**Technical Description**

This experimental unit forms part of a series of teaching systems developed in collaboration with the Department of Automation and Information Technology at the Harz University of Applied Studies and Research.

A ball-plate model acts as a weakly-coupled mechanical multivariable system. A fuzzy control is used to move the ball to a specific position quickly and with as little movement of the plate as possible, even when the position of the ball is modified by external influences.

The position of the ball is measured without feedback using a touch panel and the crisp signals sent to the fuzzy controller, where the signals are transformed into fuzzy input values and inferenced before being transformed back into a crisp output value. Two servo motors act as actuators during this process. The inclination of the plate is modified by the movements of the respective motors; these movements are transferred to the plate by the drive rod.

The learning contents of RT 123 are based on the fundamentals of RT 121. The RT 123 is a multivariable system with two separate fuzzy controllers, which can also be coupled. Optimisation of the system by fine tuning the parameters will be looked at in a later exercise.

The control algorithms are initially written in the user-friendly development software FSH-Shell, simulated and then compiled to generate microcontroller code. The control strategy can be optimised at a later date.

A joystick can be used to control the system manually. This allows the degree of difficulty of the control process to be estimated very accurately.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

**Learning Objectives / Experiments**

- Design of a fuzzy control for a decoupled multivariable system (fundamentals from RT 121 are required)
- Development of a model with two separate fuzzy controllers for each axis
- Effect of the position and velocity of the ball on the control characteristic
- Optimisation of control characteristic by additional coupling of the fuzzy controllers
- Comparison of a fuzzy control with a manually controlled system
**Specification**

1. Develop parallel fuzzy controls using microcontroller technology
2. Two-axis ball-plate system as mechanical multivariable system, MIMO (Multiple Inputs - Multiple Outputs)
3. Switchable between fuzzy and manual mode
4. 2 servo motors used as actuators to swivel the plate
5. Microcontroller with RS232 port as fuzzy controller
6. FSH-Shell development software for designing and optimising the fuzzy controller
7. Resistive analog touch panel as ball position sensor
8. Potentiometer as plate inclination sensor
9. Part of the structured learning concept: level 2b

**Technical Data**

- **Plate**: l x w: 378x303mm
- **Ball**
  - diameter: 35mm
  - weight: 174g
  - 2 servo motors
  - operating voltage: 5,0V
  - actuation torque, interpolated: 206Ncm
  - actuator velocity, interpolated: 0,18s/60°
- **Microcontroller**
  - 8bit microcontroller Zilog Z8Encore
  - 12-fold ADC 8bit
- **Software**: FSH-Shell, runs under Windows XP or Windows Vista
- **Touch panel**
  - operating voltage: 5,5V
  - active area: 378,5x303mm

**Dimensions and Weight**

- **l x w x h**: 600x520x300mm
- Weight: approx. 24kg

**Connections**

- 230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

**Scope of Delivery**

- 1 experimental unit
- 1 RS232 cable
- 1 FSH-Shell development software
- 1 set of instructional material

**Order Details**

080.12300  RT 123  Fuzzy Control: Ball-on-Plate