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A video protocolling and retrieval system for the analysis of behaviour [1]

A video protocolling and retrieval system for the analysis of behaviour. Recent developments in the data processing and video technologies have enabled the design of automatic systems for the handling of video software. The system for the protocolling and retrieval of audiovisual data (PRAVDA) described here has been developed for applications in behavioural observation and analysis. The facilities available, including time coding, search routines and automatic editing are explained and the advantages of computer aided operation are dealt with. Current applications of the system are briefly discussed.

Un système de fixation et de notation vidéo pour l'analyse du comportement. Des mises au point récentes dans le domaine du traitement de l'information et des technologies vidéo ont permis de concevoir des systèmes automatiques pour le traitement des matériaux enregistrés en vidéo. Le système de fixation et de notation des informations audio-visuelles (PRAVDA) décrit ici a été mis au point pour être employé dans l'observation et l'analyse du comportement. Les avantages tels que le codage du temps, les recherches de routine et la mise en page automatique sont expliqués, les possibilités de l'apport de l'ordinateur dans certaines opérations présentées. Les applications courantes du système sont rapidement retracées.

Ein System zum Protokollieren und Rückholen audiovisueller Daten für die Verhaltensanalyse. Neuere Entwicklungen der Datenverarbeitungs- und Video-Technologie ermöglichten den Aufbau automatischer Systeme für die Bearbeitung von Video-Software. Das hier beschriebene System zum Protokollieren und Rückholen Audio-Visueller Daten (PRAVDA) wurde für den Einsatz in der Verhaltensbeobachtung und Verhaltensanalyse entwickelt. Die Möglichkeiten des Systems, u. a. Zeitcodierung, Such-Routinen und automatische Editierung werden erklärt und die Vorteile computerunterstützter Operationen aufgezeigt. Augenblickliche Anwendungsbereiche des Systems werden kurz diskutiert.

Introduction

The use of picture and sound recording techniques for the analysis of behaviour reaches back to the turn of the century. The earliest examples of the scientific use of photography, for example, include the work of the psychologist Duchenne [3] involving the study of the human face, and that of Muybridge [10] who succeeded in producing cinematographic records of animal and human motion with his configuration of synchronised still camera equipment.

Cinematography as such, however, was first made available in the early 1890's, and despite the attempts of Edison at that time to integrate this with his phono-

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[1] The development of the system was supported by the Deutsche Forschungsgemeinschaft (Project No. Cr 39/1).

graphic system, the first successful synchronous picture and sound recordings were achieved in the 1920's [11].

For better or worse, behavioural researchers have always been very receptive to new developments in the picture and sound recording technologies so that nowadays the film or video record plays a central role in this field of research. The variety of techniques developed for film analysis associated with various branches of scientific research has been described by GALLE [5] in a review article, in which the historical development is outlined.

Of particular importance for the study of human behaviour are the concepts proposed by GESELL [6] in his work on what he entitled cinemanalysis. His conception of the film recording as a series of discrete, instantaneous registrations whereby the temporal and spatial relationships are secured, and his propositions regarding observation techniques such as frame by frame analysis, slow motion study and pattern phase analysis remain central to this methodology.

The development of the social sciences in the 1950's led to the extensive use of film recording of behaviour in many situations, particularly in the field of ethology and to a certain extent in the psychiatric therapy situation [2].

The first applications of video recording in scientific research were realised shortly after the invention of the videotape recorder by the firm Ampex in 1956. The advantages of the video medium were then quickly recognised, one consequence being the widespread use of this technology in psychology and psychiatry for behavioural analysis and in the therapy situation [1].

The difficulties arising from the collection of large amounts of video material, and the need to protocol and evaluate this efficiently led to the development of various automatic techniques for the indexing and controlling of videotapes [8]. A central feature of such equipment was the use of timecode systems.

The work on the development of a video retrieval system as reported by EKMAN and FRIESEN [4] is perhaps the most wellknown in psychological research and incorporated many of the possibilities made available by the consolidation of the video recording and data processing technologies.

