

CURRENT PROJECTS IN FUZZY CONTROL

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**Fuzzy Logic Workshop
14 November 1990**

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Projects of Helicopter Flight Control

- o Radio Control by Oral Instructions
(1989 - 1993)

Tokyo Institute of Technology
supported by Science and
Technology Agency

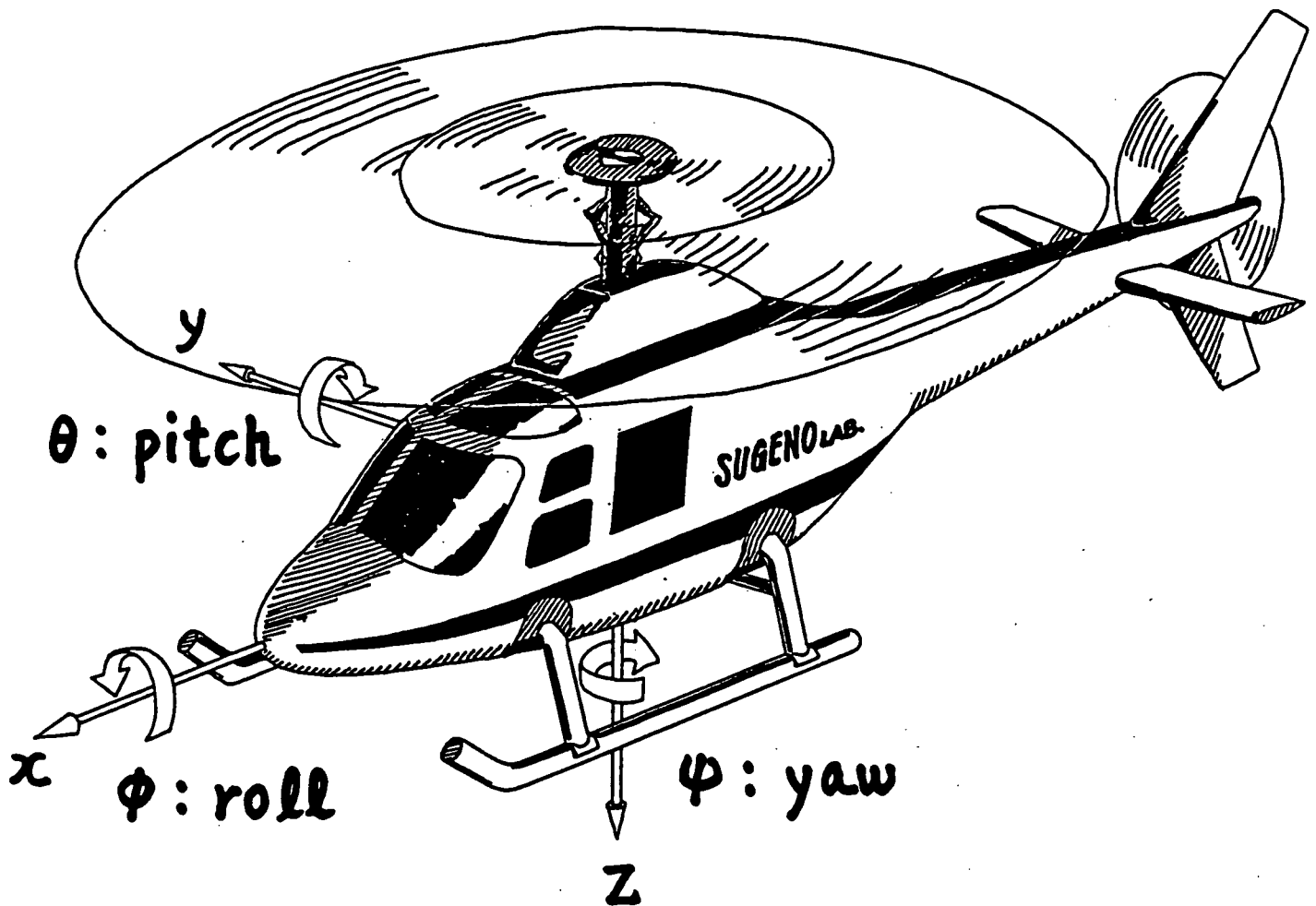
- o Automatic Autorotation Entry
in Engine Failure
(1989 - 1993)

