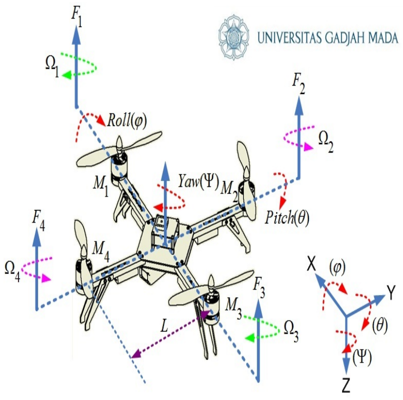


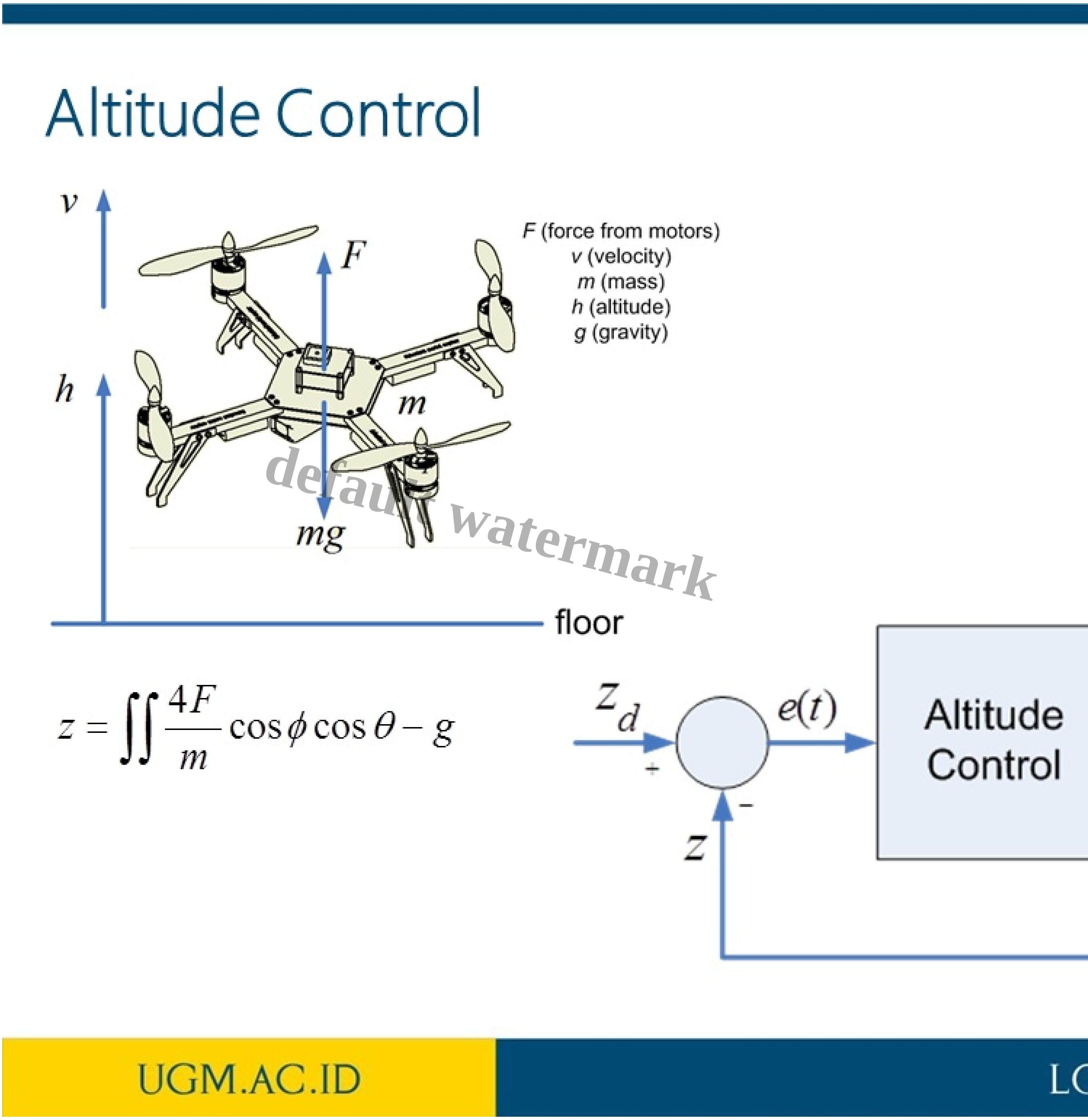
Unmanned Aerial Robot

Description

Altitude control of quadrotor using fuzzy self tuning PID controller

Abstract

This research presents fuzzy self-tuning PID controller for controlling the altitude of the quadrotor. Although the PID controllers have many advantages, it has a limitation that the main term gains called proportional gain, integration gain, and derivative gain have to be tuned manually. One of a solution to manage its limitation is adding the special feature called self-tuning. So, a fuzzy self-tuning PID controller is proposed to adjust