The methodological tradition outlined here and the recent improvements in the various technologies involved have been decisive during the conception of the present system.

Video Software Handling

For the behavioural scientist, the videotape serves as an intermediate storage medium between the occurrence of the recorded sequences and his final evaluation or analysis. It should be clear, however, that the video recording as such cannot be compared with, nor does it provide directly, a set of measured data. On the other hand, it does provide the possibility of repeated observation and measurement of the recorded sequences, and thus facilitates many approaches which would be impossible with direct observation alone.

Technically, one major disadvantage of the video tape as a storage medium is that the recorded information is not directly visible. With film, a visual image is recorded onto the carrier medium and points of interest can be determined by direct observation or by simple optical projection; with video, however, an electronic signal is recorded on magnetic tape and the reproduction of the visual image requires a substantial amount of electronic circuitry. This can become particularly problematic during the later handling and processing of the recorded vido material. The problems associated with the production of video recordings, although of substantial importance, will not be dealt with in this contribution. It is assumed here that the video material to be analysed is available in a suitably recorded form.
Amongst the prerequisites for an automatic video handling system are:
All control functions should be carried out by programmed routines. The man-machine interface equipment should operate, on the one hand, between the user and the recorders to be controlled, and on the other, between the user and the higher order algorithms in the master computer.
The operation of the entire system should remain comprehensible and as transparent as possible [7].

A system for the protocolling and retrieval of audiovisual data (PRAVDA)

The routines required during the analysis of video material may be listed as follows:

a) exact indexing of the videotape,
b) searching for defined points in time,
c) presentation of temporally defined scenes from one or more recorders,
d) editing with frame accuracy,
e) synchronicity of protocolled data.

A prerequisite for these routines is the synchronous recording of a time and control code with the usual video signal. The time code used with the present system is a digital signal containing one codeword per video frame. It corresponds to the standard proposed by the International Electrical Commission (1974). The coding system allows for the inclusion of content classification code as well as the time information.
The code signal is recorded on a longitudinal track in such a way that each video frame is synchronously formatted with the corresponding codeword.
The fundamental advantage of using timecode is that the programmed routines can operate synchronously to the video signal and to frame accuracy within the time reference. The efficiency of the automatic control functions is therefore substantially improved.
A block diagram of the entire system is shown in Fig. 1. The equipment is hierarchically ordered so that the video and audio signals and data lines to and from the recorders and monitors are controlled by the integral unit ESP III (edit/ search processor).

This unit is in turn subordinated to a process computer which is used for the control of the programmed routines and for storage of the data files and which may be switched into a larger computer network.