Kawasaki Heavy Industry / TIT
supported by STA

- o Unmanned Helicopter for Sea Rescue
(1990 - 1991)

TOKIMEC / TIT
supported by Ministry of
Transportation

Motion of Helicopter



measured variables : \ddot{x} , \ddot{y} , \ddot{z}
 $\dot{\phi}$, $\dot{\theta}$, $\dot{\psi}$

Control of Movements

Move

Control

up/down



lift of main rotor
(collective pitch level)

forward/backward

pitching



main rotor revolution
(longitudinal stick)

left/right

rolling



main rotor revolution
surface
(lateral stick)

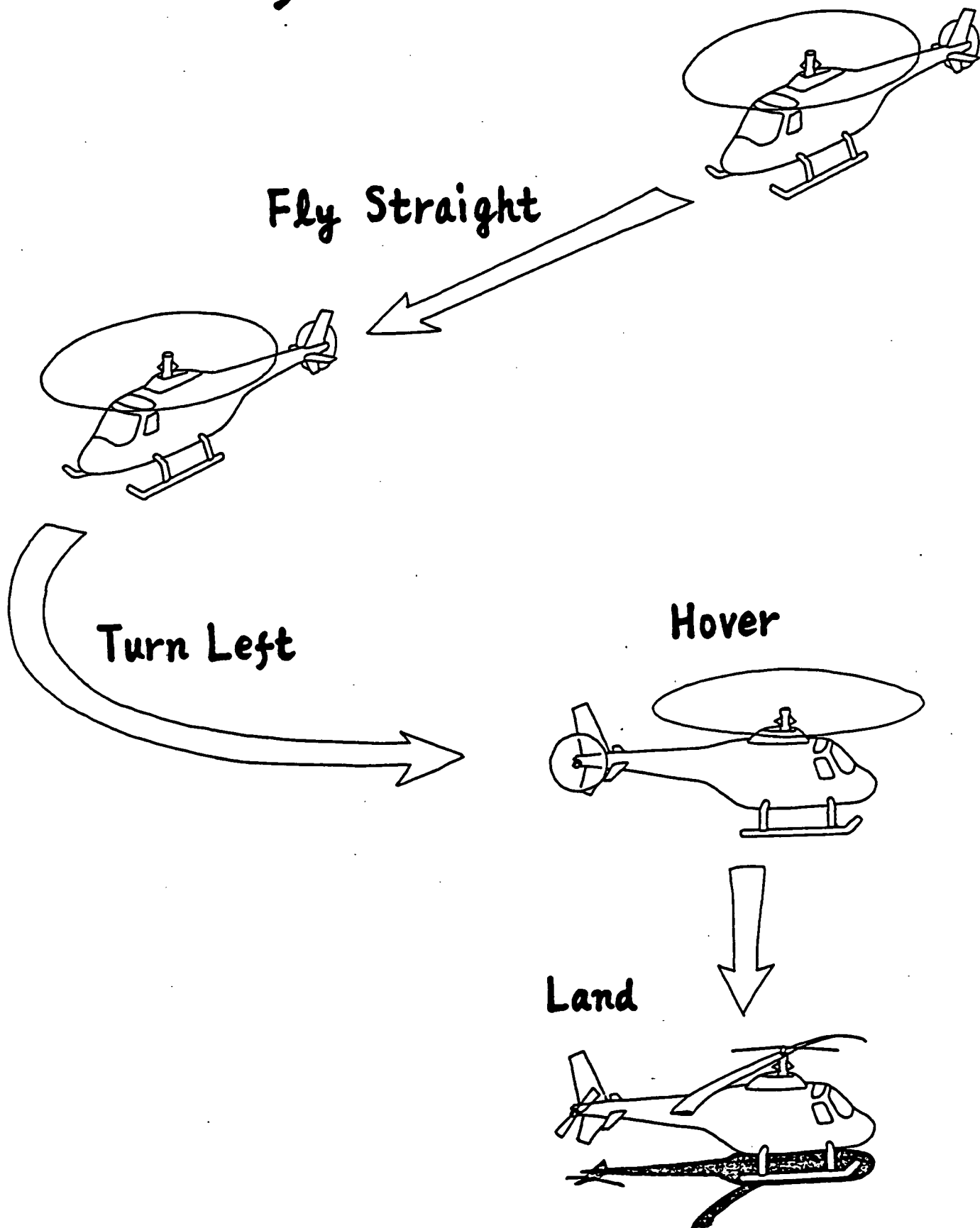
nose direction
(left/right)