the gain parameter of PID controller. As a result, two control techniques were then developed and synthesized for comparing; a linear PID controller only and fuzzy self-tuning PID controller. A complete simulation was then implemented on MATLAB/Simulink relying on the derived mathematical model of the quadrotor.


Altitude Control
v
h
F
m
mg
F (force from motors)
v (velocity)
m (mass)
h (altitude)
g (gravity)
floor
$z = \iint \frac{4F}{m} \cos\phi \cos\theta - g$
z_d
+
$e(t)$
−
z
Altitude Control
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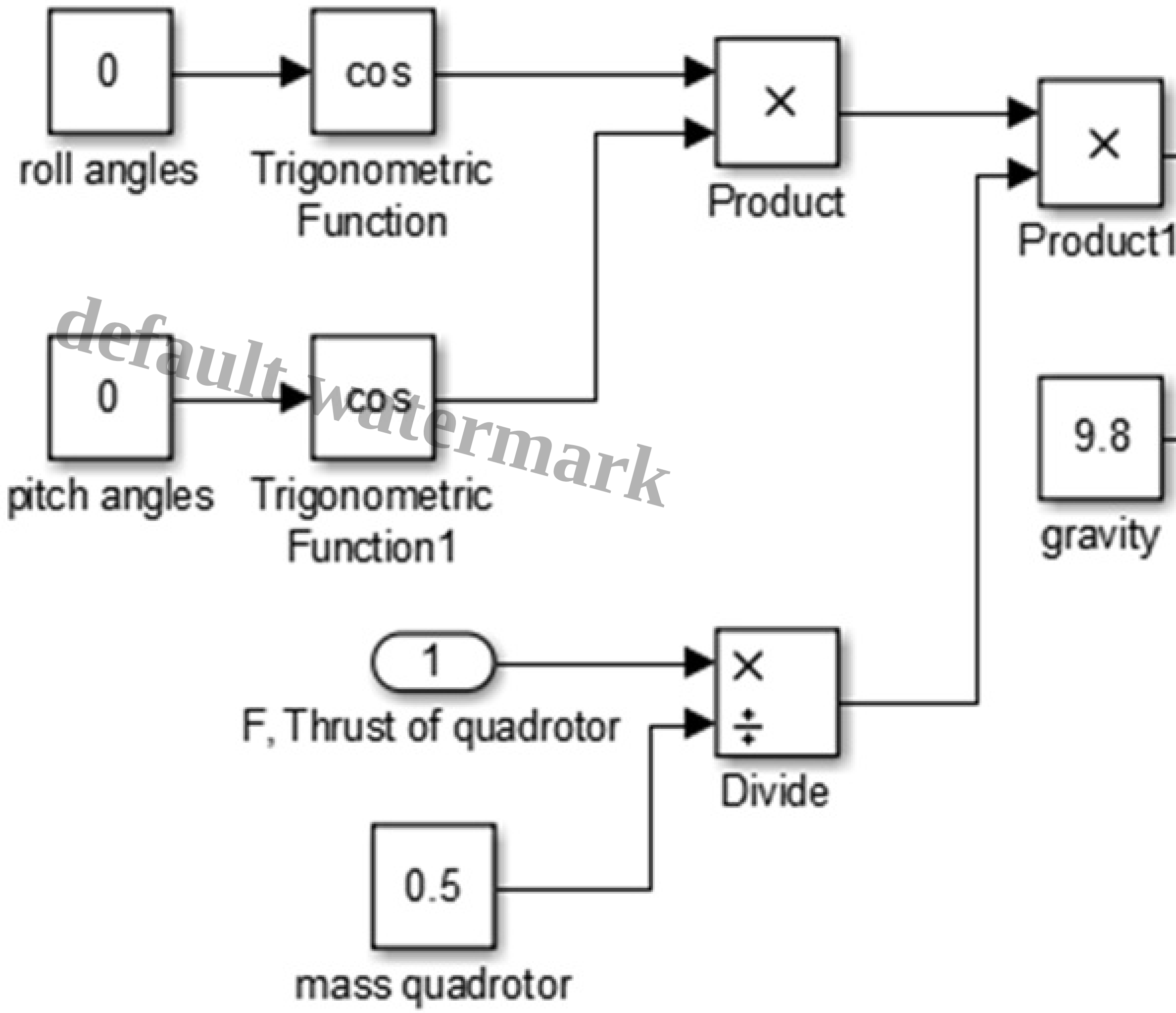
Simulink diagram for altitude/height m



