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Touch Displays: A Programmed Man–Machine Interface

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1. Introduction

A very large number of so-called automatic data-processing systems require the co-operation of human operators to achieve satisfactory operation. In many of these systems it is necessary to reduce operator reaction time to a minimum, which in turn demands an arrangement where the man-machine communications are optimized. This requires that the methods of presenting information to, and receiving instructions from, the operator should be rapid and easy.

2. The General Problem of Man-Machine Communication

For the presentation of information to the operator the system generally used is some form of printing, usually electro-mechanical. Although the normal teleprinter output is rather slow in relation to the speed with which an operator can absorb information, an extension of the technique to line printing can overcome this. Alternatively an Electronic Data Display can be, and is, used and in both cases the ‘ output mechanism ’ from the computer system does not really add significantly to the time required for an operator to accept information. There is also a considerable amount of flexibility of format available to ease understanding.

The situation is not so satisfactory in the case of accepting instructions from an operator. The normal method is to make use of some form of keyboard with either a standard set of alpha-numeric keys and/or some special keys, usually called function keys. The latter, as their name implies, usually provide control instructions to the system, whilst the alpha-numeric keyboard is used to input information, interpreted by the system in accordance with the most recent control instruction. The process can be rather slow and clumsy especially when a fairly large system is involved with each operator having a wide range of input possibilities in the interests of flexibility.

The idea of the Touch Display was conceived at R.R.E. in an attempt to overcome the limitations in man-machine communications indicated above. It was originally put forward in the context of an Air Traffic Control Data-processing System for which it has clear application, but it is felt that the arrangement has much wider application; in fact, to the whole field of data-processing systems.

3. General Principles of Operation

The first idea underlying the design and operation of the Touch Display is that, no matter what the overall and complete range of possible signals from an operator might be, at any one time the signal actually sent by the operator to the data-processing system will be one chosen from a strictly limited range. For example, the signal might be, and often is, one of the 10 numerical digits. Probably one of the widest range of choice actually exercised would be to select one from the 26 available alphabetic characters. Secondly, in order that the data-processing system should be able to interpret the signal correctly, it must know from what range of possibilities it has been chosen and also what consequences must stem from that choice. This 'knowledge' within the computer can therefore be used to restrict the range of choice available to the operator at any given time to just those possibilities which are relevant to his present task. Subsequent to any input signal being received, the system can alter the range of choice as and when required. This control is, of course, exercised by the computer programme in the system, and in consequence the operation of the Touch Display system can be described as 'Programmed Control'.

One very significant consequence of this control is that the scope for operator errors, especially errors of omission, is much reduced.

Another idea, possibly the most significant, underlying the design of the Touch Display is that the 'meaning' given by the system at any time to the 'keys' available to the operator can be made easy to interpret. That is, the 'label' attached to the keys need not be fixed, as in the case of alpha-numeric keyboards for example, but can and should be changed by the system computers in accordance with the required meaning at any time. The effect of this idea is far-reaching. Not only does it allow the number of 'keys' to be very limited whilst retaining a large measure of flexibility in their interpretation, but also it allows the 'meaning' of a key to be changed as a result of information previously input to the system. A particular example, given later, is where one meaning attached to the keys is that of the 'call signs' of the aircraft under control of a given operator. These, of course, change quite often and normally consist of up to seven alpha-numeric symbols. By labelling 'keys' in this way, communication with the system for a particular aircraft can be established in a single operation.

4. Technical Details of the Touch Display

The first requirement of a system based on the ideas outlined above is a flexible display system, capable of presenting the possible choices to an operator. Such a possibility is clearly available in an electronic data display for many applications. An extension to provide some form of graphical display may be desirable in certain cases. The second requirement is then to provide sensitive areas of the display screen which are capable of producing a signal when touched by a bare finger. Such an arrangement is described below. A description of the Electronic Data Display system is not given since the techniques are well known and the precise method by which the display is produced is irrelevant to the operation of the system, beyond the need to satisfy the requirements of being able to change the display rapidly and to be able to position the data correctly on the display tube force.

To provide the sensitive areas, an electronic system has been devised by which the computer can be informed that an operator is touching an electrical contact, a so-called 'touch-wire'. This touch-wire is completely passive mechanically and is, typically, a short length of 20 S.W.G. tinned copper wire let into a groove in the surface of a perspex mask over the surface of the display. Connection is made to the touch-wire by very thin wire retained in grooves on the undersurface of the mask. Use is made of the self-capacity of the operator to unbalance a bridge circuit, two touch-wires forming two of the arms of the bridge. A very clear and unambiguous signal is obtained when a finger is in contact and a completely negligible signal when not in contact since stray capacitors and stray resistive loads can be balanced out in the bridge.

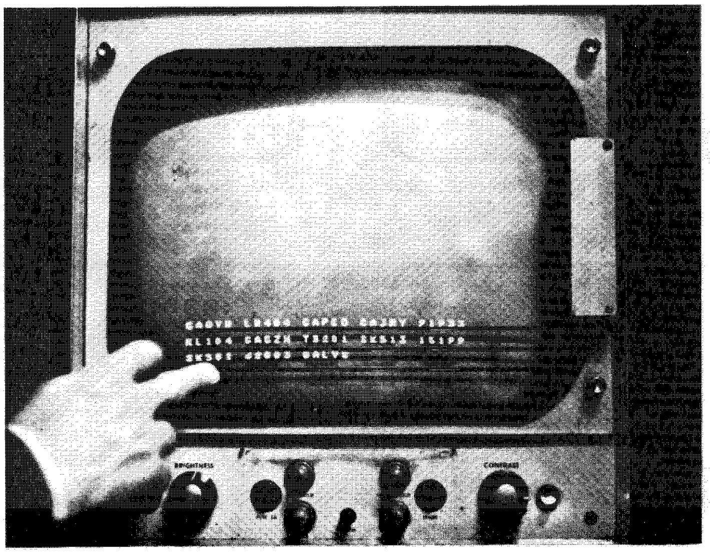

Figure 1. Display configuration.