yawing

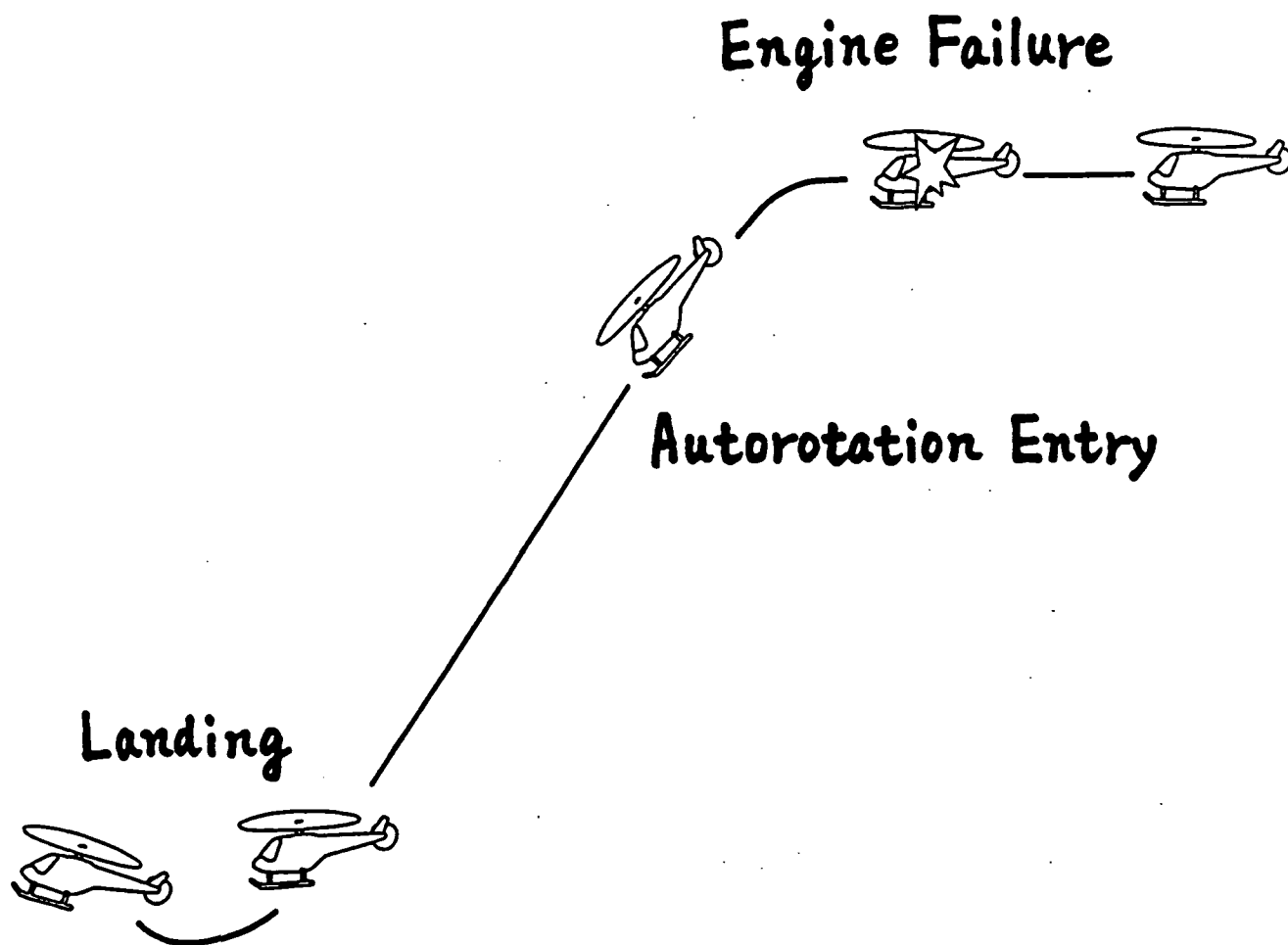


lift of tail rotor
(directional pedal)

