

The computer revolution based on discrete digits or "binary notation" (0,1) swept aside the familiar continuum of conventional analog technology. In just a few decades many things have been digitalised including audio, data, telephone and fax transmissions to name but the most obvious. This technology-driven revolution has brought many advantages such as controllable precision, exact repeatability, high fidelity, production simplicity, etc., which we already take for granted. Photography and television however remained faithful to analog technology until only recently. Even when an attempt was made a few years ago to develop "high definition television" (HDTV) the research remained true to the analog concept. Strangely enough, when it was found that an "all-digital" approach could produce the required definition, interest in the project waned. For the digital processing of pictures and films requires an enormous amount of data (tiny dots or "pixels" that make up the picture on the screen). Furthermore, most of this data is redundant, i.e. it can be recovered from the main body of data. This important discovery opened the way to the possibility of data compression, and to today's ubiquitous multimedia systems. As a young Ph.D. student in the early 70's, I worked on compressing fax data. During 30 years in the field I have been involved in a number of improvements and new applications, which now include digital TV. The sustained efforts of my team, including 30-odd Ph.D. students, have paid off. For our ideas and results have been accepted as the basis for several international standards such as the MPEG4, earning this work the 1997 IEEE ASSP Technical Achievement Award. The Swiss Federal Institute of Technology Lausanne has thus once again demonstrated that it is a force to be reckoned with in the multimedia age.

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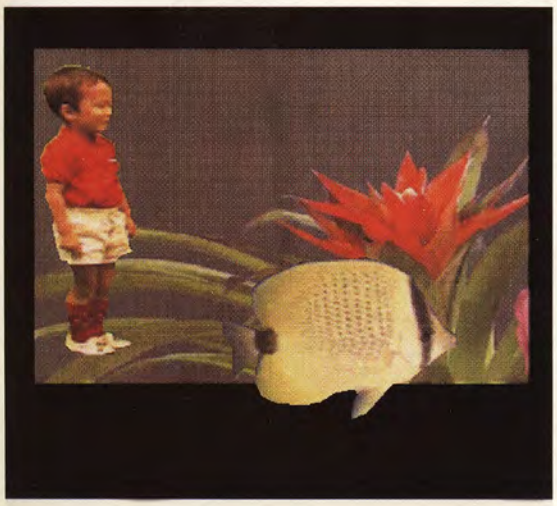
Orbit, Basel

Special focus ***p. 46***
Hewlett Packard has set up shop at the Swiss Federal Institute of Technology Lausanne (EPFL), an obligatory first step in its efforts to be a world leader for the multimedia technology of the future. Why Lausanne? Simply because the EPFL has gone further than anyone in developing the technology of tomorrow, including the elusive secrets of HDTV. Important international standards are emanating from Lausanne.

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Special Focus

Mastering the atoms of HDTV imagery





Pictures representing several million bits

To produce a single digital picture, it takes hundreds or even thousands of tiny little dots, side by side in a line, and hundreds or thousands of such lines. Each dot or "pixel" represents a grey or coloured area of the scene. On average it takes 8 digital bits (0 or 1) for each grey dot and 24 for each coloured one. A single picture thus represents several million bits. Repeated at a rate of 25 or 30 times per second, it thus takes several trillion bits for a moving picture lasting one hour - a prodigious number! Even with the fastest digital processors (computers) available today, the simplest manipulation of these bits requires very large memories and lengthy computation/transmission times. These drawbacks make many potential applications of digital imaging impractical in everyday life. If we take a closer look at the dots, we soon realise that the value changes little from one to another within a small area, except where there are sharp contours. This observation led to numerous ideas for reducing or "compressing" the total number of bits.

The EPFL brain wave

The optimum in achievable compression was reached in the late 70's. But it was limited to only a few applications. To overcome this drawback, it would be necessary to find a digital solution that did not rely on dots. Another important aspect is the image receiver "downstream", which is not photographic paper or a TV screen but the human eye and brain. Highly sophisticated though these are, the human system of perception is far from perfect. Two fundamentally new ideas - 1) to base the compression strategy on the strengths and weaknesses of the human viewer, and 2) to focus on objects in the scene rather than the conventional dots - provided the keys to the solution. These ideas were contributed by the Swiss Federal Institute of Technology Lausanne team in 1985. They have made it possible not only to achieve much greater compression, but to add new functions such as manipulating a scene, object by object. The two pictures in the illustration show the same objects combined in different ways.

The importance of standards

In a world which offers many possible solutions, standards are absolutely essential, for without them exchanges on a large scale would not be possible. Strangely, most existing standards are limited, and require systems to be rigid. This situation has resulted in a plethora of standards, and equipment which is correspondingly incompatible. Ad hoc engineering has been the only way of achieving any kind of compatibility in such circumstances. This fact has definitely slowed the pace of globalisation, as anyone who has ever tried to shave in an English hotel with a Swiss electric razor knows only too well. Since the pace at which new standards are introduced is far slower than the rate of technical progress, it makes sense to opt for a solution which is global, open, advanced, and evolving rather than rigid. The new MPEG4 (Motion Picture Expert Group) multimedia standard adopted by the International Organisation for Standardization (ISO), which is due to be finalised in 1998, is based on principles established by the Swiss Federal Institute of Technology Lausanne in 1985, together with several more recent direct contributions by our team in Lausanne.

A Swiss centre of excellence

The 1997 IEEE ASSP Technical Achievement Award and the adoption of our ideas in the MPEG4 standard is neither a coincidence nor a piece of luck. It is the result of 30 years of sustained efforts, by myself and a large number of my Ph.D. students. Most of these have since gone to work for major companies in the digital television and multimedia field, which will be dependent on the MPEG4.

The Swiss Federal Institute of Technology, Lausanne is a world leader in image processing technology. This was recognised recently by Hewlett-Packard when it came to us with an ambitious new project to design the multimedia systems of the future, in which digital photography will play a major role. The new project will take 10 people and 5 years to complete.

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