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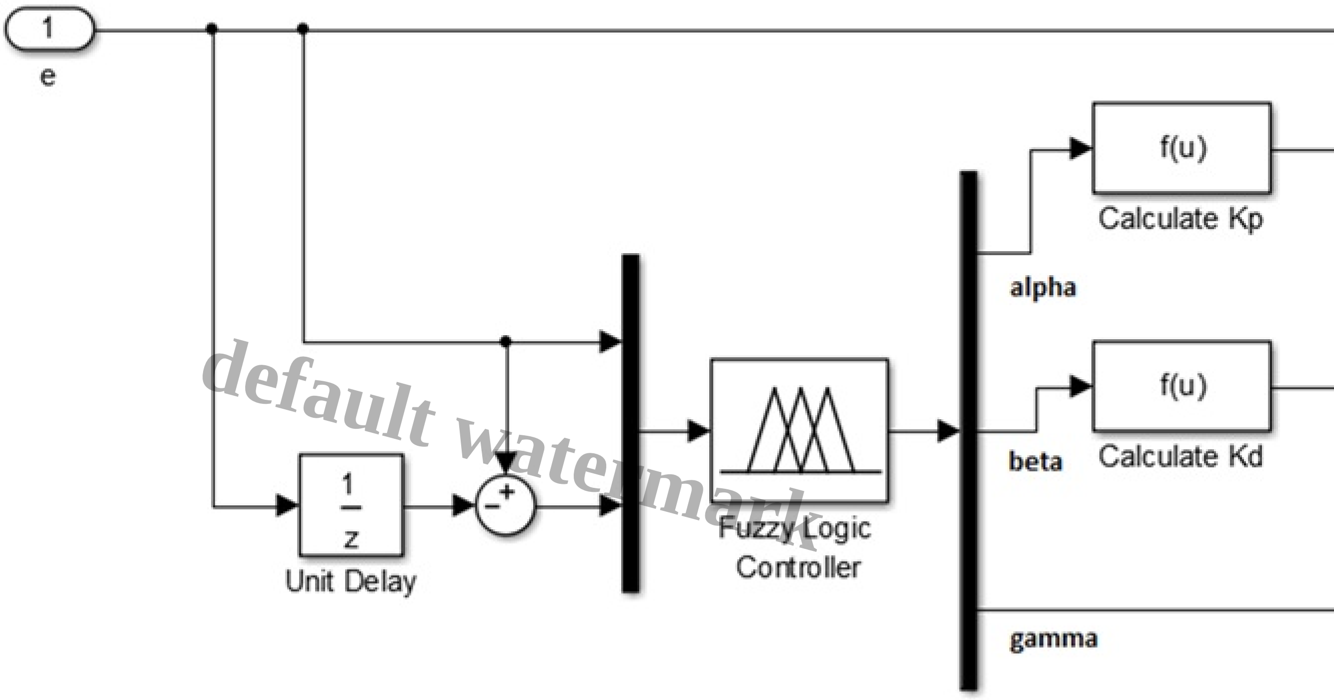
LC

