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THE RAPID DIGITISATION OF TIDE CHART RECORDS

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INTRODUCTION

Although tide recording installations are increasingly being provided with punched-tape outputs, the majority of tide recordings have been and still are, for historical, economical or visual reasons, on roll or strip chart paper.

Therefore, in the analysis of tide recordings, there is often the need for digitisation of the data, so that computer methods can be employed. Digitisation can be accomplished manually, but the process is laborious and slow even with the aid of electro-static X-Y plotters, and especially so if shorter than hourly time increments are required.

The authors encountered the problem recently in a tidal hydraulics study of the Western Solent entailing the installation and maintenance of six autographic recorders — five of the pneumatic type and one having a float well. These recorders were maintained for a minimum period of 1 year, and the requirement was for digitising at 15-minute intervals for subsequent computer analysis of water surface slopes. This required the extraction of some 16 800 data points per month.

The paper describes the technique and equipment employed to achieve a rapid and effective digitisation of the recordings, and is thought to be novel with regard to this particular application.

BASIC EQUIPMENT

After considering various alternatives it was decided to purchase a Science Accessories Corporation Sonic Digitiser. This consists of a flat perspex table with sensitive microphones along the X and Y axes. It is designed to deal with individual graphical representations.

The operating principle is very simple. A sound pulse is transmitted from the nib of the " graf pen " when pressure is applied. The time interval between transmitting and receiving the pulse is a function of the nib distance from the microphones, and the cartesian co-ordinates of each point

are displayed to the nearest 0.1 mm. Several modes of operation are available. The " point " mode enables individual points to be identified whilst the " line " mode delivers a continuous sound pulse at a pre-selected rate.

MODIFICATIONS

For the purpose of strip chart recording several modifications to the basic design were necessary. The table, with microphones attached, was fitted into a metal support frame with roller facility at either side to accommodate the chart rolls. The Y microphone had to be raised by 1 mm so as to allow the chart paper to pass freely underneath and on to the take-up spool on the right hand side of the table. The general arrangement is shown in fig. 1 ; varying chart widths can be accommodated.

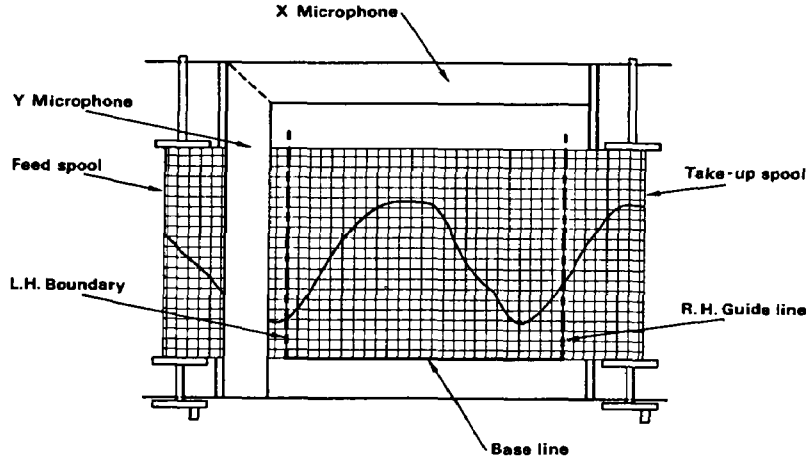

FIG. 1. — Plan view of the sonic digitiser with modifications.

In order to enable each section of chart to be correctly positioned, both boundary and guide lines were inked onto permatrace which was then accurately placed in position on the working surface. A fluorescent strip light, positioned under the perspex table, enables the chart section to be correctly aligned with the boundaries (fig. 2).

For direct recording onto magnetic cartridge it was necessary to construct a data serialiser which could be coupled into the standard system. This was provided with a two-digit reference number, identifying any particular data file. The identification number, together with a four digit X- and Y-coordinate, is stored on either magnetic cartridge or paper tape.

DIGITISING TECHNIQUE

The first attempt at digitising was performed on the " point by point " basis. Individual points were identified and recorded on magnetic cartridge.

A preliminary program was written to check through the stored data, endeavouring to detect missing and duplicate points. This proved very tedious and difficult to operate and has now been superseded by the following more efficient and successful method.

