Powder Metallurgy & Mining

Editorial Open Access

# Computer Simulation and Machine Vision

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In recent decades, the performance of digital cameras and computers has rapidly increased while their cost has decreased; thereby enabling machine vision and computer simulation to be applied in a range of sectors, for realising affordable andextensive potential benefits. This has resulted in considerable research efforts internationally; and over the last twenty years at the University of the West of England, Bristol, I have been researching into applications of machine vision and computer simulation in fields that have ranged from powder metallurgy (PM) to detection of skin cancer. In all of these areas I have found that the use of machine vision for collecting 3D data from objects/surfaces and then the application of advanced 3D modelling for analysis, is a potentially very powerful method and one that has been relatively underutilised in comparison with 2D approaches. For example, in PM the morphology of the powder particles has a profound influence over the packing and flow behaviour of the powder and therefore is critical for efficient die filling. Despite this, relatively little 3D modelling of irregular particle morphologies and packing behaviours has been reported. To fill this gap I developed a technique called 'Random Sphere Construction' that involved stochastically overlapping smaller spheres onto a larger one in order to produce 3D models of particles, where machine vision is used to relate the 3D models to real particles. The modelled 3D particles are then employed in Discrete Element Modelling where they are moved in order to simulate the effects of gravity on particle assemblies; and packing experiments showed that predicted packing densities were in line with measured ones [1]. The method has been employed by a number of researchers, who have published journal papers and it was developed into a commercial package called "DigiPac" for simulating particle packings. In their 2004 paper, Gan et al. state that the method employed in DigiPac is similar to that described in the 1997 CMS paper [2]. There are in fact many other applications in PM where machine vision, simulations and AI techniques such as neural networks can be applied to generate productivity or cost benefits [3]; and I have also found that the technology can be usefully applied to industries that include: freight metrology, quality inspection of tiles and polished stone, and new generations of non-contact wheel alignment systems. In addition to these conventional industrial applications, an ability to measure in 3D at high resolution and to analyse the results has also been shown to be useful in numerous medical areas. For example, over the last ten years I have been developing the 'Skin Analyser' which is a unique device that employs machine vision for recovering 3D as well as 2D data from skin lesions. I have employed this for a number of years at Frenchay Hospital and by analysing the data have established a relationship between the amount of irregularity in the 3D texture of a lesion and the likelihood of it being cancerous [4-6]. Other medical areas where I have found 3D machine vision to be useful include non-contact breathing measurement and detection of Plagiocephaly [7].

My research into 3D machine vision and computer simulation has been interesting and fruitful, and I believe there is still much potential to expand application areas and to develop new techniques that will provide advanced functionality. Developments in CAD, Rapid Prototyping and low-cost 3D imaging devices such as the 'Kinect' have helped to acceleratethe recent expansion in 3D vision research that has been undertaken internationally; with useful outcomes in areas such as inspection and quality control, reverse engineering and robotics. Many examples of such research are described in a Special Issue of the journal *Computers In Industry* for which I was a Guest Editor. The title of this publication is: '3D imaging in Industry' [8].

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**Received** January 30, 2014; **Accepted** February 03, 2014, 2013; **Published** February 04, 2014

**Citation:** Smith LN (2014) Computer Simulation and Machine Vision. J Powder Metall Min 3: e128. doi:10.4172/2168-9806.1000e128