Simulink diagram for fuzzy self tuning PID co



$$K_p = Kp_{min} + (Kp_{max} - Kp_{min})$$

$$K_d = Kd_{min} + (Kd_{max} - Kd_{min})$$

$$K_i = \frac{K_p^2}{K_d \times \gamma}$$

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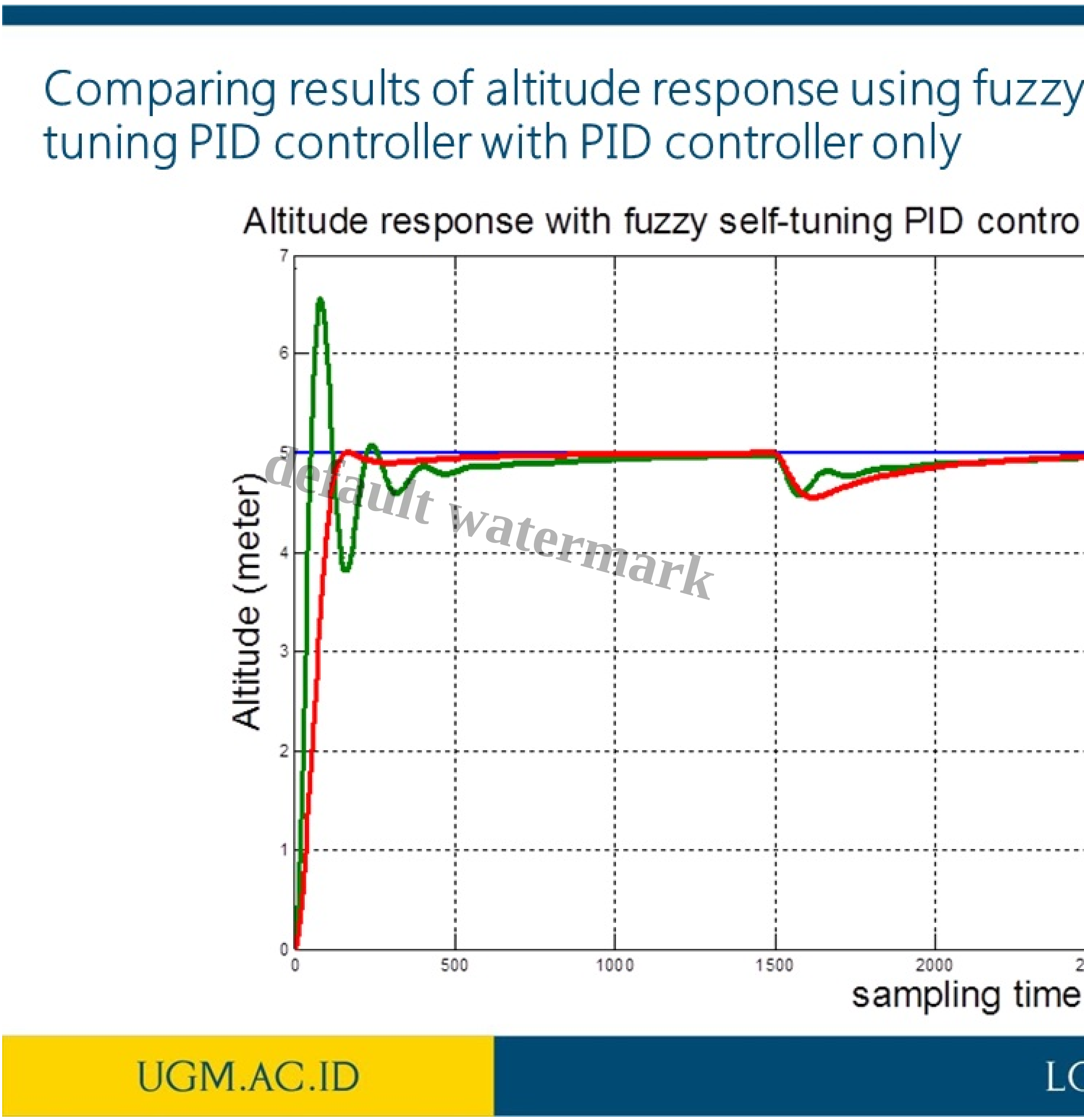