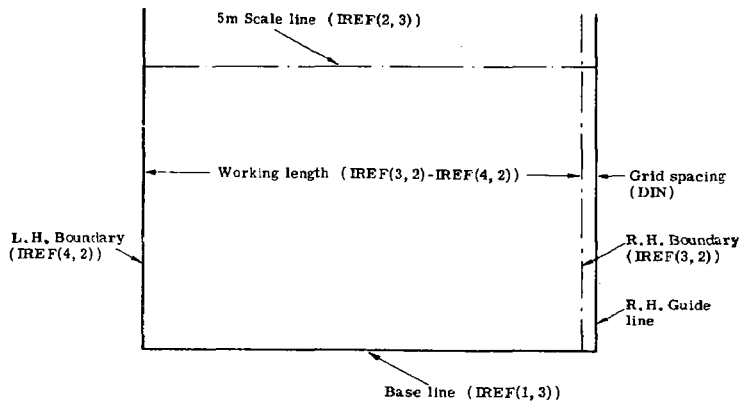

FIG. 2. — Boundary positions.

The first section of chart roll is positioned with the initial time line coinciding with the first grid interval to the left of the right hand guide line (fig. 2). The " line " mode is selected and the rate adjusted to give an appropriate number of pulses per second, the actual number depending on the various factors ; in the case of a well-defined tidal curve four pulses per second would be adequate.

Each section of chart is followed from right to left with the " graf pen " inclined at a steady angle. Typically it would occupy 20 seconds to trace a semi-diurnal tidal curve.

PROGRAMMING TECHNIQUE

A program was written to divide the working length into a number of equally-spaced grid intervals, representing fifteen-minute increments in time (5 mm at 20 mm/hr).

The recorded points from the plot were fed into the program and sifted to find pairs of points spanning corresponding grid lines. On finding two such points, an interpolation is carried out to compute the value of the tidal height at the specific gauge time, and the position of the next grid line is computed. If the two selected points still span the new grid line, a second interpolation is carried out using the same data. This process is repeated until the two points no longer span the line ; at this stage the next data value is considered. For the final section, the left hand boundary of the working length is re-positioned to coincide with the final time line and the interpolations are then carried out in a similar fashion.

Built into the program is a check to test that the spacing of the two

data points used for the interpolation process of each line does not exceed a specified value. When the program has established values for each time line throughout the record, a check is made to confirm that the correct number of data points have been calculated. The processed data is then re-stored on magnetic cartridge and is ready for future analysis.

