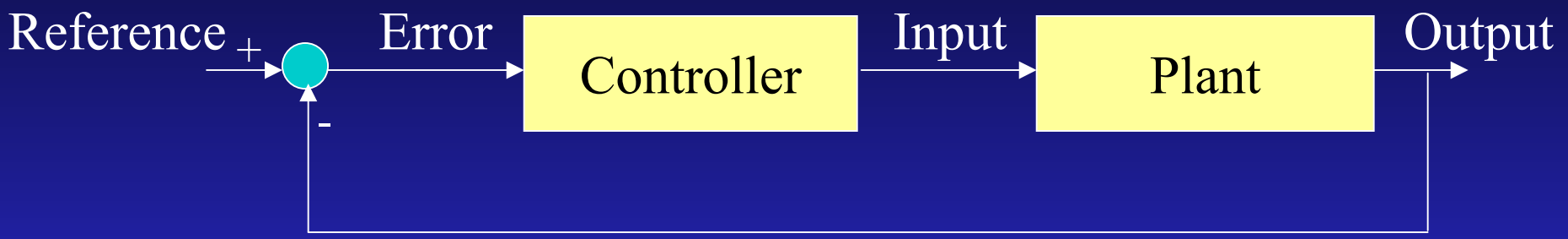
LECTURE 4

ENGR5: Intro to Engineering Practice

MEM Project

LEGO Robotics & Control – Killough's Platform

Closed-Loop Control



Input:	Motor Commands
Output:	Position
Reference:	Line
Error:	Distance from the line

Now the controller can correct the input of the plant to achieve the objective!!!

Light Sensors

The measurement is NOT continuous!!! ⇒ Error Signal is NOT continuous

WHITE	White_Value
BLACK	Black_Value

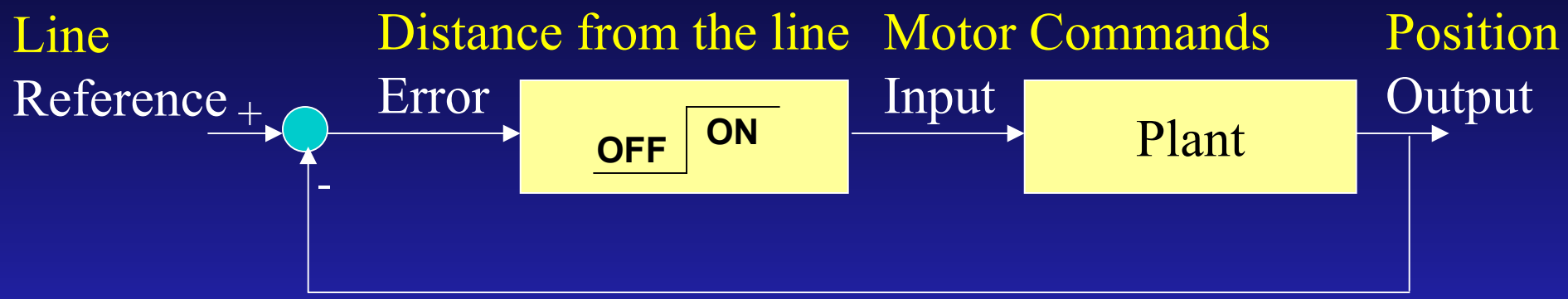
These values depend on:
-Room lightning
-Distance of the sensors from the table

CALIBRATION

Sensor Reading Interpretation

LEFT SENSOR	RIGHT SENSOR	INTERPRETATION	ACTION
BLACK	BLACK	ON TRACK	KEEP THERE
BLACK	WHITE	MOVING RIGHT	TURN LEFT
WHITE	BLACK	MOVING LEFT	TURN RIGHT
WHITE	WHITE	OUT OF TRACK	BACK TO LINE MEMORY?

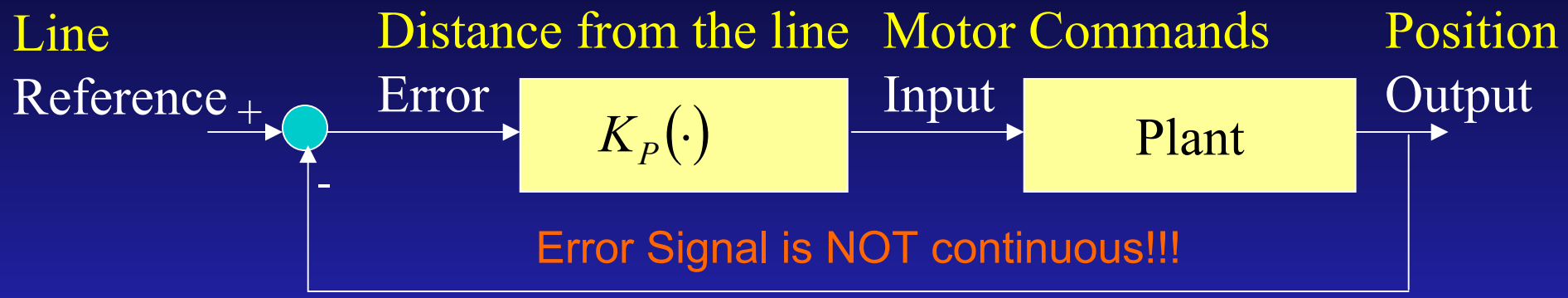
Closed-Loop Control: ON-OFF



LEFT SENSOR	RIGHT SENSOR	INTERPRETATION	ACTION
BLACK	BLACK	ON TRACK	OFF: DO NOTHING (Keep Forward)
BLACK	WHITE	MOVING RIGHT	ON: CORRECTION (Magnitude?!!!) (Keep Forward + Rotation)
WHITE	BLACK	MOVING LEFT	
WHITE	WHITE	OUT OF TRACK	

