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Memorandum M-1126

Electronic Computer Division
Servomechanisms Laboratory
Massachusetts Institute of Technology

SUBJECT: BI-WEEKLY REPORT, PROJECT 6782, November 10, 1959

To: J. W. Forrester

1. GENERAL

(R. A. Nelson)

It may be helpful to indicate the present plan of our work. Dodd's coding of the Mk 47 computer equations should provide an idea of the size of the overall single-target fire control problem. Katz' investigation of radar and gun characteristics should reveal what requirements must be met by the digital solution if it is to work with existing analog equipment. Consideration will then be given to what aspects of the solution,(such as stabilization) could be more efficiently performed by analog equipment so as to leave computer capacity free for problems like those involved in multiple-aircraft attacks. Also, in the general field of digital data use, the possibility of making use of the digital computer to give better servo performance will be examined, as suggested by Linvill. In general, we shall try to see how digital computers can make the best contribution to the fire control problem.

I have been reading more of the Mk 15 report. It appears that ship's-motion compensation is accomplished in that system by continuous stabilization of the sights and guns, on the basis of gyro detection of pitch and roll, rather than by computation in the computer.

I have also been studying a report on Task 2 of the Mk 65 Project of Bell Labs. This consists of 9 memoranda which contain several points of interest to us. They have determined that the inherent unsteadiness of flight of an airplane greatly reduces the probability of kill. Evasive maneuvers of targets (other than weaving) can generally be handled best by a helical-prediction computer, but at short ranges linear prediction is better; they recommend a combination of the two types.

(A. Katz)

For the past two weeks I have been attending the weekly seminars (Numerical Analysis-Course 6.533) conducted by Prof. Z. Kopal. These seminars dealt with the frequency distribution of round-off errors in performing summation and integration. Summation is involved in the

1. GENERAL (Continued)

use of a digital register as an error differential in a servo loop. Integration is involved in the digital simulation of analog compensation networks and in the solution of differential equations relating to the fire control problem. Hence it is important that we be able to predict the probable error resulting from round-off.

If possible, I shall continue to attend these seminars so long as they deal with problems in which we are interested.

3. CODING

(R. A. Nelson)

As mentioned in the previous bi-weekly, it would be helpful to use WWI to check some of our codes, especially in the cases of the more complicated solutions of Mk 47, where the adequacy of the digital solution would not otherwise be easily determined. Checking should consist of additional orders to use with the actual, unaltered code to be checked.

I worked out as an example the simple case of obtaining an exponentially smoothed bearing rate when consecutive bearings are given. Bearings computed from the computed smoothed bearing rate are displayed with the actual bearings. Different kinds of noise, different target paths, and different amounts of smoothing could be tested.

Such displays could be useful in demonstrating how well a digital computer solves the fire control problem.

(J. M. Dodd)

Programs have been written for the Linear Rates and Acceleration Smoothing sections. These two had presented greater obstacles than had any other sections in Mark 47; from now on coding should proceed more rapidly.

Jack Arnow's subroutine for arctangent has been modified to meet our needs. A subroutine for arcsine is being prepared.

4. DATA CONVERSION

(A. Katz)

During this period I had intended to begin an investigation of the dynamics of a gun positioning system. This did not prove

4. DATA CONVERSION (Continued)

necessary as we found that an excellent theoretical analysis of a gun drive had been prepared by R. J. Kochenburger, formerly with Servo Lab, Bldg. 32. Although this deals with a specific drive, the Gunar Mark I Control System, it is felt that this typifies the sort of system into which a computer may feed positioning signals.

Proceeding on the basis of Kochenburger's analysis, we are now in a position to study how such a system, Gunar Mark I, will react to discrete orders. Much of the bi-weekly period was devoted to a study of the transfer characteristics of the analog compensation networks and to an effort to simulate these by numerical means. Work along these lines will continue during the next period.