SCIENCE AS A VOCATION AND CAREER

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HIGH SPEED IMAGING; HISTORY AND DEVELOPMENT

High speed imaging or high speed photography could be defined as the science of capturing photos for a very fast process or phenomena. The science of high speed photography was started very early in 1878 by taking photos in a horse race which is called gallop. The photo was taken by the English pioneer photographer Eadweard Muybridge. In the race they tried to prove that the horse feet were all off the ground at the same moment during the gallop.

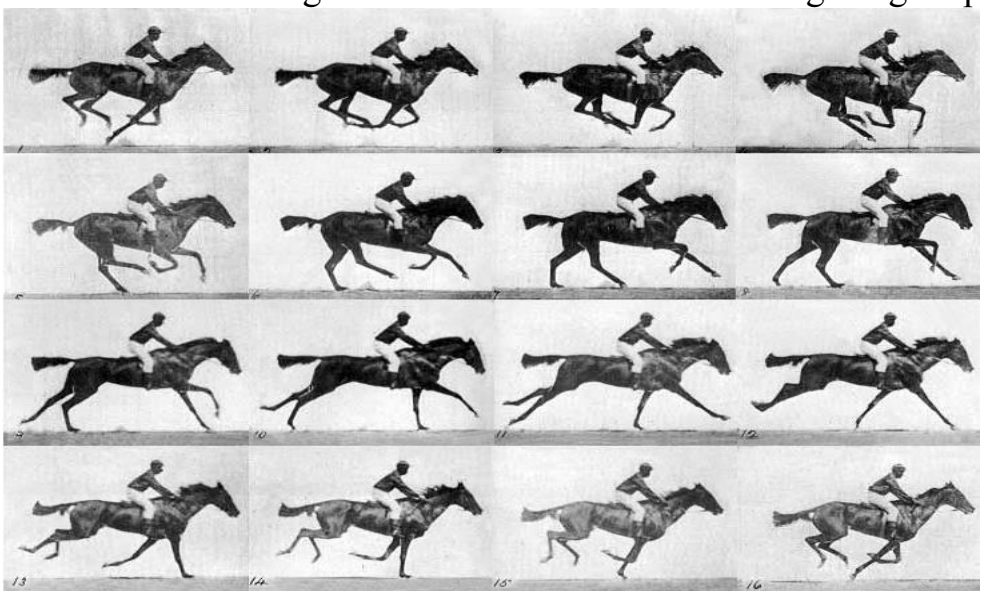

Fig.1. Sequence of a race horse galloping. Photos taken by Eadweard Muybridge (died 1904), first published in 1887 at Philadelphia [1].

Later in the early 1886 the first photograph of flying bullet of a supersonic was taken by the Austrian physicist Peter Salcher. The same technique of this photograph was used by the German weapon scientist Ernst Mach for studying the supersonic motion in 1916. Considering all the previous phenomena only a beginning for observing and understanding the processes acting very fast, the high speed photography was used in Manhattan project in 1940s by the technician photographer Berlin Brixner. The application of high speed photography in the first nuclear bomb production had the key role for solving technical issues about the shape and the speed of implosion. The following figure

shows a nuclear explosion of 20m diameter after 1mellisecond of the explosion.

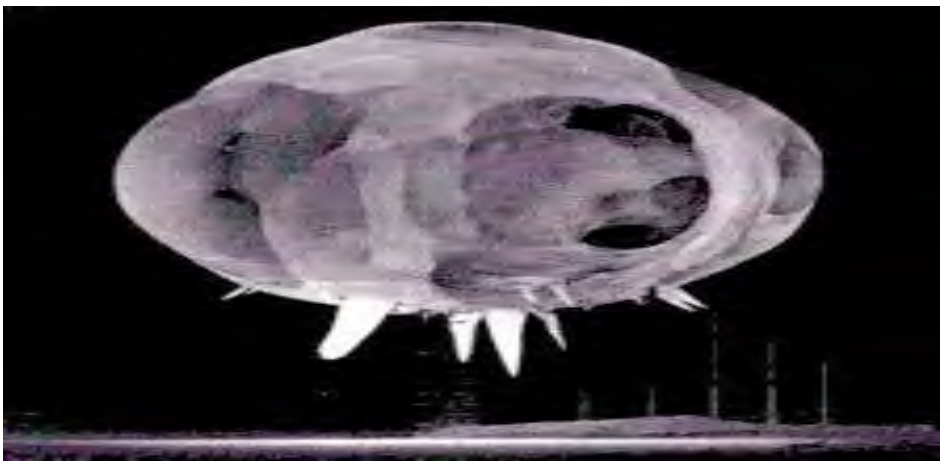

Fig.2. Nuclear explosion photographed with the Rapatronic camera less than 1 millisecond after detonation [1].

Nowadays the technology of high speed photography is growing in the field of non-destructive testing using laser illumination and x-ray illumination. The geo-materials such as rocks and concrete or bricks are tested under dynamic loads, the recent technology of high speed photography helps to clear understand the properties of those materials during testing. To discover what is going exactly inside the processes around us we need a continuous development of high speed photography.

Table.1.

History of development of high speed photography[2].

Date	Organization/ person	Achievement
1878	Eadweard Muybridge	The first practical application of high-speed photography
1886	Peter Salcher	The first photograph of a supersonic flying bullet
1931	Japanese Institute of Aeronautical Research	manufactured a camera capable of recording 60,000 frames per second
1940	Cearcy D. Miller	Patent for the rotating mirror camera, theoretically capable of one million frames per second
Recent technology		1Tfps have been reached by sequentially timed all-optical mapping photography

Development of the tools of high speed photography since the first photo of the horse in 1878 is ongoing till now. The first photo was taken with a frame rate 69 fps. A classification divided the high speed imaging into four categories according to the frame rate, a) High speed imaging in the range of 50-500 frame/second (fps), the system uses mechanical shuttering and discontinues film motion; b) Very high speed imaging with rate between 500-100,000 (fps), using a continuous moving film and a digital video system; c) Ultra high speed imaging, 100,000–10 million fps (Mfps),using stationary film with moving image systems and electronically with image converter cameras; and (d) super high-speed, more than 10 Mfps, where film has been largely superseded by electronic imaging and recording [1].

Nowadays recent technology achieved many types of cameras capable of photographing with a very high frame rate, for example we have “Shimadzu HPV X2” camera recorded photos with 10 Mfps also “Kirana” camera achieved 5 Mfps [2].

REFERENCES

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CFD APPLICATIONS IN PWR THERMAL-HYDRAULICS

Introduction

In the last decade, three-dimensional CFD codes have increasingly been used to predict single-phase and multiphase flows in nuclear reactor applications under stationary or unsteady conditions. CFD is used to process mathematical modelling of a physical phenomenon involving fluid flow and solve it numerically using computational prowess. CFD modelling and analysis became a popular online simulation solution as the difficulty grew in applying