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6673  
Memorandum M-2022

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Air Traffic Control Project  
Servomechanisms Laboratory  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

M-2022

SUBJECT: BI-WEEKLY REPORT, NOVEMBER 11, 1949

1.0 GENERAL

(W. P. Welchman)

Work on the third Summary Report is nearly complete. The preparation of a concise statement of the order code led to a general review of computer operation in which several people took part. While these discussions were still fresh in our minds, it seemed a pity not to prepare a concise general explanation which could go with the order code and form a short guide to coding. This is being done and it is hoped that the two sections of the short guide will be printed on opposite sides of the same sheet of paper. This will form the last page of the Summary Report and a number of extra copies will be made for inclusion in other reports that present coded programs.

(C. R. Wieser)

A 6673-group meeting was held to outline some of the engineering considerations which determine an air traffic control system and the application of a digital computer. Control and guidance problems and communication and identification problems were discussed.

The determination of the sampling rate suitable for operation of closed-loop control requires a knowledge of the aircraft dynamics, courses to be flown, and the allowable tolerances in adhering to the course. The method of guiding the aircraft from one lane to a moving block on a parallel lane will have to be studied to determine whether the scheduled position data may be switched suddenly from lane to lane and the cross-over course determined by the servo characteristics, or whether the computer must furnish schedule data for a computed cross-over path.

Flight from lane to lane without a computed cross-over will involve a very large error transient in the control loop and will require large angles between the aircraft heading and the direction

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(C. R. Wieser) - continued

of the lanes. Hence coordinate-conversion must be considered, and careful attention must be given to the effect of non-linearities in the control-loop when a large error is suddenly inserted.

(P. Franklin)

Continued the study of Orden's method of approach sequencing and found additional conditions for the existence of clear paths.

(W. Linvill)

The dynamic characteristics of an airplane are being investigated. Prof. R. C. Seamans of the Instrumentation Laboratory has given information on the flight characteristics of the airplane. He has supervised performance tests on the A-26 airplane. Its characteristics do not differ radically from those of a commercial airliner. He has knowledge of both the characteristics and the instrumentation used to observe them.

In air traffic control studies a rather limited study of the flight equations is adequate because the maneuvers of an airliner are constrained to be very mild by conditions of passenger comfort. Study of three simple maneuvers is contemplated. They are: (1) bank in level flight, (2) climb or dive, (3) speed up or slow down. The equations describing the airplane's performance in these basic maneuvers give information always necessary and sometimes sufficient to:

- (1) Establish the practical rate at which the computer should supply control information to each aircraft (the sampling rate).
- (2) Prescribe what sort of information should be supplied.
- (3) Estimate the limits of deviation between a controlled plane's position and its prescribed position.

(A. Orden)

A preliminary study is being made of the motion of an aircraft relative to a desired path on the basis of simplified equations of aircraft motion with servo control.

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(F. A. Foss)

Frequency modulation techniques have been considered with respect to their application to private line communication. The identification of individual aircraft could be accomplished by the assignment of different frequencies to each aircraft. These frequencies would correspond to the modulating frequencies in a frequency modulated wave. At the aircraft receiving end they would be separated by selective circuits at the discriminator output. A single aircraft would only require one bandpass circuit tuned to the range of its assigned frequency. The identification frequency signal for a particular aircraft would be transmitted only during that time interval in which information pertaining to that aircraft was being transmitted over parallel frequency modulated subcarriers. The aircraft would use the identification frequency signal to time its sampling of the information channels. A transient study of some of the aspects of this problem indicate that modulating frequencies greater than 10 kilocycles would be desirable for this identification function.

A frequency modulated multiple subcarrier communication system could be used to transmit information in several ways. A frequency modulated subcarrier could be assigned to each digit. Alternately, if the data has been converted from a binary to a decimal system on the ground, a single frequency modulated subcarrier could transmit the decimal information for each data channel. The first method would require commutation of the incoming data and binary to decimal data conversion in the aircraft. The simpler second method does not require any commutation of the incoming data. The first system would have the greatest signal to noise ratio.

(D. R. Israel)

This past two-week period has been spent in preparing the private line code of E-2003 for Summary Report III. Work was also done on Appendix I of that report, the appendix being a continuation of the "Introduction to Coding" which appeared in the first report. An explanation of the use of ri when storing only an address, the explanation of the ao, ta, and sa orders and illustrations of their use, and general explanations of the six input-output orders are included. The explanations of the input-output orders resulted only after considerable discussion among interested parties and the final decision was not to explain these orders in terms of the film equipment, but rather in terms of more general external units.

For use in Summary Report III and in other reports of the 6673 project a one page detailed tabulation of the Whirlwind Order Code

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(D. R. Israel) - continued

has been compiled. Present plans call for copies of this page to be made available to the 6345 project. Work will also begin shortly on an accompanying one page summary of the "Introduction to Coding". It is thought that these two pages, the tabulations of the orders and the summary will be a valuable addition to most coding studies which are distributed for use outside the project.

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