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Memorandum M-2081

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SUBJECT: BI-WEEKLY, PROJECT 6673, JANUARY 5, 1951

1. ANALYSIS

(W. C. Welchman)

It was mentioned in the last bi-weekly that the proper positioning of an intercepting aircraft at the start of the final phase of an attack had been discussed with Mr. Gras and Mr. Fieldman. Further consideration indicates that their requirements could probably be met in theory by steering a collision course aimed at an imaginary target traveling on a track parallel to that of the real target. Whether it will be possible to derive the required accuracy from radar observations is another matter.

J. W. Forrester has asked for programs to demonstrate whether auxiliary magnetic drum storage with associated control circuits could greatly increase the usefulness of Whirlwind with 256 or 512 registers of ES. For this purpose provisional methods of operation have been drawn up and these have been discussed with R. R. Everett.

The plotting of an exponential solution of a differential equation in a test storage program prepared for course 6.535 led to an interesting phenomenon. Variation of the damping coefficient led to a divide alarm when the second derivative was being computed. This seemed peculiar at first because the true value of the second derivative was quite clearly a small quantity. It was then observed that the solution as plotted by the computer split into two branches. This is accounted for by the fact that with certain values of the damping coefficient and the extrapolation interval an error in the value of y for one particular value of x causes a larger error of the opposite sign at the next value of x . Consequently the computer plots points alternatively above and below the true curve. These points generate two curves on either side of the true curve and the two curves get further and further away from the true curve until the false y'' associated with the erroneous points causes an overflow.

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(J. W. Salzer)

With C. W. Adams' help a new type of arccosine subroutine has been unearthed from Wilkes' report on the EDSAC programs. This subroutine is based on a clever algorithm, in which the successive digits of the angle sought are determined according to the sign of the given cosine of the angle, the cosine of double the angle, of quadruple, of octuple, . . . , etc. of the angle. The program is easily converted to get the arcsine, rather than the arccosine, and might be useful in our work. It has the advantage over other arcsine programs that it is shorter (occupies less storage if one counts the extra subroutines other arcsine programs make use of) and more precise.

Discussed means of private line communications of computer output to aircraft with representatives of Air Force Cambridge Research Lab and R. Wieser. Since the transmission must be serial, the question was whether to use the in-out register of WWI for converting from parallel to serial or transfer the word in parallel to a buffer register and then do the conversion. The latter scheme was agreed upon for two reasons: first, it will not tie up the whole computer until each word is actually transmitted; second, it permits greater flexibility of recoding a message for security purposes. The question of timing the transmissions with respect to the operation of the computer is being further considered.

(D. R. Israel)

The major part of the past bi-weekly period was spent on vacation. Since my return the chief effort has been in coordinating and planning the final phases of the work necessary for carrying out an interception. Some consideration has been given to changes in programs (for example -- use of r, θ coordinates) which may be made possible when the digital PPI display is available and also to various phases of problems which we shall handle after performance of a successful interception.

(R. L. Walquist)

The greater portion of the past bi-weekly period was spent in familiarizing C. Gaudette and H. Saxenian in the operation of the computer and the use of test storage. The program run on the computer was the solution of a second order differential equation which arose in conjunction with W. G. Welohman's course (6.535, note 24). Some changes had to be made in the program to improve the display. The occurrence of overflows proved helpful in pointing out particular details of computer operation. After a successful solution to this problem was obtained, an attempt was made at familiarizing Gaudette and Saxenian with ES. Considerable progress was made and their program for determining the error in

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(R. L. Walquist) - continued

an arctangent formula was run successfully.

Some thought has been given to the rate of rotation of the radar antenna and the rate at which information is being received over the phone lines. The antenna rotation, with MTI, is supposedly 2 rpm, while the rate of receipt of information is supposedly once each 1/50 of a second. However, while running some of our display programs on the computer, it has been noticed that the antenna speed might be somewhat greater than 2 rpm. This poses a very serious problem, since all present tracking programs count the number of pieces of information received in order to determine when the antenna has made a complete revolution (this corresponds to 1500 counts for an antenna speed of 2 rpm and one new piece of information each 1/50 of a second). In order to study the problem, H. Saxenian is working on a program to determine the total number of counts between successive returns from the same target. Allowance is also made in the program for a study of the time needed for printing out information on the Flexowriter equipment.

(J. Arnow)

The major portion of the last bi-weekly period was spent on vacation. Consequently, the only constructive work accomplished was the addition of the data simulation program to D. R. Israel's program for tracking a single aircraft (RTP-II) in order to test the latter.