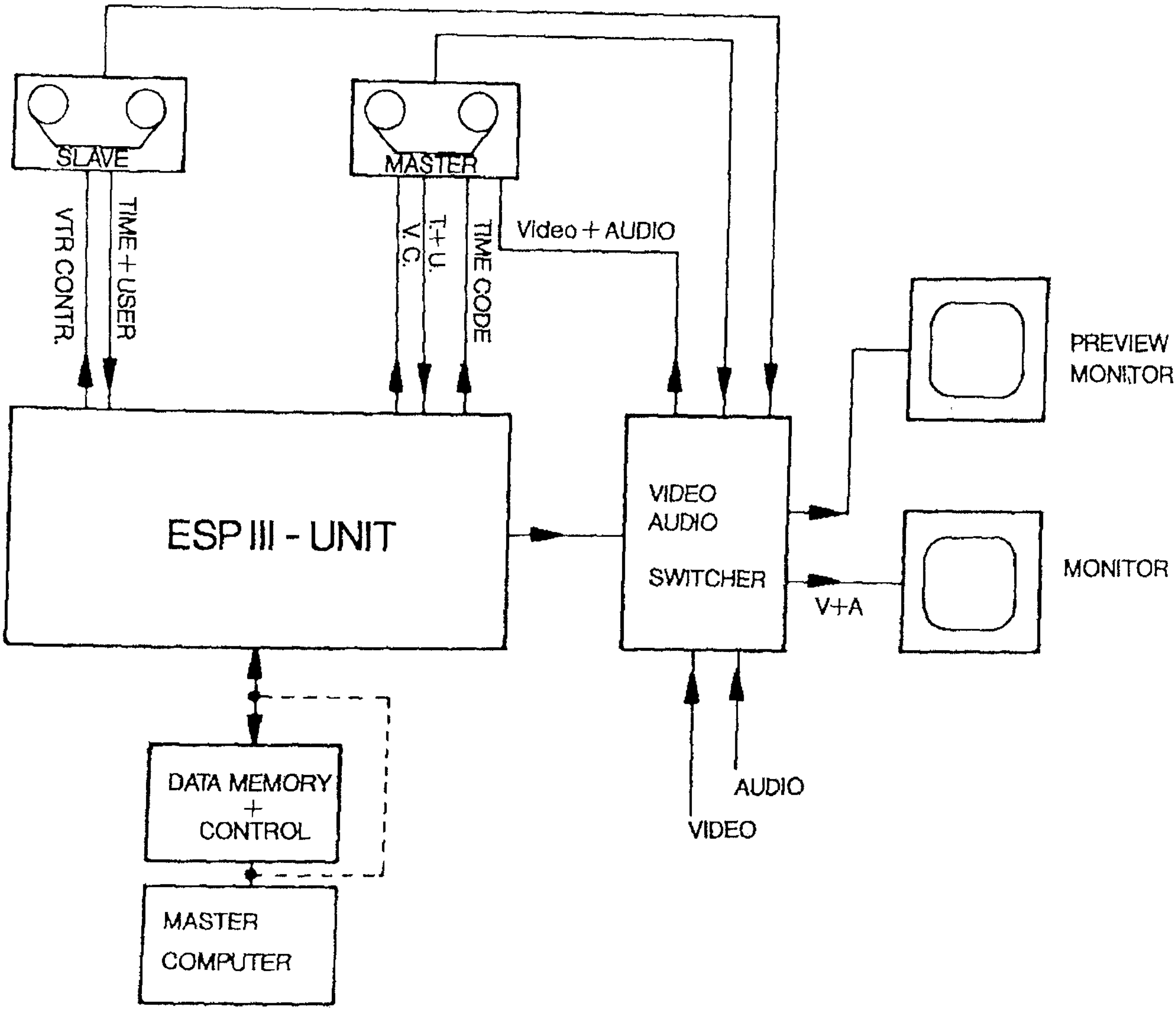

Fig. 1: Block diagram of the PRAVDA system. The master and slave recorders are controlled by the ESP III unit. The time and control code is recorded together with the video and audio signals. During replay the timecode is taken as reference and the video and audio signals are switched to the appropriate monitor equipment. The master computer is interfaced to the ESP III unit via a data memory and control unit.

Microprogrammed Control Routines

Essentially the handling of timecoded videotapes involves various combinations of three basic control routines: searching for a given point in time; presentation of a temporally defined scene; and editing of selected scenes from production tapes to the edited tape.
These routines are controlled in the PRAVDA system by a hardwired microprocessor situated in the ESP III unit.

The search routine involves the controlling of one videorecorder such that the videotape is positioned to any given point in time – selected from the 110 minute tape length. The routine should also be performed in the shortest possible time.