PROBLEMS:
- Correction too small "for out of track" condition → Slow
- Correction too big for "close to track" condition → Overshoot

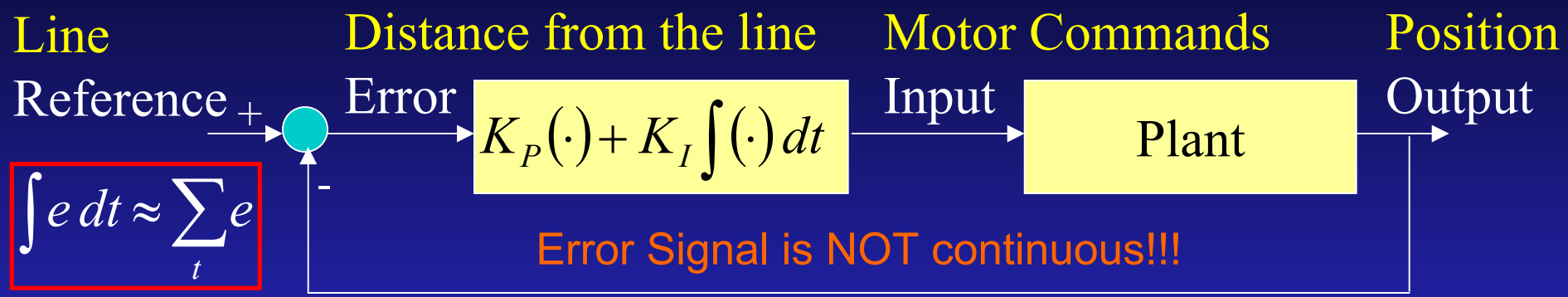
Closed-Loop Control: PROPORTIONAL



LEFT SENSOR	RIGHT SENSOR	INTERPRETATION	ACTION
BLACK	BLACK	ON TRACK	ZERO: DO NOTHING (Keep Forward)
BLACK	WHITE	MOVING RIGHT	MAGNITUDE 1: CORRECTION (Keep Forward + Small Rotation)
WHITE	BLACK	MOVING LEFT	
WHITE	WHITE	OUT OF TRACK	MAGNITUDE 2: CORRECTION (Keep Forward + Big Rotation)

PROBLEMS: - May not be enough! We have only two levels of correction
- We still have one level of correction in the “out of track” condition

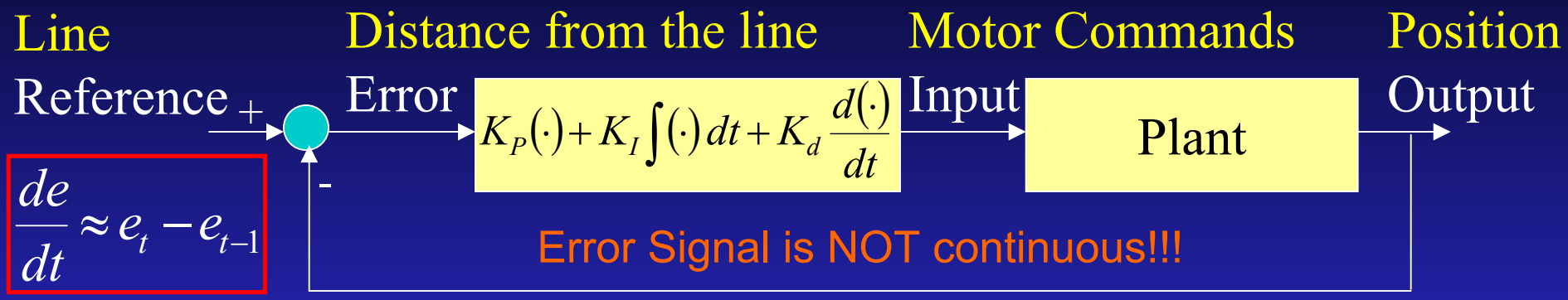
Closed-Loop Control: INTEGRAL



LEFT SENSOR	RIGHT SENSOR	INTERPRETATION	ACTION
BLACK	BLACK	ON TRACK	ZERO: DO NOTHING (Keep Forward)
BLACK	WHITE	MOVING RIGHT	MAGNITUDE 1: CORRECTION (Keep Forward + Small Rotation)
WHITE	BLACK	MOVING LEFT	
WHITE	WHITE	OUT OF TRACK	VARIABLE MAGNITUDE IN TIME : CORRECTION (Keep Forward + Variable Rotation)

PROBLEMS: - We still have possible overshooting in “close to track” condition

Closed-Loop Control: DERIVATIVE



LEFT SENSOR	RIGHT SENSOR	INTERPRETATION	ACTION
BLACK	BLACK	ON TRACK	ZERO: DO NOTHING (Keep Forward)
BLACK	WHITE	MOVING RIGHT	VARIABLE MAGNITUDE IN TIME: DERIVATIVE CORRECTION (Keep Forward + Variable Rotation)
WHITE	BLACK	MOVING LEFT	
WHITE	WHITE	OUT OF TRACK	VARIABLE MAGNITUDE IN TIME : INTEGRAL CORRECTION (Keep Forward + Variable Rotation)

PROBLEMS: - Hard to implement with our measurement restrictions!

Built-in Functions

TIME:

void reset_system_time( )

Resets the system time.

long mseconds( )

Returns the count of system time in milliseconds. Time count is reset by hardware reset (i.e., pressing reset switch on board) or the function reset_system_time( ).

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