(C. H. Gaudette)

The program for optimizing the arctangent formula (see Bi-weekly Nov. 10, 1950) was run successfully on the computer on January 4th. On the first trial on January 2nd an error on the tape was discovered. At this time no significant information was obtained since ES was operating imperfectly. On January 4th the corrected tape was read into the computer for the second trial of the program. A frequent gain of digit 12 in the address of a tape order limited progress. The first part of the program, the computation and display of the maximum error of the arctangent approximation and the plotting of the error curve for a particular value of b, gave satisfactory results. The values of b and k, a constant to increase the deflection on the scope, were changed manually. The second part of the program, the computation and display of the value of b

(C. H. Gaudette) - continued

that gives the least maximum error and the plotting of the maximum error vs. b , gave the expected results on two trials.

The solution of the differential equation

$$c^2 \frac{d^2 y}{dx^2} + \frac{a}{b} \frac{dy}{dx} + y = f(x)$$

where $f(x) = 2(x - x^2)$ and $c < \frac{1}{4} < b < 1$

was run in test storage on December 26th. The program displays both the function $f(x)$ and the solution of the differential equation for selected values of the constants b and c . When an overflow did not occur, a sufficient number of oscillations of the solution for demonstration purposes could not be obtained. R. Walquist suggested scale factoring to remove some of the limitations on the constants b and c . On December 28th a revised program gave satisfactory results when an overflow did not occur.

The possibility of using (r, θ) coordinates in tracking is still under consideration. In conjunction with this, Israel's tracking program has been studied in detail.

(H. Saxenian)

A program to check the exact rate of input of radar data from Bedford, and the amount of information skipped by the computer while printing n characters and a carriage return has been written.

A modification of the tracking and selected data print program provides for the 6-6-4 reversed mode of input which will make manual intervention more convenient. It plots a circle instead of a spiral and prints x and y to the nearest hundredth instead of the nearest tenth.

The arctangent display program has been run satisfactorily on the computer.

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2. ENGINEERING
(C. R. Wieser)

During the past two weeks the radar at Bedford has not been operated because the operating personnel have been on vacation. Operation will be resumed Monday, January 8. It is estimated that about a week of experimental operation of the new radar will be required before flight tests are made.

The digital PPI display which AFCL is building for WWI is scheduled for delivery during the week of January 8.

Messrs. Staples, Ryan, Tariat, and Wulfberg of the communications section of AFCL visited us to discuss methods of connecting a future automatic ground-to-air communication link to WWI. The communication link will transmit data serially using pulse code modulation. However, they prefer a parallel output from WWI so that the conversion from parallel to serial can be done arbitrarily for military security. For this reason it was decided that no attempt would be made to utilize the existing WWI in-out register and that they would design their equipment to work off the new WWI in-out register.

The present plan at AFCL includes a flip-flop register which would receive parallel data from the WWI in-out register. The digits would then be shifted off the data link register in about 25 milliseconds. A new word cannot be read into the data link register until the shifting is completed. The data link register, control, and encoding equipment when built will be installed in the Barta Building. The radio transmitter might also be installed here, although this is not yet certain.

Most of the equipment needed for a trial interception is now ready. One of the difficulties is getting a radio frequency for ground-to-air transmission to the Instrumentation Laboratory aircraft. This is being worked out by Green of Instrumentation and Staples at AFCL. Probably a receiver channel in the aircraft will have to be shifted to the AFCL frequency.

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2. ENGINEERING (continued)
(D. A. Buck)

Intelligible reproduction has been obtained from the Bedford voice-link recording system using a seven kilocycle voice-modulated carrier. A filter was designed and constructed to remove frequency components in the clipped-speech waveform above two kilocycles. These were riding through the modulator and high-pass multiplex protection filter and introducing distortion into the system. Design of the demodulation equipment is in progress. Circuitry has been completed to make the M scope "D-F-Both" selector switch operative. Modification of the line driving stages in the intensification gate generator is under consideration so as to make the outputs adjustable. Small variations in component values seem to be making the order Q^2 produce a slightly brighter spot on the M-scope than does the order QD .

A test setup has been provided as a permanent feature in the special display rack. This provides for Z-axis intensification gates (with restorers blanked out) to all three scopes without use of the computer.

(H. J. Kirchner)

Construction of the second light-gun amplifier chassis has been completed. This unit is presently undergoing test.

A second light-gun will be constructed to operate with this new chassis. When this construction is complete, the light-gun unit presently being used will be modified so that it will be interchangeable with the new equipment.

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2. ENGINEERING (continued)
(R. L. Best)

The deflection amplifier for the 16 inch display oscilloscope has been tested, and operates satisfactorily. Deflection across the full face of the tube takes 15 microseconds, and a 5 microsecond intensification time will give 15 second persistence. A master's thesis report is now being written on the subject.

(R. E. Hunt)

Satisfactory progress is being made on the display unit. Drafting work on the tube-amplifier unit is about 50% complete.

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