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APPLICATIONS OF MICROCOMPUTERS TO ORTHOPTIC MEASUREMENT

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Abstract

This communication emphasises the advantages of direct and objective measures of visual functions in the clinical setting. The applications of microcomputers in the role are outlined and an example of such a system as developed in the School of Orthoptics at Cumberland College of Health Sciences, Sydney, is described. This system utilises the basic IBM microcomputer for analysis and storage of patient data. Additional hardware enables the system to generate complex visual stimuli and to record the visual responses evoked by these stimuli.

Current interests are centred on visual evoked responses, electroretinograms and eye movement studies. The interfacing of standard ophthalmic testing equipment, eg perimeters and ultrasound, adds a further dimension to the system. The relatively low cost and simplicity of operation of microcomputer/based systems suggests they are likely to proliferate within the eye clinic environment.

INTRODUCTION

Many measures of visual function used by orthoptists tend to be subjective in that they rely upon verbal responses from subjects and therefore their co-operation and ability to communicate effectively. In some patient groups, such as infants, these inbuilt variables may limit the reliability and accuracy of measurements to the extent that their clinical value is questionable. There is therefore a strong incentive to develop techniques capable of direct or objective measurement of visual parameters.

To date the advantages of objective measurement of visual responses have been more than offset by the technical nature of the necessary equipment, its cost, a lack of technical support personnel and the time required and complexity of testing procedures. Due to these limitations, such equipment has been largely restricted to a few specialist clinics and research laboratories.

The purpose of this communication is to draw attention to the current and potential impact of microcomputers on measurement.

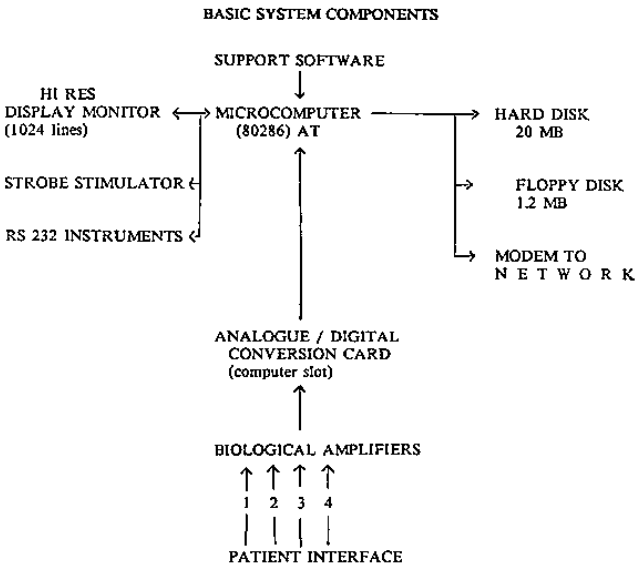

Figure 1: Flow diagram of major system components.

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BASIC SYSTEM COMPONENTS

In recent years, we have begun to develop microcomputer-based systems for selected measurement applications. These have been used in teaching and collaborative clinical research. The current system is shown in Fig. 1. To the basic IBM AT computer, additional hardware can be added via slots provided in the rear of the machine. In our system a variety of biological signals are amplified and then fed to the computer via a slot-mounted analogue to digital converter (IO) board. Recordings, the results of data analysis and patient details are then stored on the large capacity hard disk and backed up on floppy disk.

VISUAL STIMULATION

Currently VER, ERG and EOG signals are processed on the above equipment. The properties of these responses are largely stimulus dependent. The value of the test is substantially increased by tailoring of the stimulus to suit the test design, the ideal being complete control over all stimulus parameters. Microcomputer systems offer advantages in this area. With suitable interfacing to stimulator devices important stimulus parameters may be set from the keyboard. By way of example, patterned stimuli are generated by the computer and presented to the patient on a high quality monitor with reasonable control of intensity, contrast, size, spatial and temporal frequency and drift (movement). A bright strobe flash stimulator is needed for conventional ERG testing. In this case, appropriate computer interfacing enables control of stimulus intensity and temporal frequency.

