Title	Tracking operation by group
Sub Title	
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Publisher	慶応義塾大学藤原記念工学部
Publication year	1965
Jtitle	Proceedings of the Fujihara Memorial Faculty of Engineering Keio University (慶応義塾大学藤原記念工学部研究報告). Vol.18, No.71 (1965.) ,p.123(59)- 124(60)
JaLC DOI	
Abstract	
Notes	Summaries of Doctor and Master Theses Master of Engineering, 1965 Administration Engineering
Genre	Departmental Bulletin Paper
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO50001004-00180071-0059

Tracking Operation by Group

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In a tracking operation, in which given input signals are received by human eyes and the control object is manually controlled, if a group of parallel connection (each member is given equal weight) controls a single control object the following facts were observed concerning the control effect (integral of error function square).

1. As the number of persons consisting the group increases the control effect improves.
2. As the number of persons increases the variation of the control effect decreases.

On the other hand it was reported that the process of transforming signals received by eyes into hand motion is described by a transfer function, and the human characteristics can be approximately described by proportional operation, first order differential operation and first order integral operation.

Transfer function of an operator i is

$$a_i s+b_i+c_i \frac{1}{s}$$

where a_i is a first order differential operation factor, b_i is a proportional operation factor, and c_i is a first order integral operation factor.

If the parameters a_i, b_i and c_i were regarded as constants, the above stated observed facts could not be explained.

Man has adaptability and ability to learn as his essential character. At a given time man's motion is affected by unpredictable stimulus inflicted by the circumstance and complicated factors that arises from his own inner states. Therefore, the structure of parameters in the transfer function may be hypothesized as:

$$K_i(t)=k_i+L_i(t)+\varepsilon_i(t)$$

where k_i : man's characteristic value that is determined according to a given control object.

$L_i(t)$: a function that deseribes the process of learning

$\varepsilon_i(t)$: a fractuating function that is affected by the operator's outside and inside factors during operation.

This being assumed, parameters in the transfer function of a group of n persons are deduced as:

$$\frac{1}{n}\sum_{i=1}^{n}K_i(t)=\frac{1}{n}\sum_{i=1}^{n}k_i+\frac{1}{n}\sum_{i=1}^{n}L_i(t)+\frac{1}{n}\sum_{i=1}^{n}\varepsilon_i(t)$$

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The group's characteristics can be appreciated if $L_i(t)$ is considered as a constant after a certain degree of learning is accomplished, and if $\varepsilon_i(t)$ varies independently with regard to each person according to the equation

$$\lim_{n\to\infty} \frac{1}{n} \sum_{i=1}^{n} \varepsilon_i(t) = 0.$$