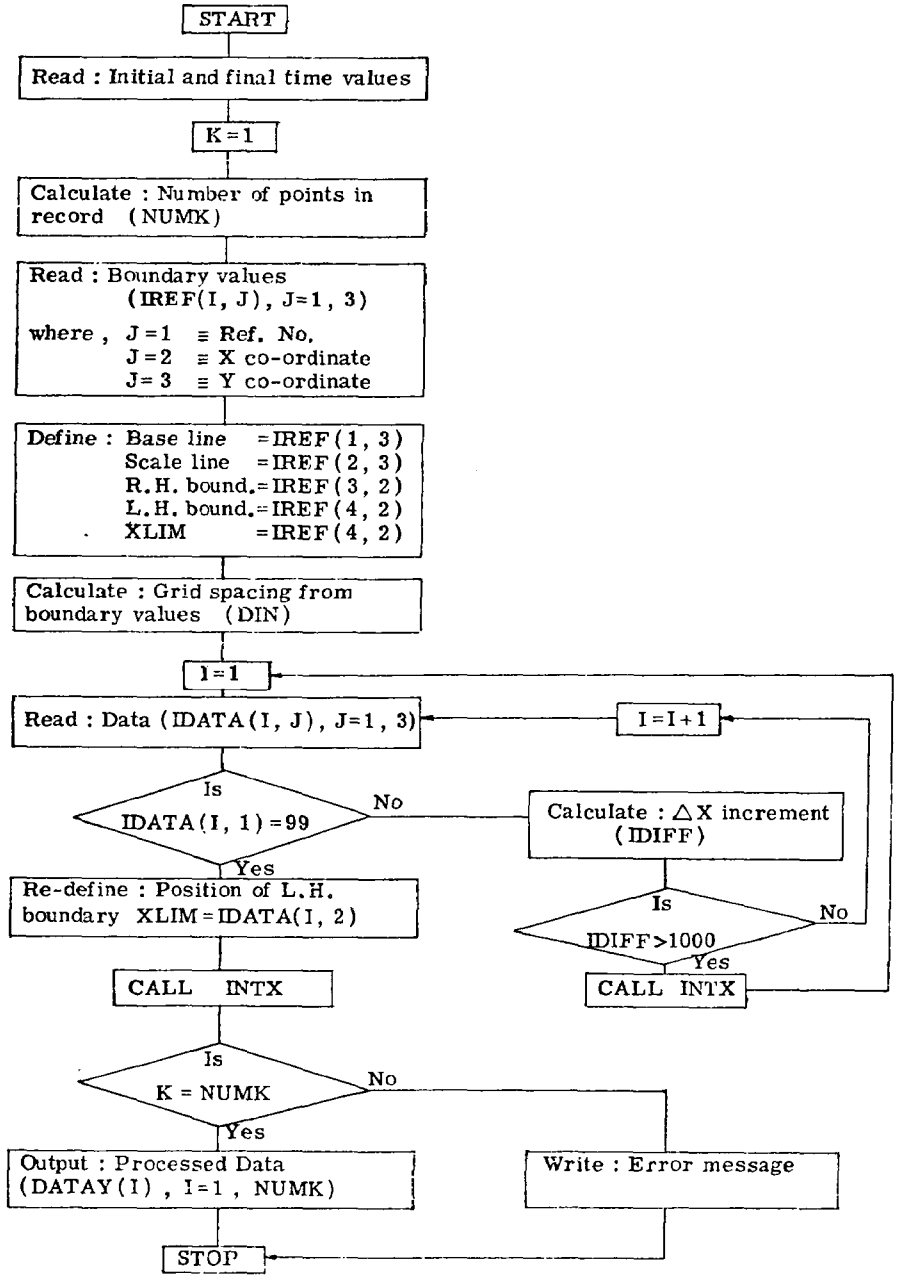

FIG. 3. — Main program.

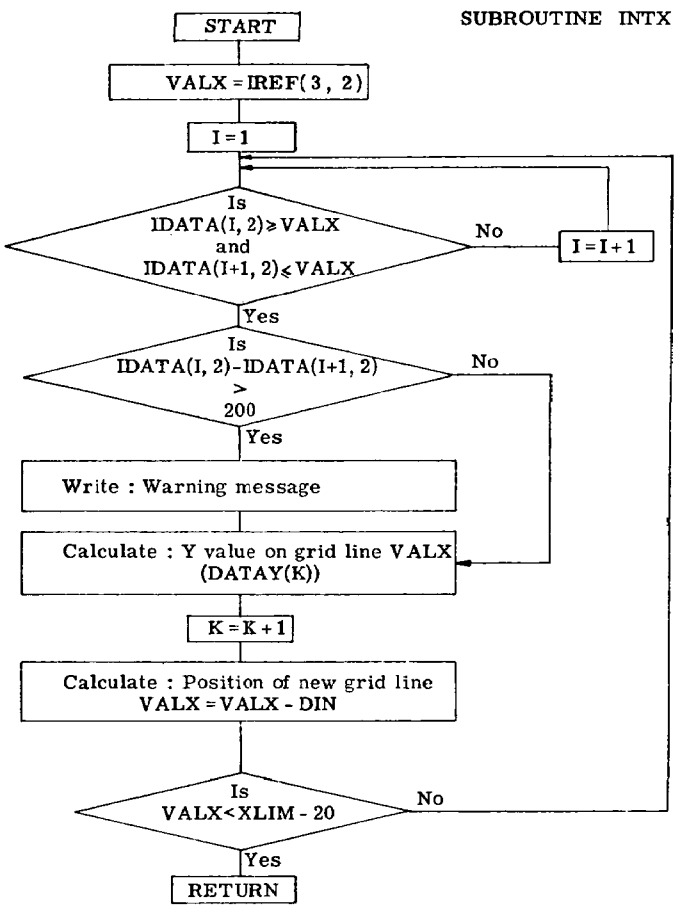

Fig. 4. — Flow diagram for the main programming technique.

PERFORMANCE

Utilising this technique it has been possible to digitise one month of strip chart tidal records in 20 minutes.

The accuracy to which records can be digitised is dependent not only on the ability of the operator to follow the tidal curve but also on the positioning of each section of chart paper on the table.

The results obtained by this method have been compared with the water levels read directly from the tidal curve, and have been found to compare very favourably. Fig. 5 shows the distribution of water level differences for a sample of 224 points. The standard deviation was only 13 mm with a maximum scatter of 55 mm about the mean.

