

6673
Memorandum M-2099

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SUBJECT: BI-WEEKLY REPORT, PROJECT 6673, MAY 25, 1951

1. GENERAL

(C. R. Wieser)

The major effort over the past period has been the preparation and presentation of a demonstration for Air Force officers. The demonstration included a new program for painting velocity vectors for two tracked targets on the display scope. Also, decimal heading instructions for the interceptor were displayed on a new system of lights, which give a direct decimal reading. The decimal headings are obtained from a new relay converter, which is connected to the indicator light circuits of FF3.

During preparation and again during the demonstration live interceptions were run successfully.

2. ENGINEERING

(R. Best)

Two decoder output amplifiers have been built and installed in the computer to boost the signal from the previous 1.5-volt swing to a swing of 20 volts, also into a terminated line. This increased swing has made it possible to eliminate the pre-amplifiers in the 16-inch display scope. The gain and position controls, which used to be in the pre-amplifier, have been re-wired so that they may still be used. The final amplifiers have been modified so that they now have more gain, in order to obtain full deflection for 5/8 full decoder. This is desirable for certain display problems involving radar data. The system appears to work satisfactorily.

(H. J. Kirshner)

1. Relocation of equipment in Room 224 was completed during this bi-weekly period. No major difficulties were encountered; however, there were three tube failures which may probably be attributed to the movement.

2. An amplifier was constructed for the purpose of tapping the Barta-Bedford private line so that conversations on the line could be heard on a speaker in test control.

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2. ENGINEERING (Continued)

3. Maximum effort was concentrated on preparation for visitors.

3. ANALYSIS FOR BEDFORD EXPERIMENTS

(D. R. Israel)

The flight tests held during the past bi-weekly period seemed to indicate less favorable results when the two aircraft met at right angles. Investigations of this phenomenon will be made as soon as the data analysis programs mentioned in previous bi-weeklies are put into operation.

The major effort during the past bi-weekly period has been in preparing and testing programs for a visitor demonstration on Friday, May 25. At first the efforts were put into developing improved programs using the extra ES registers; however, a decision was made during the early part of the week of the 25th to restrict our operations to the present 256 registers. These programs were successfully prepared.

Several new methods of smoothing have been proposed, and it was interesting to learn that Airborne Instruments Laboratory is now using a smoothing equation with analog equipment which has the following form:

$$a_n = fa_{n-1} + g|\bar{x}_n - x_n|$$

where f and g are constants less than unity. This is quite similar to an equation which we had been considering using, and which we shall test in the near future.

(W. S. Attridge, Jr.)

I have written a new and shorter numeral display program originally intended to be used to display heading angles on the scope with the interception program.

The combat program has been improved and now includes the smoothing equations. It has also been arranged to run at fairly constant speed.

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3. ANALYSIS FOR BEDFORD EXPERIMENTS (Continued)

The interception program with punched tape output has been improved with encouraging results. I have also written a short tape analysis program which will read the output tape, convert and print on the typewriter what has been punched.

Most of the second half of the bi-weekly period has been spent preparing for the demonstration for the Air Force.

(F. E. Heart)

Several tests and modifications have been made on the program for printing from R,θ input tapes. This program is not yet completely checked out. Large quantities of data have been taken with the most recent modification of the Criteria Smoothing program, which operated successfully. Studies of other types of smoothing are in progress.

Part of the time was spent assisting in the preparation for the demonstration of 5/25/51. Prior to the decision not to use any programs utilizing the extra 48 registers, a program was written which modified the multiple aircraft tracking program by the addition of vector display. This program has not been tested yet.

(D. A. Kemper)

Most of the preceding fortnight was spent preparing for the demonstrations which took place on May 25. The velocity vector program was modified to paint vectors whether or not the a/c was missed and to increase by a factor of four the spacing between dots, which helps the eye smooth out the kinks in the vectors due to decoder quantization.

(J. Rossbach)

Have prepared a program which uses as the observed position of the aircraft the mean of all pieces of data which fall inside the search area. Have also prepared a modification of a program, written by D. Kemper, which uses as observed position the mean of the present radar reading and the previous radar reading.

Two display programs were run on the computer. One successfully displayed a circle and 13 fixed points. The other displayed a heading angle but the program contained some errors which have since been corrected.

4. THEORETICAL ANALYSIS

4.1 Systems Studies

(D. R. Israel)

Von Neumann's report on an ultimate system has been carefully studied, and a good deal of thought has been given to methods of data-handling and processing in the Muldar System. A definite scheme of attack has been formulated and is now being studied in more detail before being written up and discussed with interested parties. In this connection some thought has been given to the type of computer orders which would be valuable in data correlation and combinatorial problems. This has led to a certain amount of programming in order to see what the gain in storage and operating times would be for such functions as half-length storage, comparison of the positions of two points in space, and the transfer of data from one set of registers to another.

4.2 Data Smoothing and Aircraft Control

(J. M. Salsar)

The study of prediction and smoothing is continuing. A prediction program was found which gives excellent results up to frequencies of

$$\omega = \frac{\pi}{3T} \quad (\text{i.e. } \omega T = 60^\circ)$$

which corresponds to taking 6 readings while the plane flies a complete circle. Compared with the present prediction program, it gave about one-fourth the error at $\omega T = 45^\circ$, but this only on clear (non-quantized) data. With quantization the picture is reversed, and the reason for this is that the more precise prediction program, although accurate up to $\omega T = 60^\circ$, accentuates the higher frequencies $60^\circ < \omega T < 180^\circ$ and thus acts as a poor low-pass filter or smoother. Efforts are being made to correct this deficiency and still keep the precision at low frequencies.