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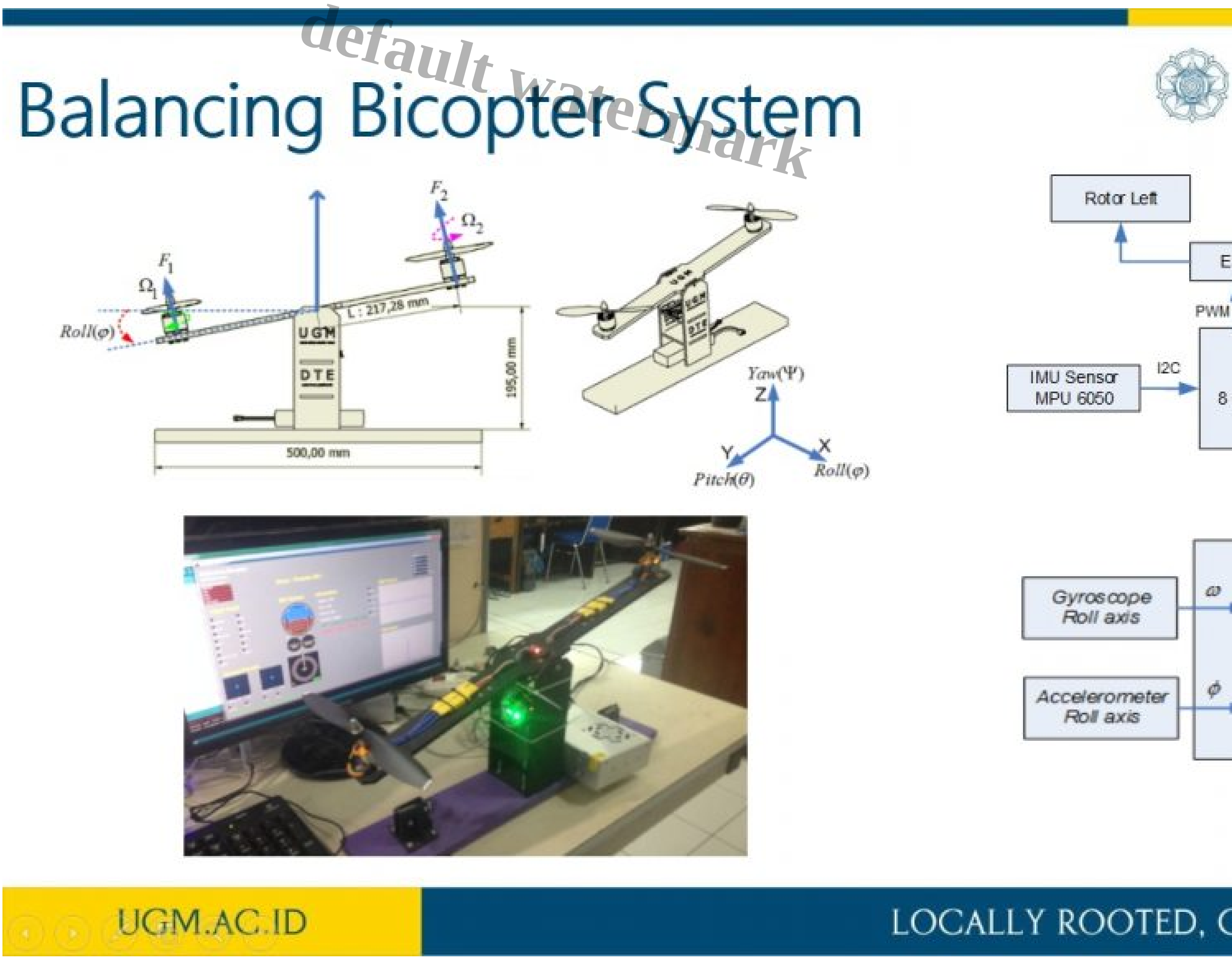
[Rigorous Modelling Steps on Roll Movement of Balancing Bicopter using Multi-level Periodic](#)