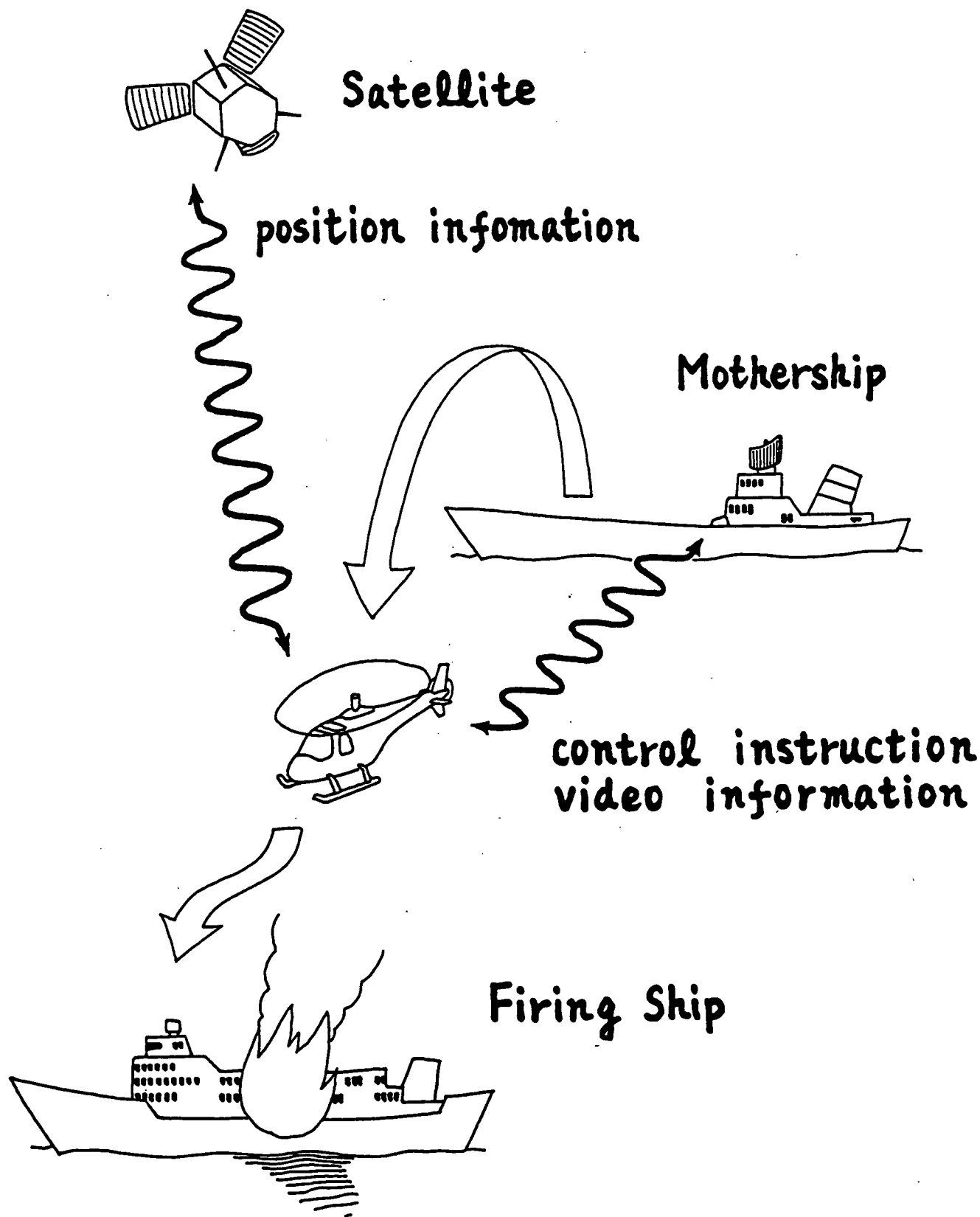
Remote Control of Helicopter by Oral Instructions