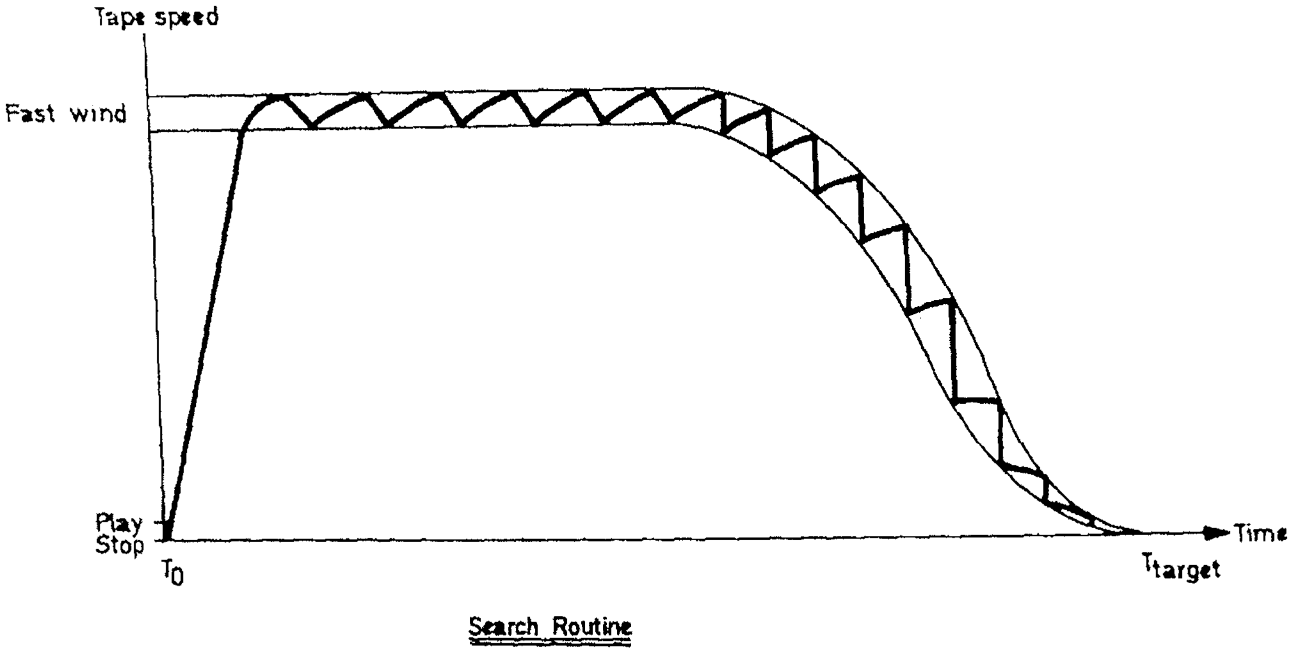

Fig. 2: After definition of the target time T_{target}, the recorder is controlled so that the tape speed is held within the tolerance range shown. The tape is positioned with frame accuracy to the defined time. The routine is performed by a hardwired microprocessor.

After selection of a point in time the routine operates such that the tape speed is controlled as shown in Fig. 2. The target time is thus accurately obtained during a single tape movement.

The routine for the presentation of a temporally defined scene is also programmed so that the shortest delay occurs between selection of the entrance and exit points and actual presentation at the video monitor. The control sequence is illustrated in Fig. 3.

First of all a search routine is performed such that the tape is positioned shortly before the entrance point to the scence. The recorder is then switched into play mode and after the cue-up time, which allows the recorder to stabilize mechanically, the video and audio signals are switched to the monitor exactly at the selected entrance time. The signals are then switched down at the exit point and the machine is halted. Since the entrance and exit points are stored, the scene can be presented repeatedly with negligible delay.

The same routine can be performed for two recorders (Fig. 4) whereby the two selected scenes are presented on the monitor contiguously.

The routine shown in Fig. 4 is also used for editing scenes from production to edit tapes. The one difference being that an edit command is given to the edit recorder during the vertical interval at the entrance point to the second scene.

