APPROXIMATION OF RAIN INTENSITY BY MEANS OF DATA FROM CYLINDRICAL OMBROGRAPH

Abstract

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This paper proposes a solution of the problem to find a smooth approximation of rain intensity in a point on the earth–surface in which the amount of rainfall has been registered by a mechanical device called cylindrical ombrograph. For this approximation, quadratic splines are used and an effective algorithm for their construction is derived. Then a modification of this construction able to separate different rains and to guarantee non–negativity of the rain intensity approximation is described.

The cylindrical ombrograph records time–points such that in every interval between two consecutive points, the height of rainfall is equal to a prescribed value h [mm]. There is $h = 0.2$ except intensive rains where h may be an arbitrary positive–integer multiple of 0.2. A sense is explained in which the rain intensity is optimally smooth and existence and unicity of this optimally smooth rain intensity are declared. Further, an effective algorithm approximating the optimally smooth rain intensity by a quadratic spline is derived. This algorithm is modified, so that different rains are localized and all the approximate rain intensities are non–negative. These modified rain intensities and their first derivatives are proved to be continuous. Moreover, the total amount of rainfall determined by this approximate rain intensity is shown to be equal to the amount measured by the cylindrical ombrograph.

The above–mentioned procedure is the basis of a computer program able to approximate values of the rain intensity in any time from a given interval. As a tool for an approximation of the intensity of flow of water into a building construction through its surface, this program is one component of a system modeling the process of heat and moisture distribution inside of exterior layers of building constructions which have porous structure and are directly influenced by whether–determined factors like temperature, hydrostatic pressure, intensity of sunshine and intensity of rain. The programming system is based on a model proposed by Jiří Svoboda and presented in the preprint Dal ík, Svoboda, Šťastník, *A model for the moisture and heat propagation in porous materials.*

[1]Supported by a grant GA ČR 103/05/0292

The resulting approximation described in this paper is not optimal in any exact sense; such an optimal solution would satisfy an extensive system of non–linear equations and its numerical approximation would require an essentially larger amount of computations.

The presented procedure has been applied to the data from the meteorological station of the Faculty of Civil Engineering of Brno University of Technology. In these data, the time–points registered by the cylindrical ombrograph have been measured in minutes. For strong rains, which produce increase of the height of rainfall greater than 0.2 mm in one minute, this fact is a source of big errors. As all other meteorological data are measured with the time–step of 15 minutes, it is natural to choose this value as the time–step in the modeling of heat and moisture transfer. Motivated by this fact, average rain intensities have been computed in 15 minutes intervals from the data of the cylindrical ombrograph before entering the above–described procedure. Computation with these transformed data has minimized the role of the above–mentioned source of error.

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