The potential applied to the touch-wires in the bridge circuit is about 6 volts r.m.s. at 3000 c/s and is fed through a 500 pF capacitor. Such a potential is of course completely innocuous and the short-circuit current is limited to only 60 microamps by the capacitor. Since these capacitors should be as near as possible to the touch-wires, they are grouped at the edge of the display; screened leads of up to 6 ft long may be used to connect to the rest of the electronics. Any unbalance in the capacity of the screened leads can be taken up by the balancing mentioned above.

In order to produce a system with a large number of touch-wires, a number of bridges may be sampled in time sequence, or alternatively the bridges may be combined in such a way that the output of the system is a binary coded representation of the number of the wire actually touched. The system presently preferred is the sequencing one and in it the sequence is stopped when a signal is detected and until the data has been accepted by the computer. This acceptance actually occurs at the 'end of touch', that is, when the finger is removed from the touch-wire. It is of course necessary to guard against unintentional double operation and this is done by introducing a delay of about 100 msec after the touch has apparently finished before allowing the

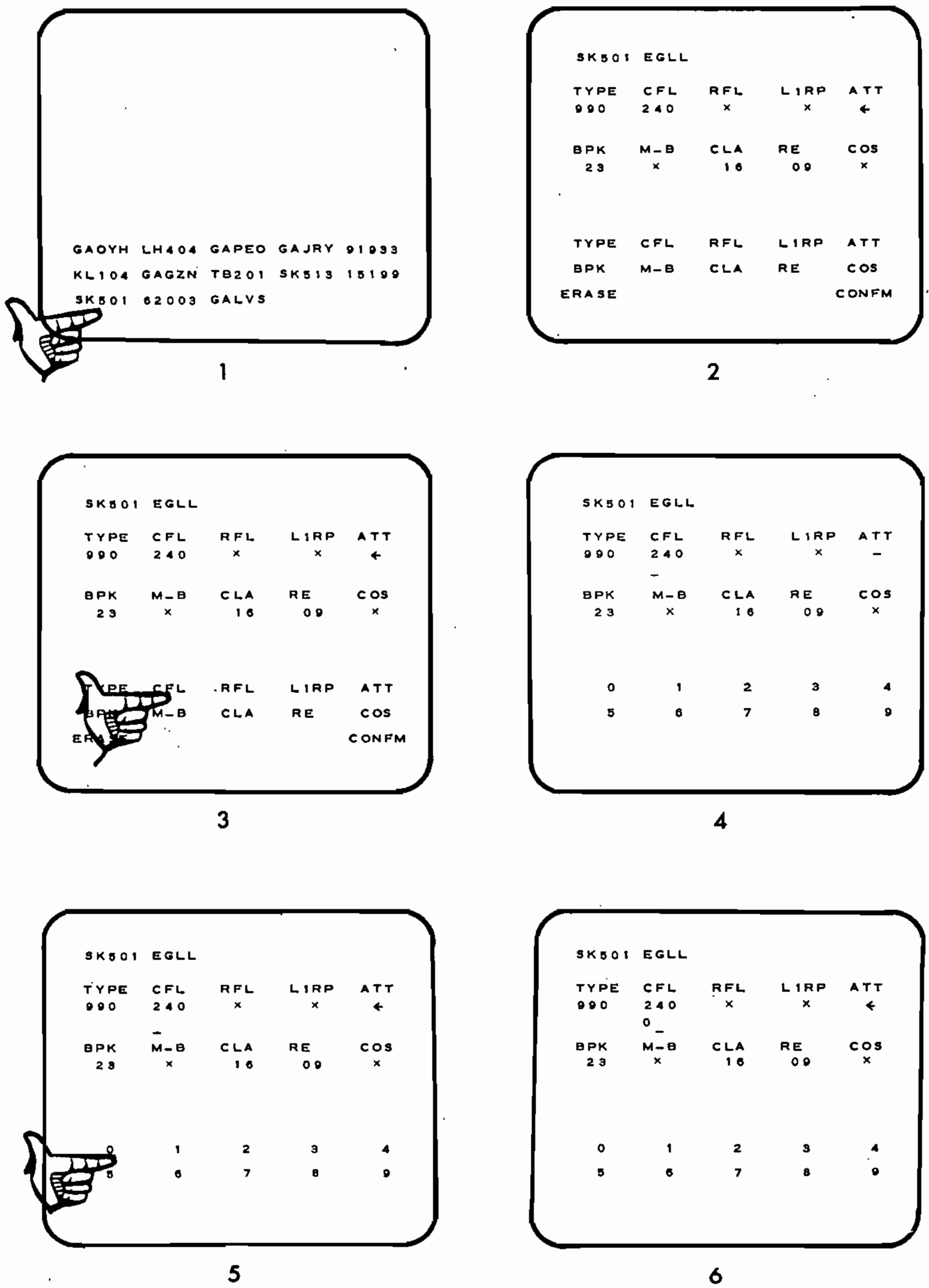

Figure 2. A typical amendment sequence.

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