The problem of smoothing (without prediction) and of velocity smoothing is studied in the frequency domain. The picture gained by the preliminary is quite illuminating and points up the limitation of simple numerical methods. The smoothed velocity program mentioned by C. Gaudette is Simpson's 3/8-th integration rule used in reverse for differentiation.

4. THEORETICAL ANALYSIS (Continued)

4.2 Data Smoothing and Aircraft Control

(J. M. Salzer)

It has good low-pass characteristics and appears to be stable (convergent) after a superficial preliminary study. Whirlwind will tell us if such a superficial study suffices.

(C. H. Gandette)

The "One Coordinate Prediction Testing Program" has been revised to include more elaborate manual intervention and facility to print results. A selected constant of the prediction equation may be varied by using the Adjustable Constants Switch. At the same time the changes in the error curve may be observed on the scope. When the amplitude of the error curve is small, the operator may initiate the printing subprogram, which prints the values of the constants and all the information previously displayed on the scope.

A recent run of the previous "One Coordinate Prediction Testing Programs" and the "Locus Display Program" gave satisfactory results. Several photographs were taken.

A "One Coordinate Velocity Smoothing Program", which uses a method of smoothing suggested by John Salzer, has been written. The n^{th} smoothed velocity is given by the equation

$$v_n = \frac{g}{3} \hat{i}_n - \frac{g}{3} i_{n-3} - 3v_{n-1} - 3v_{n-2} - v_{n-3}$$

where $v_n = n^{\text{th}}$ smoothed velocity
and $\hat{i}_n = n^{\text{th}}$ quantized position.

The amount of quantization is adjustable. The smoothed velocity is computed by the equation above and by the general linear smoothing equations to allow comparison. Each smoothed velocity is compared with the true velocity, and the errors are plotted on the scope.

4.3 Correlation Studies

(R. L. Walquist)

Work has been completed on my thesis entitled "Analysis and Design of a Digital-to-Analog Decoder". Copies of the thesis are available in the library for interested persons.

Additional thought has been given to the problem of correlating incoming information with stored information for a computer-radar network operating with a large number of targets. The problem of correlation involves comparing the incoming information with the stored information; this comparison process is necessary in order to determine which piece of incoming information should be associated with which stored target.

Basically, there appear to be 4 different ways in which this comparison process may be carried out (the first 2 of these were previously mentioned in the 6673 Bi-weekly, M-2093):

In each of the following, N is the number of radar returns which must be correlated by the computer.

1. If the targets are stored in a single block in a completely random fashion, the number of comparisons is proportional to N^2 .
2. If the targets are stored in K blocks, and the address of a particular block is obtained by some formula from the positions of the targets, the number of comparisons is proportional to N^2/K .
3. If a separate binary-digit storage position is kept for each possible position of a target in the radar network (X equals the total number of "cells" for the quantized X, Y, Z target positions), the number of comparisons is proportional to N .

4.3 Correlation Studies (Continued)

(R. L. Walquist)

4. If the targets are stored in a single block, but are kept in an X, Y, Z positional order within this block, it is possible to do the required correlation by a method of "step-comparison". Using this method, the number of stored targets which might correspond to the present piece of input information is cut in half by each comparison. As a result, the total number of comparisons for N targets is proportional to $N \log_2 N$.

An examination of methods 1 through 3 indicates that as one attempts to decrease the correlation problem, the amount of storage necessary for targets must increase. However, the method 4 circumvents this problem by introducing a "presort" by means of which the targets are always kept in a prescribed positional order. Present effort is being directed towards obtaining a relative evaluation of the various methods.

6. RECORD OF COMPUTER UTILIZATION

(J. Arnow)

5-15-51

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|-------------|--|
| 1325 - 1425 | The Simulated Combat Program operated with reasonable results. |
| 1425 - 1530 | A program to print data on tracked aircraft from punched paper tape was run, |
| 1530 - 1630 | A new PWTWS program did not operate satisfactorily. |

5-16-51

- | | |
|-------------|--|
| 1300 - 1500 | The one C _o -ordinate Prediction Testing Program and the Locus Display Program were used to take several photographs. |
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6. RECORD OF COMPUTER UTILIZATION (Continued)

(J. Arnow)

- 1500 - 1530 A punched tape analysis program was run with success.
- 1530 - 1600 A program to print data from punched paper tape indicated the need for further testing.
- 1600 - 1630 The Data Transcription Program contained programming errors.
- 1630 - 1700 Two Display Programs were run but contained programming errors.

5-17-51

- 1300 - 1700 A smoothing program was run in order to take much data.

5-18-51

- 1245 - 1430 Several programs were run in preparation for a demonstration.
- 1430 - 1500 A One Co-ordinate Least Square Smoothing Program indicated the need for program adjustments.
- 1500 - 1600 A 2 a/c interception program with punched tape output did not operate to its full capacity.
- 1600 - 1700 The program to print from tapes indicated satisfactory operation of the program.

5-19-51

- 1320 - 1345 Data was taken on the operation of the 2 a/c interception program used on 5-18-51.
- 1345 - 1400 A number display program operated satisfactorily.
- 1400 - 1700 The Criteria Smoothing Program operated satisfactorily, and data taken for the linear case.

5-21-51
thru
5-25-51

- The Computer was used in preparation for a demonstration to a group of Air Force Officers.