# Adaptive Taylor Series and its Applications in the Interval Finite Element Method

Andrzej Pownuk

March 22, 2010

Many engineering problems require solution of the system of equations (usually PDE) with the interval parameters $\mathbf{p}$

$$A(p)u = f(p) \quad p \in \mathbf{p}. \tag{1}$$

The solution $u = u(t, x, p)$ depend on the time $t$, special variable $x$, and the vector of uncertain parameters $p = (p_1, ..., p_m)$. The interval solution can be defined in the following way

$$\underline{u}(x,t) = min\{u(x,t,p) : p \in \mathbf{p}\}, \quad \overline{u}(x,t) = max\{u(x,t,p) : p \in \mathbf{p}\}. \tag{2}$$

Using the Finite Element Method it is possible to solve the equation (1) for each specific value $p_0$ i.e. $u = u(x, t, p_0)$. In order to get approximate values of the function $u$ around the point $p^{(i)}$ it is possible to apply the Taylor polynomial $P_n(x, t, p, p^{(i)})$. Approximate values of the interval solution can be calculated in the following way

$$\underline{u}_i(x,t) \approx min\{P_n(x,t,p,p^{(i)}) : p \in \mathbf{p}\} \tag{3}$$

$$\overline{u}_i(x,t) \approx max\{P_n(x,t,p,p^{(i)}) : p \in \mathbf{p}\} \tag{4}$$

In order to increase the accuracy the solution can be calculated in many points $p^{(i)}$. Numerical examples will be presented during the conference.