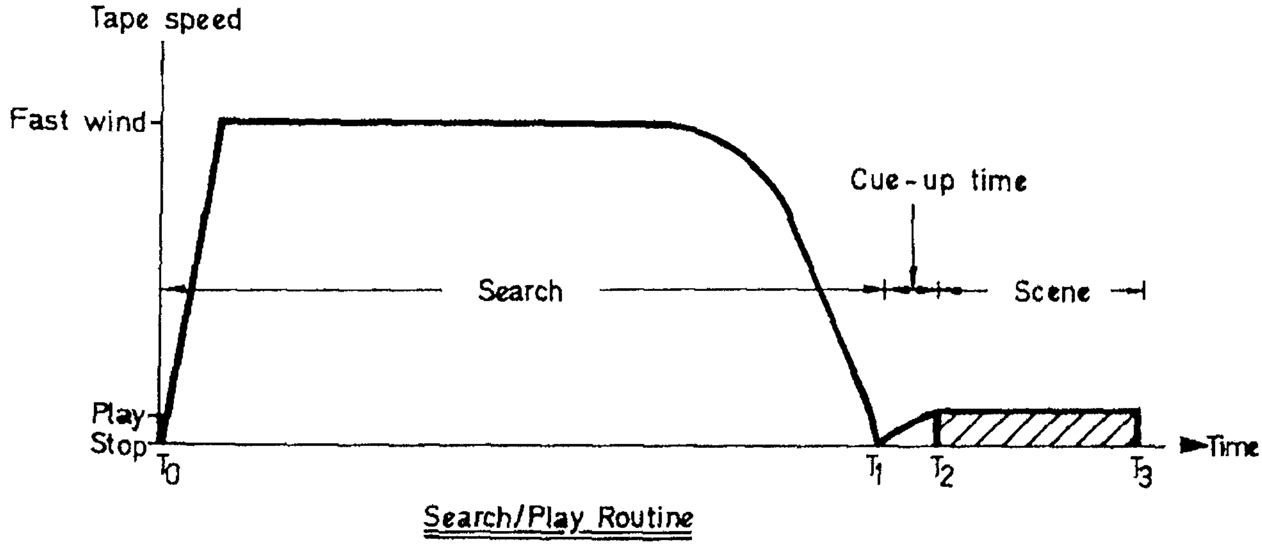

Fig. 3: The presentation of a scene requires the definition of an entrance point T_2 and an exit point T_3. When these points have been defined the routine performs a search such that the tape is positioned at the cue-up point T_1. The recorder is then switched into play mode so that after the cue-up time (typically 5 seconds), the video and audio signals are switched to the monitor exactly at the entrance point and switched down again at the exit point.

