

1 Defining Manufactured Mean Flow Functions

For SWIRL, the absolute bare minimum requirement is to define the corresponding flow components for the domain of interest. SWIRL assumes no flow in the radial direction, leaving only two other components, axial and tangential for a 3D cylindrical domain. Since SWIRL is also non dimensionalized, the mean flow components are defined using the Mach number. SWIRL uses the tangential mach number to obtain the speed of sound using numerical integration. The speed of sound is then used to find the rest of the primitive variables for the given flow.

The goal is to manufacture functions that will test the numerical integration used to obtain the speed of sound. This requires a manufactured function for either the tangential Mach number or the speed of sound. For example

1.1 Checking if guidelines for creating manufactured solutions are followed

1. smooth
2. general enough to exercise each term in the governing equations
3. Enough derivatives to appropriately test scheme
4. bounded by a small constant
5. Make the same assumptions as code (non-dimensional variables, so they should not exceed one or be negative)
6. Defined on a connected subset of 2d/3d space
7. function needs to make sense to the derivatives in the pde

1.2 Mean Flow (steady)

$$\tilde{A}(\tilde{r}) = \sum_{j=1}^n R_{ij}$$

i++i

1.2.1 Speed of Sound

2 appendix

Non-dimensionalize radius,

$$\tilde{r} = \frac{r}{r_{max}} \tag{1}$$

$$\tilde{r}_{min} = \frac{r_{min}}{r_{max}} \tag{2}$$

$$\tilde{r}_{max} = \frac{r_{max}}{r_{max}} = 1 \tag{3}$$

Define a new radial term, \hat{r} to scale the radius to 0 to 1,

$$\hat{r} = \frac{\tilde{r} - \tilde{r}_{min}}{\tilde{r}_{max} - \tilde{r}_{min}} \quad (4)$$

$$\hat{r}_{max} = \frac{\tilde{r}_{max} - \tilde{r}_{min}}{\tilde{r}_{max} - \tilde{r}_{min}} = 1 \quad (5)$$

$$\hat{r}_{min} = \frac{\tilde{r}_{min} - \tilde{r}_{min}}{\tilde{r}_{max} - \tilde{r}_{min}} = 0 \quad (6)$$

$$(7)$$

The next step is to define the workflow for defining the manufactured solution for SWIRL