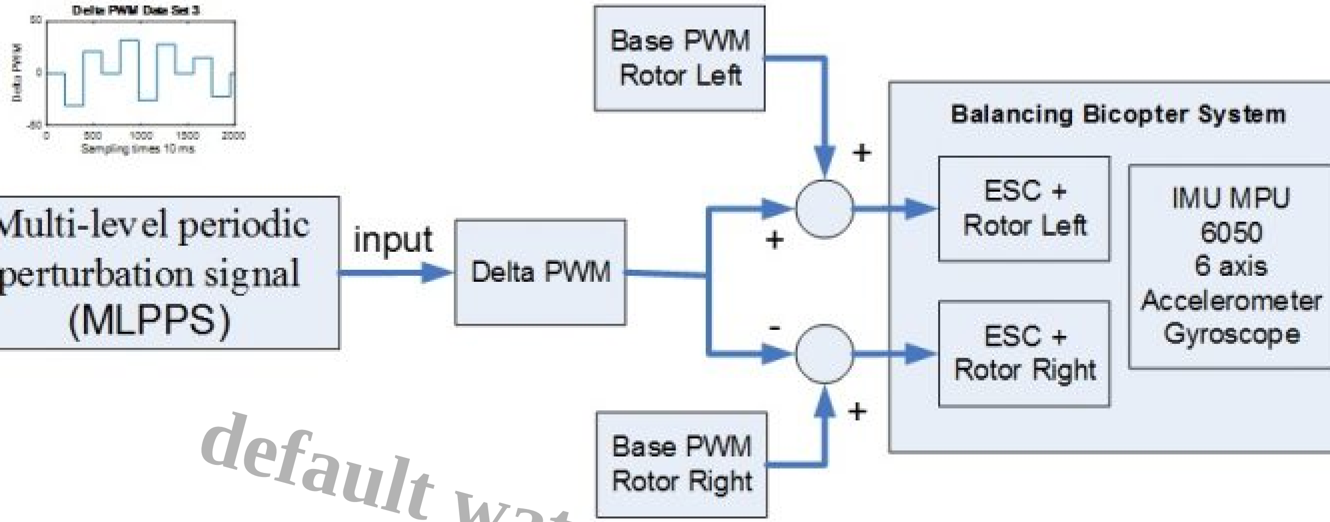
Perturbation Signals

Abstract

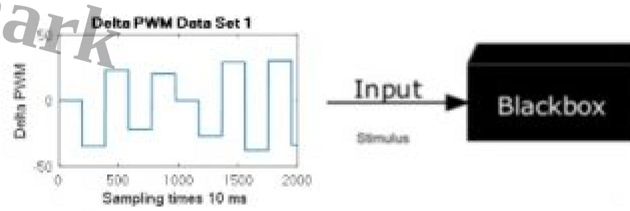
This research presents the modelling steps of balancing bicopter for its roll movement in a rigorous way. This research uses delta speed between two rotors as an input while the roll angle obtained from an inertial measurement unit (IMU) sensor after refined by a complementary filter (CF) considered as an output. The single input and single output (SISO) data are used to build a model. Multi-level periodic perturbation signal (MLPPS) treated as an input signal for the identification process to provide a good model which is indicated by fitness value. A particular cross-distribution of MLPPS data sets is used in the validation process to earn the best model. Furthermore, a simple feedback control scheme is used to re-examine the model with the real system. The result declares that by using MLPPS, simulation of the model conducted in MATLAB Simulink gives a close performance to the measured real experiment which is implemented using Arduino Uno.



MODELING METHODS



1. Generating the data sets of input signal
2. Collecting the response of the system
3. Estimating the system based on prescribed model
4. Validating the model using a distribution of data sets
5. Determining the best model based on fitness value
6. Test the chosen model in a simple feedback control scheme



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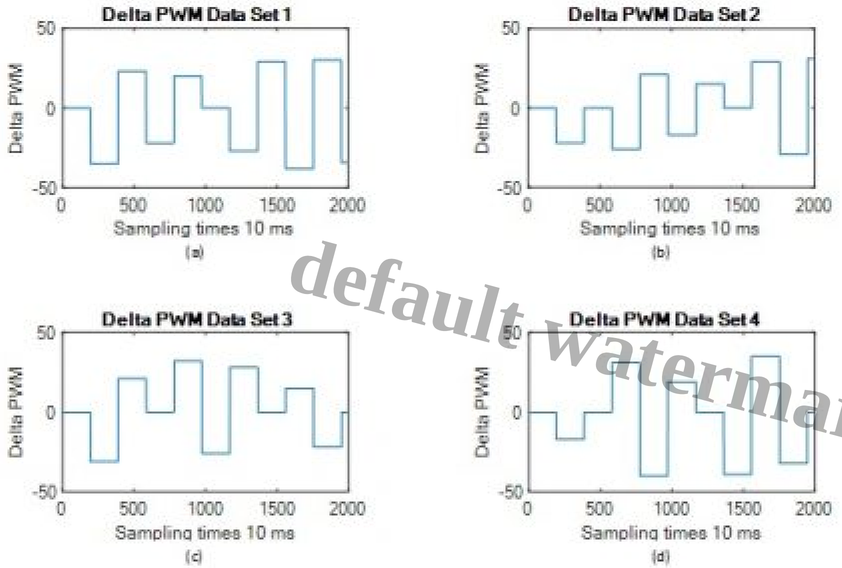
MODELING METHODS

multi-level periodic pertubation signal (MLPPS)



Model	Working data	Validation data
Model 1 (ARX221)	1	2
	2	4
	3	1
	4	3
Model 2 (ARX441)	1	2
	2	4
	3	1
	4	3
Model 3 (AMX2221)	1	2
	2	4
	3	1
	4	3

Polynomial Models:
ARX221 → Auto-Regressive , [na=2, nb=2
ARX441 → Auto-Regressive , [na=4, nb=4
AMX2221→ Auto-Regressive Moving-Ave
OE221→ Ouput-Error, [nb=2, nf=2, nk=1]
Transfer -function models:
TF21 → Number of pole = 2, number of ze
TF43 → Number of pole = 4, number of ze

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Fitness Value of All Model Candidates