Drum charts, which are more difficult to interpret, can be handled provided the complete record is reduced to fit within the active area on the digitising table. With a minor modification to the basic program, these records can be handled successfully.

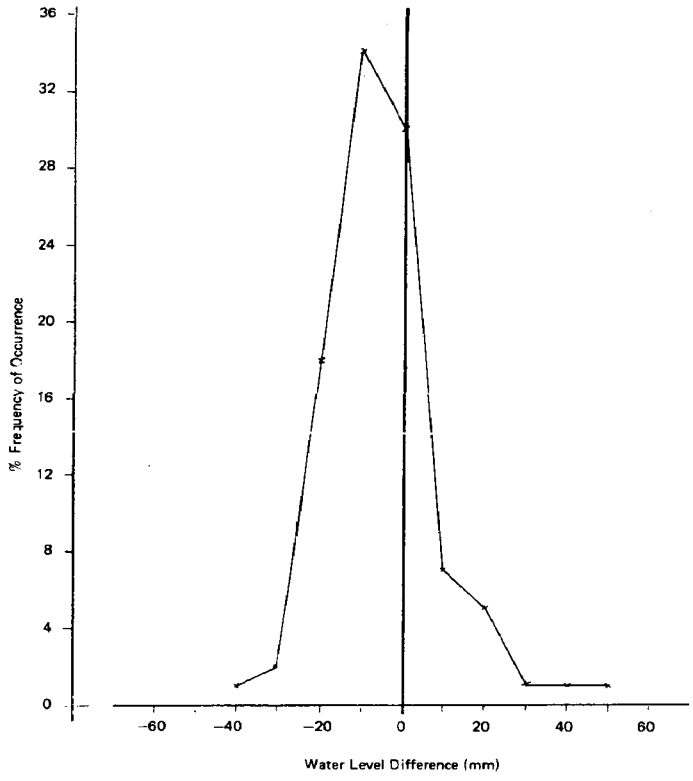

FIG. 5. — Distribution of water level difference.

Although specifically designed for the digitising of tidal curves, the procedure has been applied to the digitising of a wave trace, where the spectrum of a storm was required to be derived. The waves were of mean zero upward crossing period 8 s (*), and the chart scales were 10 mm to 20 s, with a wave height reduction of 1 : 100. A visual display of the digitised records (grid interval 0.5 mm) showed that a very fair representation had been achieved.

CONCLUSION

For tidal analysis and statistical purposes it is often necessary nowadays to digitise tidal chart records.

The sonic digitisation method described herein enables this to be quite rapidly and accurately achieved.

(*) The mean zero-crossing interval, as obtained by dividing the record duration by the number of times the water elevation crosses the mean record level in an upward direction.

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A MARINE INSURER'S VIEW OF CHARTS

"... The need to provide a seaworthy, well-maintained vessel, equipped with the necessary aids to navigation and safety measures, must rest with the Shipowner himself. It is, perhaps, unfortunate that as in many other spheres the tools of the trade or profession tend to be taken for granted, and so it is with navigational aids, such as charts.

However, it is perfectly obvious that modern up-dated charts, properly used, must make for the safer conduct of trade on the seas and thereby also provide the potential for a reduction in the number of losses which might otherwise occur.

However, it has always seemed to me to be curious that those involved in international considerations relating to the seas have not directed more of their attention to the need to provide the necessary service and money for a comprehensive system of charts to cover the trade lanes world-wide. Most nations, even land-locked nations, owe some part of their well-being to the seas, and accurate and up-to-date surveying and charting of the sea bed and the potential hazards which it presents would seem to me to be a matter of self-interest for all nations.

It may be that the current deliberations in the various international political arenas dealing with commercial and other matters relating to the seas will lead those involved to recognise the self-evident need for accurate and comprehensive knowledge of the land beneath the seas, and may even lead them to some sort of acceptance of their moral responsibility to provide the means whereby those upon whom their legislation will have greatest effect may reasonably be able to discharge the onus upon them.

It may be that a new age is dawning for hydrographers. As a representative of Marine Insurers, who naturally regard your work with admiration and as an essential contribution to safety at sea, I sincerely hope so."

Extracted from "The role of Lloyds in the settlement of marine claims and their relation to hydrography", a paper given by Mr. Richard RUTHERFORD at *Oceanology International* 1978 in Brighton, England, on 8 March 1978.