Automatic Autorotation Entry



Unmanned Helicopter for Sea Rescue



Linguistic Rules for Hovering

- 1) If the body rolls, then control the lateral in reverse
- 2) If the body pitches, then control the longi. in reverse
- 3) If the nose turns, then control the pedal in reverse
- 4) If the body moves sideways, then control the lateral in reverse
- 5) If the body moves back and forth, then control the longi. in reverse
- 6) If the body moves up and down, then control the collective in reverse

Fuzzy Control Rules for Hovering (longi. stick control)

1) pitch is PO \rightarrow longi. is NE

2) " NE \rightarrow " PO

3) $\frac{d}{dt}$ pitch is PO \rightarrow longi. is NE

4) " NE \rightarrow " PO

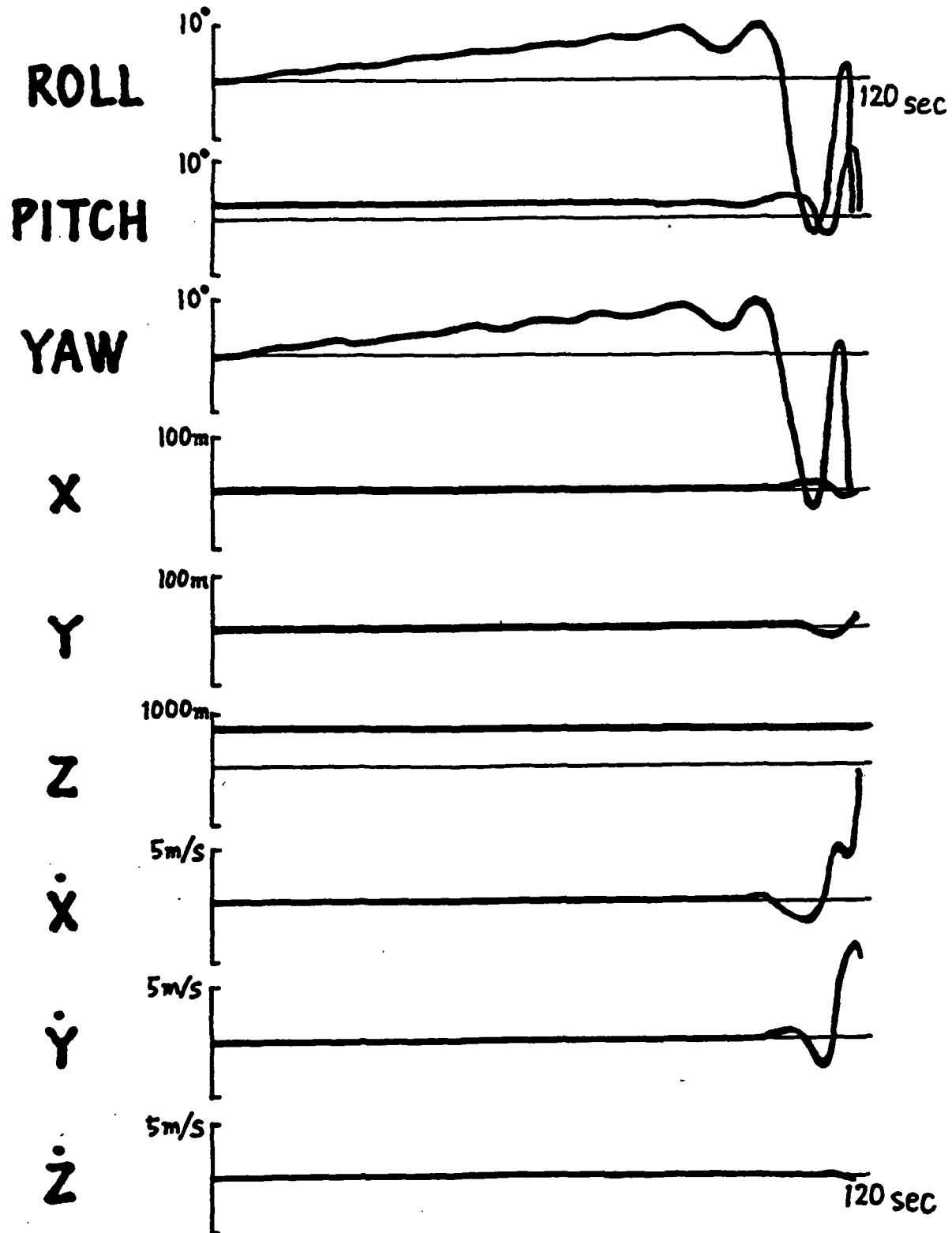
5) x is PO \rightarrow longi. is NE

6) " NE \rightarrow " PO

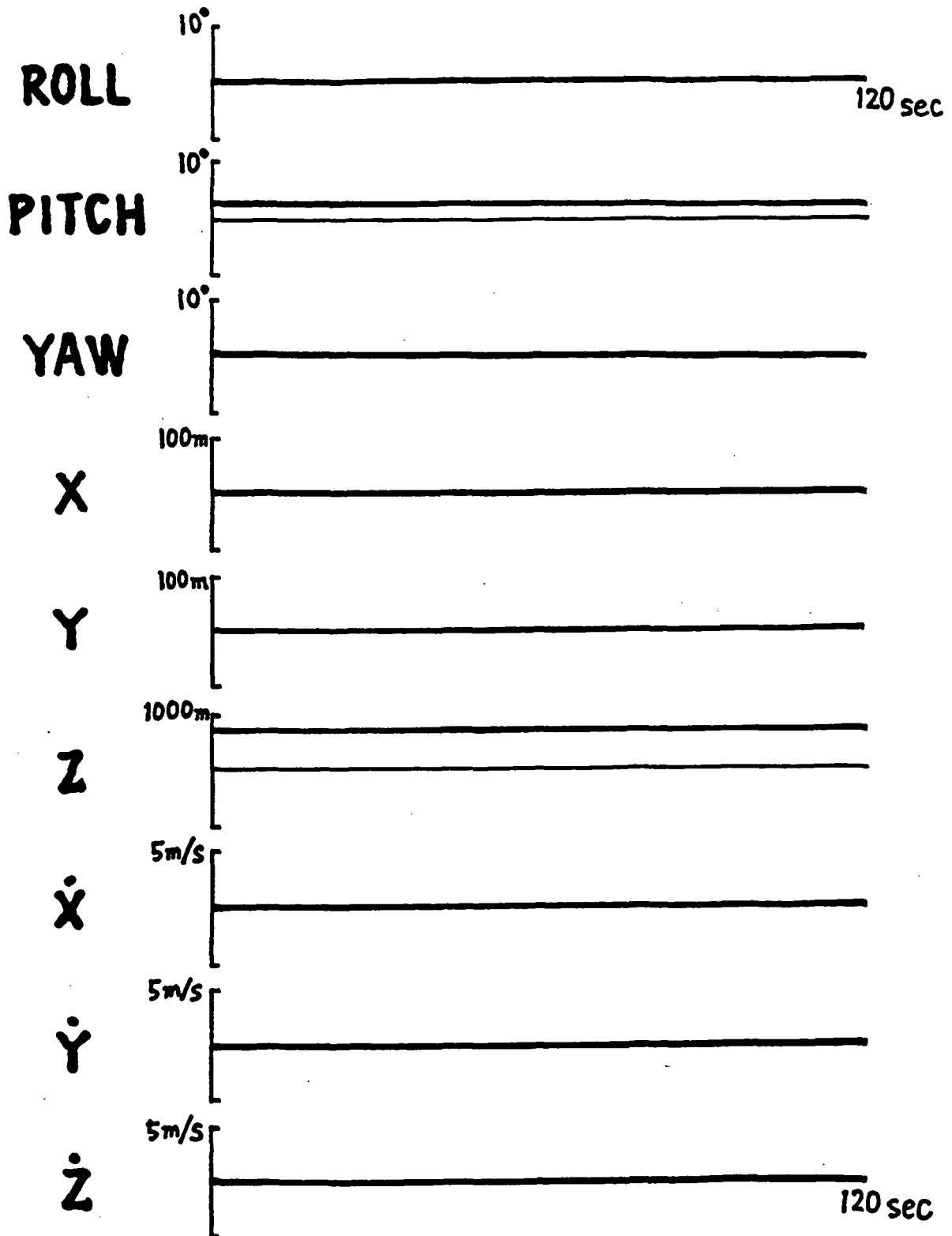
7) $\frac{dx}{dt}$ is PO \rightarrow longi. is NE