CURRENTLY SUPPORTED TESTS

Fig. 2 summarizes a range of tests supported by the system as described above. These fall under the broad headings of evoked responses, eye movement analysis and psychophysical assessments. The latter rely upon verbal/subjective responses rather than electrical measures, however computers offer the advantages of improved control over stimulus parameters and presentation.

1. Evoked Responses
   - Pattern visual evoked responses

   Which support the following assessments:
   - — lesions
   - — grating acuity
   - — contrast sensitivity
   - — field loss and abnormal projections

   - Flash ERG

   Which support tests of:
   - — retinal integrity
   - — rod/cone function
   - — pigment abnormalities

   - Pattern ERG

   Which supports assessment of:
   - — localised retinal lesions
   - — ganglion cell/optic nerve function (eg. optic neuritis, glaucoma)
   - — retinal contrast sensitivity

2. Eye Movements
   - Electro-oculogram

   To investigate:
   - — retinal adaptation
   - — peripheral disorders of ocular motility
   - — central nervous system pathology/nystagmus

3. Behavioural/Psychophysical Measurements
   - Contrast sensitivity
   - Grating acuity
   - Snellen acuity
   - Colour vision

Figure 2: List of tests supported by the current system.

Figure 3 illustrates the potential for generating a haploscopic stimulus by the addition of a second monitor. A project has commenced at this college to use such an arrangement to generate Hess screen measurements.

RS232 INSTRUMENT INTERFACE

Increasing numbers of instruments are supplied with the above computer interface (eg. Allergan Humphrey perimeter, Allergan ultrasound, some autorefractors). In general this facility enables transfer of test measurement data files to the PC. The advantages of this facility include the establishing of normative data banks, centralising of

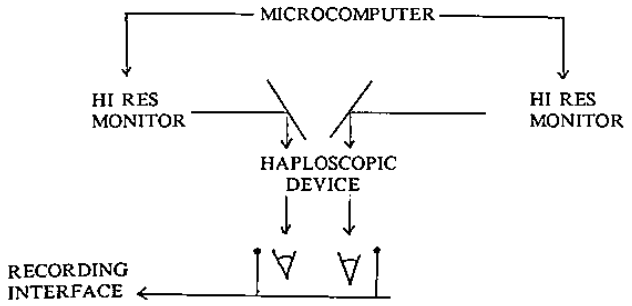

Figure 3: Illustrates use of dual monitors with suitable optics to provide a haploscopic stimulus.

patient files and tailoring of evaluation and reporting protocols.

IMPLICATIONS OF MICROCOMPUTERS FOR CLINICAL PRACTICE

The ability of microcomputers to rapidly store and retrieve large volumes of information enables them to readily accumulate a data bank of test measurements and patient data. This raises the possibility of improved statistical evaluation of individual results against normative data. These features can be incorporated into the software used for report generation so that they are fully automated and become a routine part of the patient assessment. The result is improved confidence and reliability in testing.

The addition of a modem (interface to the telephone) to the system raises the possibility of transferring test data, patient details and completed reports between clinics. Networking of clinics offers a number of exciting prospects including the pooling of normative test data so as to increase the size of the bank.

CONCLUSIONS

The applications described above probably represent only a small fraction of those with potential in orthoptic practice. The analysis and information handling capabilities of the modern systems provide an opportunity to include valuable but previously too complex and time consuming procedures into routine patient assessments.

The flexibility of microcomputer systems is such that the number of applications is limited only by the imagination and the availability of suitable computer interfaces. It is now very apparent from the most preliminary cost/benefit analysis that the applications will continue to proliferate through most areas of practice within a relatively short time. The challenge for Orthoptists will be to join the initiaters rather than the recipients of this technology.

ABSTRACT

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