamma) = Ring vortex circulation associated with the shroud     |
% |               (Vinf) = Stream velocity                                         |
% |               (Dquarter) = Shroud diameter at c/4                              |
% |               (R) = Shroud radius                                              |
% |               (TR) = Isolated rotor thrust                                     |
% |Output       : (T) = Total thrust generated                                     |
% |               (TS) = Thrust generated by the shroud                            |
% |Note         :                                                                  |
% ================================================================================

function [T, TS] = elica_intubata(rho, Gamma, Vinf, Dquarter, R, TR)
% ------------------------------------------------------------------
% Propeller's induced velocity calculations
%  eq 4.24
w0 = .5*(-Vinf + sqrt(Vinf^2 + 2*TR/(rho*pi*R^2)));
```

```
% -------------------------------------------------------------------------
% Streamtube's radius rt calculated via the continuity
%  eq 4.20
A = pi*R^2;
const=0;
const = (Vinf + w0)*A;
rt = sqrt(const/(Vinf*pi));
% -------------------------------------------------------------------------
% Radial velocity component induced by the rotor at c/4
%  eq 4.23
cquarter=1/4;
viRquarter = -.5*rt*w0*R^2/((R^2+cquarter^2)^1.5);
% -------------------------------------------------------------------------
% Thrust component due to the shroud
TS = -rho*viRquarter*Gamma*pi*Dquarter;
% -------------------------------------------------------------------------
% Total thrust
T = TR + TS;
% -------------------------------------------------------------------------
end
```

Listing 1: Function `elica_intubata.m`

Listings

1 Function `elica_intubata.m` 2

References

[1] Tognaccini Renato. *Lezioni di Aerodinamica dell'ala rotante*. Università degli Studi Ferico II, 2020.