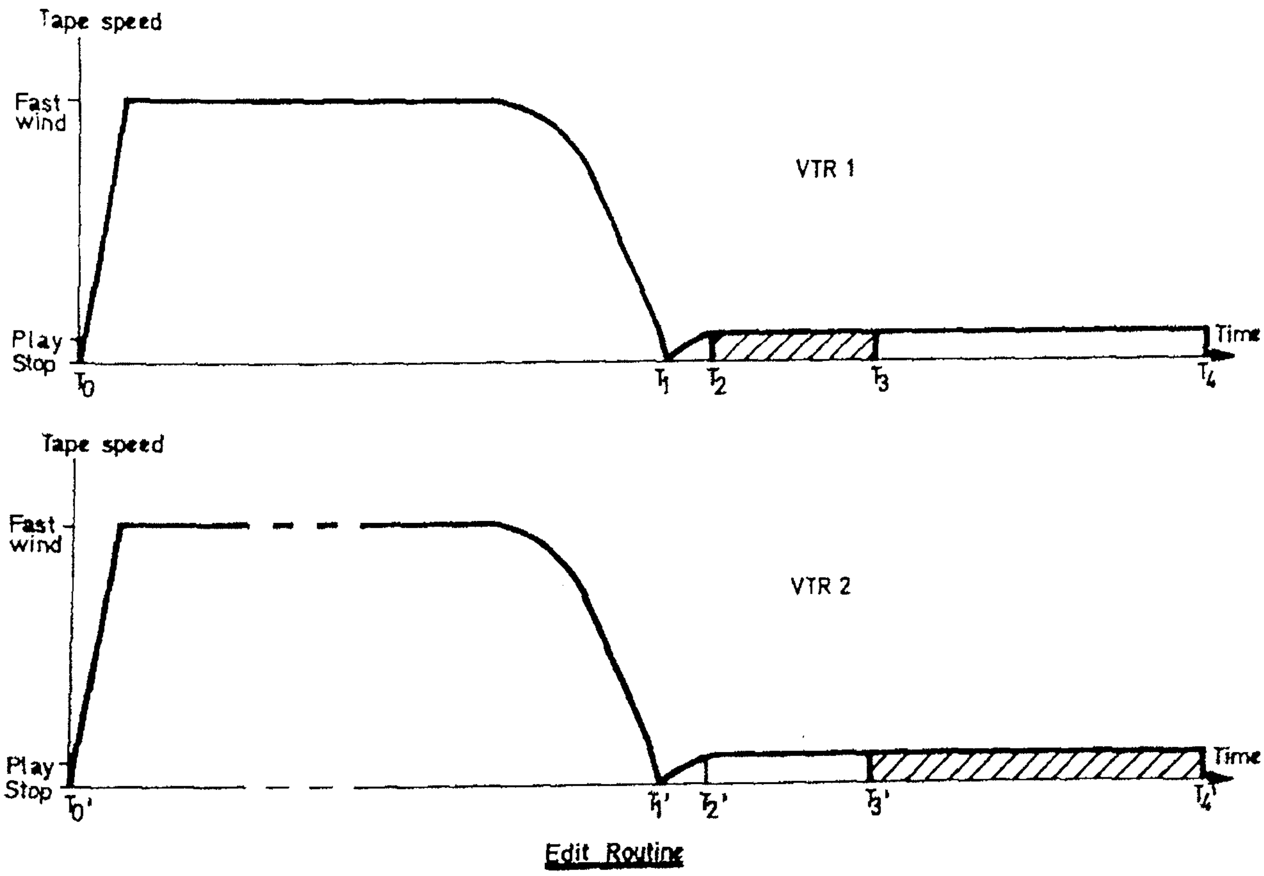

Fig. 4: After the definition of two scenes (T_2–T_3, T'_2–T'_3) on different recorders, the routine is performed as shown so that the scenes are presented contiguously at the monitor. This routine is also used for editing from VTR 2 to VTR 1 whereby an edit command is issued to VTR 1 at the point T_3. The edit is carried out that no disturbance occurs in the picture at the edit point.

Storage of Time Information

In order to perform the routines described above, those points in time must be stored at which the recorders have to be switched e.g. entrance and exit points for one scene.
The definition of the stored points can be carried out in three ways:

a. The time information can be entered by hand via a keyboard. The entered data are then assigned to the corresponding storage location.
b. During observation at the video monitor an arbitrary number of points in time can be stored by pressing a pushbutton. The time information thus selected is assigned to a data file in the process computer and may be complemented by content classification data at a later date.
c. The time information may be transferred from a data file which has been assembled earlier in the process computer.

Computer aided operation

The interfacing of the video recording equipment to a computer system provides the user with an extensive range of data management and controlling facilities. The configuration used in the PRAVDA system allows the transfer to and from the computer of time and content data, and enables high level monitoring of the video equipment.
The program systems developed include procedures for the assembly and storage of protocols and edit lists as derived during an observation or analysis phase, associative search algorithms for the assembled data files and fully automatic editing procedures.
All of these programmed routines derive their time reference from the timecodes recorded on the videotapes so that absolute synchronicity to the video content is maintained.

Current Applications

The investigation of communicative behaviour currently being performed with this system encompasses the description of various aspects of socially meaningful behaviour and the conditions relating to disturbed communication, in particular during depression.
Various observational methods and the associated interobserver reliability are being examined.
A further product associated with this work is the collection of video records of clinically interesting cases, which is being assembled in a form suitable for demonstration and teaching purposes.
These applications are dealt with more extensively elsewhere in this issue.

Conclusion

The successful realisation of such a system has been largely dependent on the recent developments in the video recording and data processing technologies.

The improvement of the video handling procedures obtained, on the one hand, by eliminating much time wasting and frustrating operation of recording machinery, and on the other, through enhancement of associative memory capacity by computer algorithm, should contribute to the researcher's insight into the behaviour under investigation.

It is to be foreseen that further technical development of the man-machine interface to the system will provide more ergonomically comfortable facilities for the researcher. However, such development must depend largely on the experience gained from routine usage of the equipment.

The implementation of further programmed algorithms for the organisation and manipulation of the computer-stored data should allow the researcher more flexibility in his approach to the observation and analysis of behavioural phenomena.

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