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System for monitoring and acquisition of physical processes dynamics: the decomposition of CaCO3 tablets in deionized water

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A software application developed from open-source code libraries has been used to analyze digital video recordings of physical system evolution. The process of calcium carbonate tablet decomposition in deionized water was recorded with a digital video camera at 12 Mp resolution and 30 frames per second. The tablets were formed by compressing micronized CaCO3 powder with a cylindrical press mold and a Perkin Elmer hydraulic press. Applied pressures were in the interval from 174.89 MPa to 813.4 MPa with an increment of 73.95 MPa and three different particle sizes of the micronized calcium carbonate powder were used: 20 μm, 40 μm, and 90 μm. All prepared tablets were the same mass of 1 g. The used code libraries were the standard Windows C++ library and the open-source code library OpenCV. For application development, the standard Windows C++ library was exploited for the storage and export of the output data. The OpenCV library provides information about the position of objects within the frame by analyzing the recorded video frame by frame. The colored image was transformed into a grayscale format followed by a blur function as a sort of low-pass filter to remove noise from the image. Finally, a threshold function was applied to the image, which turned the grayscale image into a binary one. The threshold function was assigned the level of detail of the image, which allowed keeping the contours of the tablet itself and removing unwanted noise in the form of air bubbles or particles floating in the water. In addition, erosion and dilatation operations to remove noise from the contours were also used. The contour detection function was used to determine the image moments of the given frame. The image moments were used to calculate the centroid of the given image. The time dependence of the centroid position graph provided a possibility to extrapolate the time interval needed for the tablet's dissolution. The correlation between the particle size of the CaCO3 powder, the pressure applied during the tablet production, and the time required for the decomposition of the tablets was established. The developed analytical software presented here could be useful for monitoring and analyzing the dynamics of a wide range of physical systems as they evolve over time. Also, the applicability of the presented software could be in the pharmaceutical and chemical industries for optimization of the process of tablet production and decomposition.

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