No	Model structure	Fitness value, validat		
		Data set 1	Data set 2	Data se 3
1	ARX221	73.89	64.93	77.20
2	ARX441	74.88	70.36	75.69
3	AMX2221	72.68	75.12	76.47
4	TF21	72.68	75.68	82.60
5	**TF43**	80.11	75.29	**84.83**
6	OE221	79.66	77.00	83.37

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Best Model

- From the experiment involving TF43 structure, the m
validated by data set 3 has the highest fitness value.
finally considered as the best to represent the real dy
balancing bicopter system.

$$\frac{\phi_{(s)}}{\Delta PWM_{(s)}} = \frac{0.6126s^{3} - 1.359s^{2} + 28.81s}{s^{4} + 2.27s^{3} + 19.89s^{2} + 2}$$

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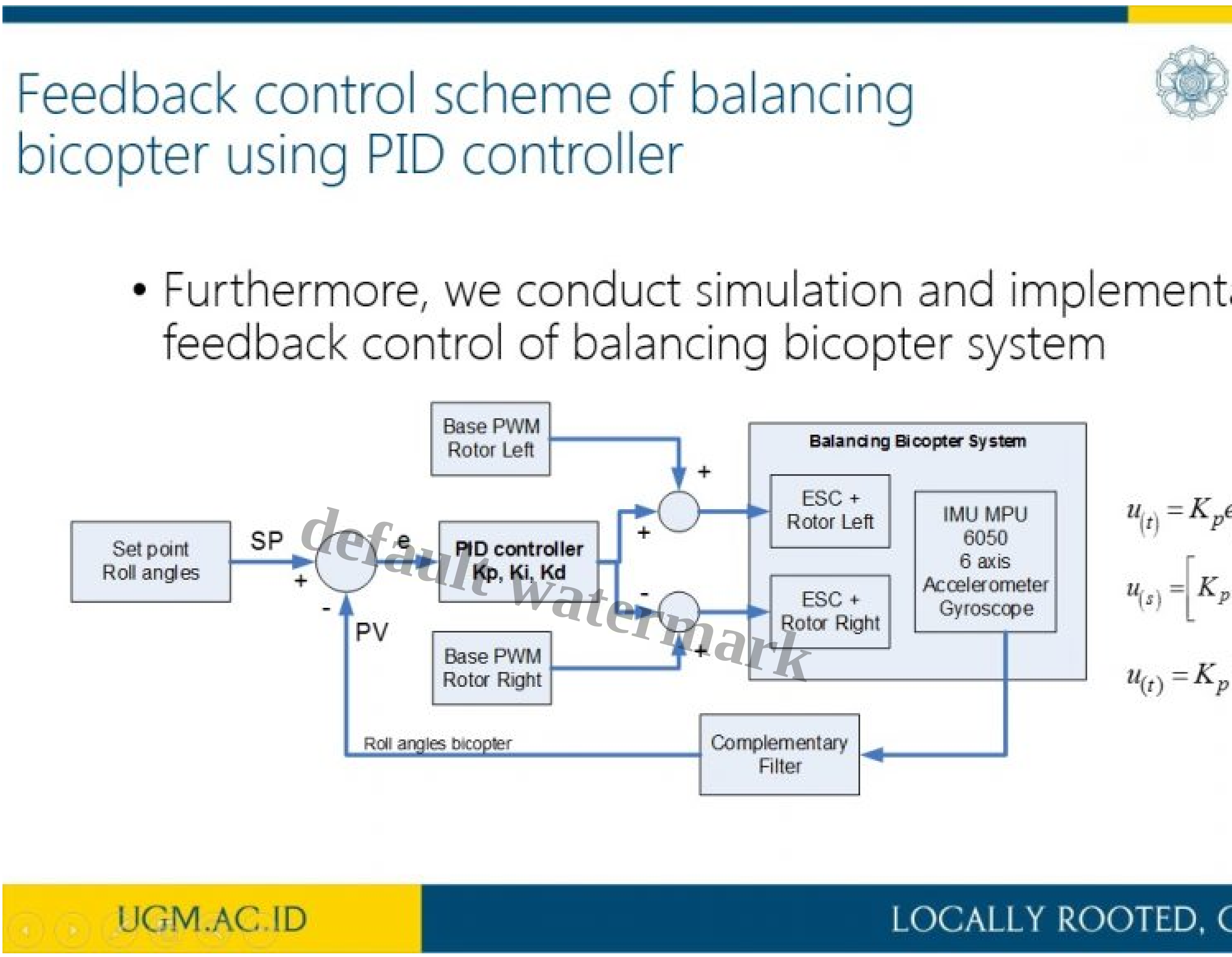
Feedback control scheme of balancing bicopter using PID controller
• Furthermore, we conduct simulation and implement
feedback control of balancing bicopter system
Base PWM Rotor Left
Balancing Bicopter System
Set point Roll angles
SP
e
PID controller Kp, Ki, Kd
ESC + Rotor Left
IMU MPU 6050 6 axis Accelerometer Gyroscope
ESC + Rotor Right
PV
Base PWM Rotor Right
Roll angles bicopter
Complementary Filter
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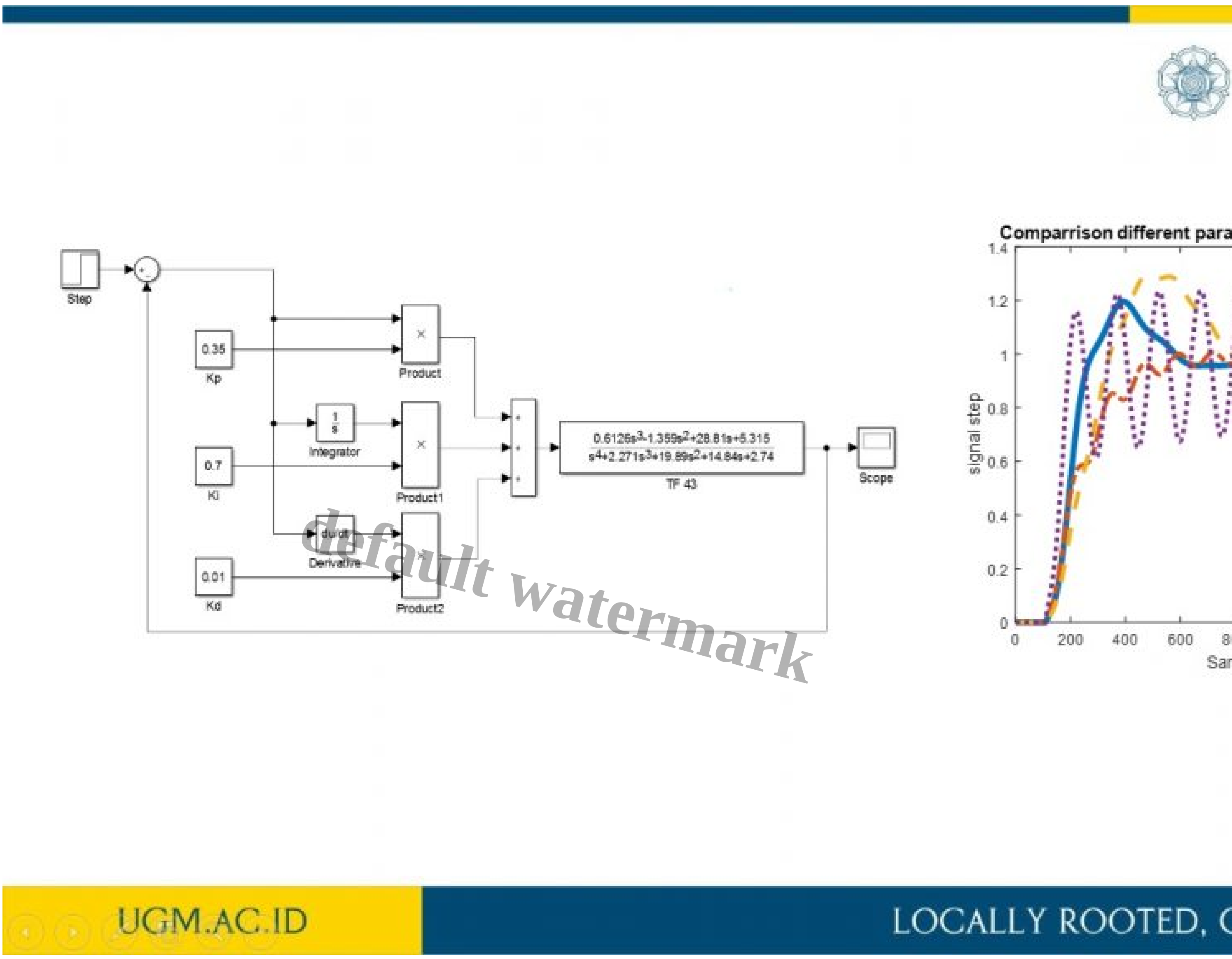

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fahmizal