8) " NE \rightarrow " PO

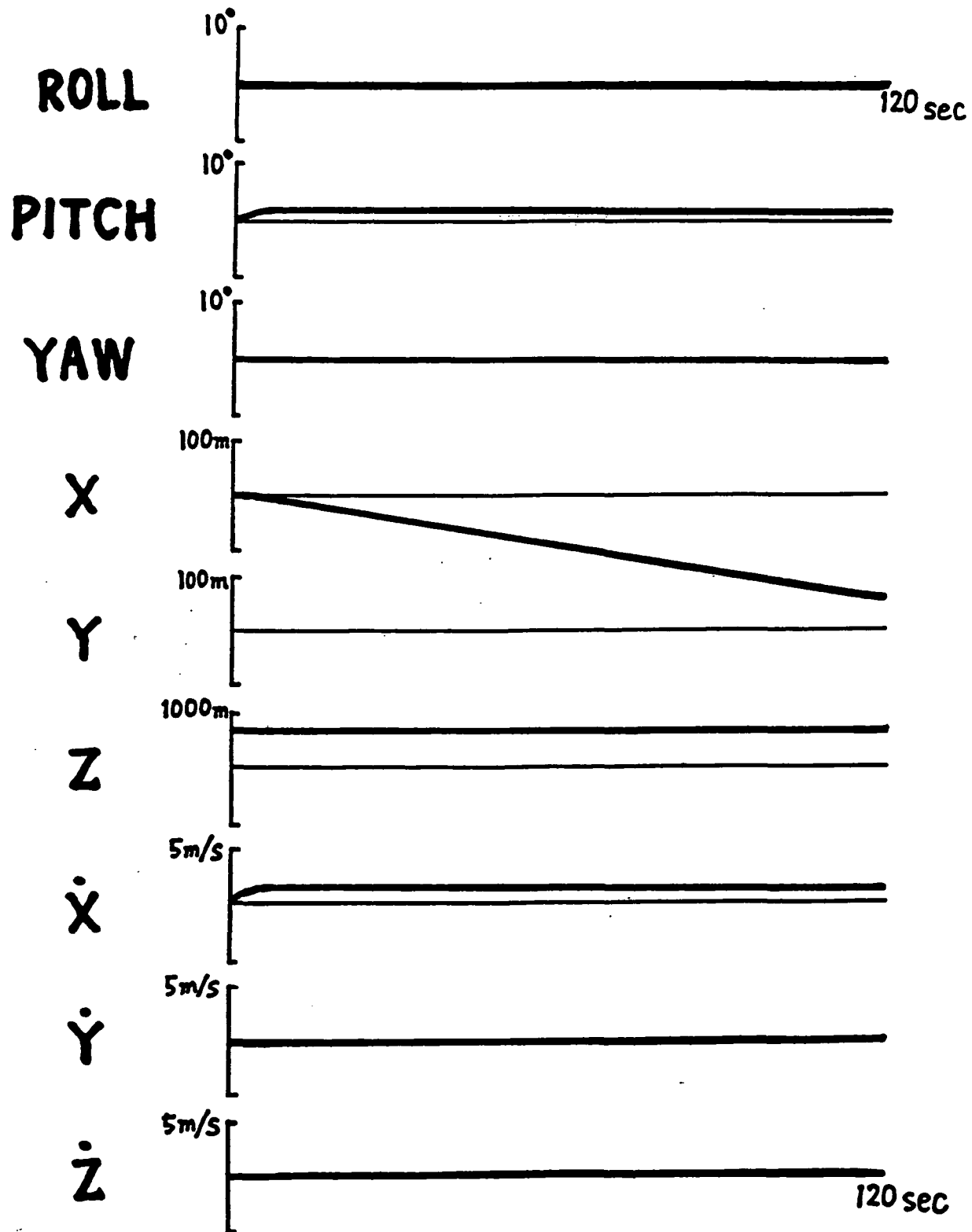
Hovering without Control



Hovering with Fuzzy Control



Forward Flying Control in Low Speed



Autorotation Entry by Fuzzy Control

(keep rotation speed of main rotor)

