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FACULTY OF TRANSPORTATION ENGINEERING
Department Automotive and Engine

DESIGN A DIRECT ADAPTIVE FUZZY CONTROLLER FOR A DC MOTOR

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I. INTRODUCTION

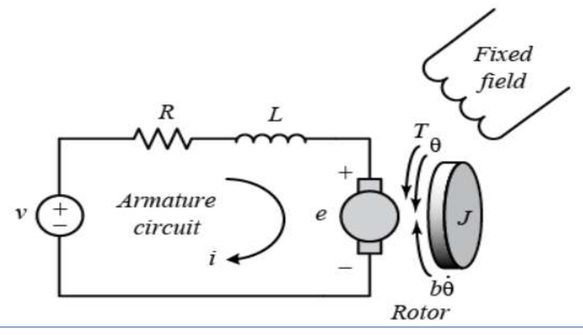

Figure 1. DC motor with electric equivalent circuit and rotor

- Project on design a direct adaptive fuzzy controller for a DC motor
- The aim of project is to simulate Direct adaptive fuzzy controller for DC motor in Simulink and create user interface in App designer
- The requirement of the project that can control the speed of the DC motor follows the desired speed, ensure the control error always converges to 0

II. THEORETICAL BASIS

Controller adaptability

- The conditions and working modes of the subject are always changing, just as the subject itself is always changing with time, and the effects of noise that distorts the measured values as well as the control values
- Controller needs to be able to adjust its own control parameters, to ensure the desired control quality against these uncertain changes

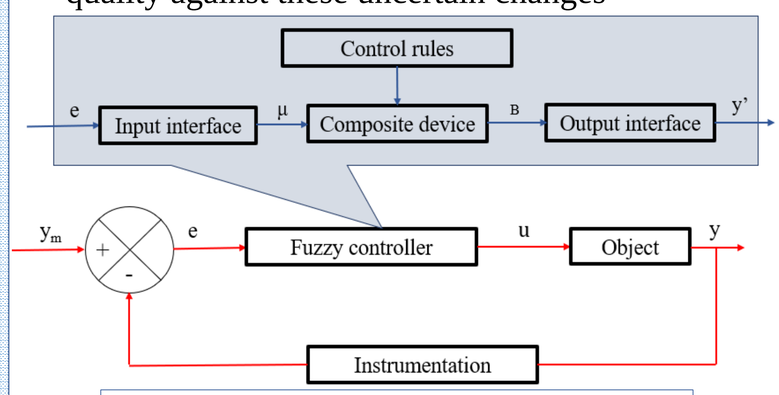

Figure 3. Fuzzy controller structure

Direct adaptive fuzzy controller

- Fuzzy system:

$$u = u_D(X, \theta) = \theta^T.\xi(X)$$

Approximate the unknown control law, to ensure the control quality when the object parameters change or have the impact of noise during the working process, at the same time, in order to take advantage of the knowledge and experience of object control

- Adaption law:

$$\dot{\theta} = \gamma.E^T.p_n.\xi(X)$$

The adaption law determined according to the Lyapunov stability criterion ensures the stability of the system, does not require parameter estimators, and the computational volume is small

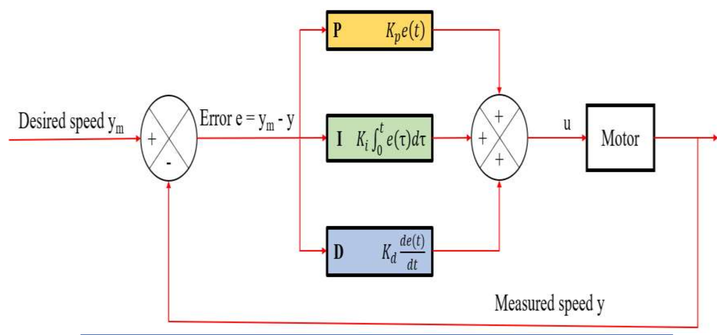

Figure 2. PID controller structure

Fuzzy controller

- The input interface includes fuzzify and additional auxiliary stages to perform dynamic problems such as differential, integral, ...
- Composite device whose nature the composition rule implementation is built on the basis of control rules
- Output interface includes defuzzification and direct interface with the object

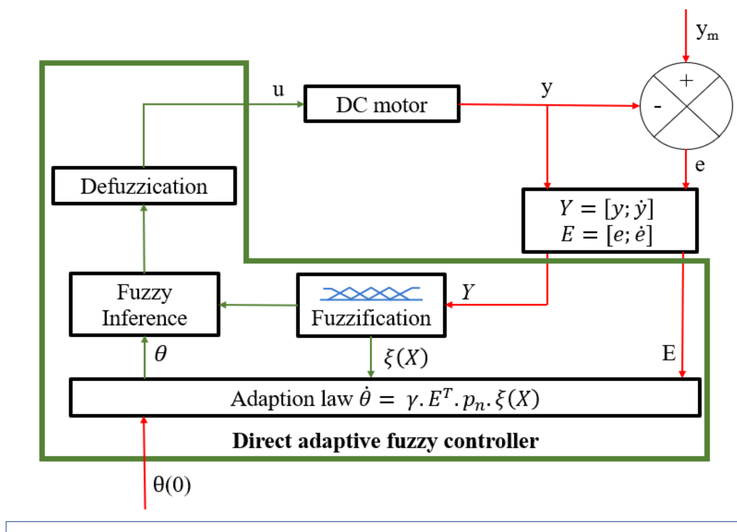

Figure 4. Direct adaptive fuzzy controller structure

III. GENERAL LAYOUT DESIGN

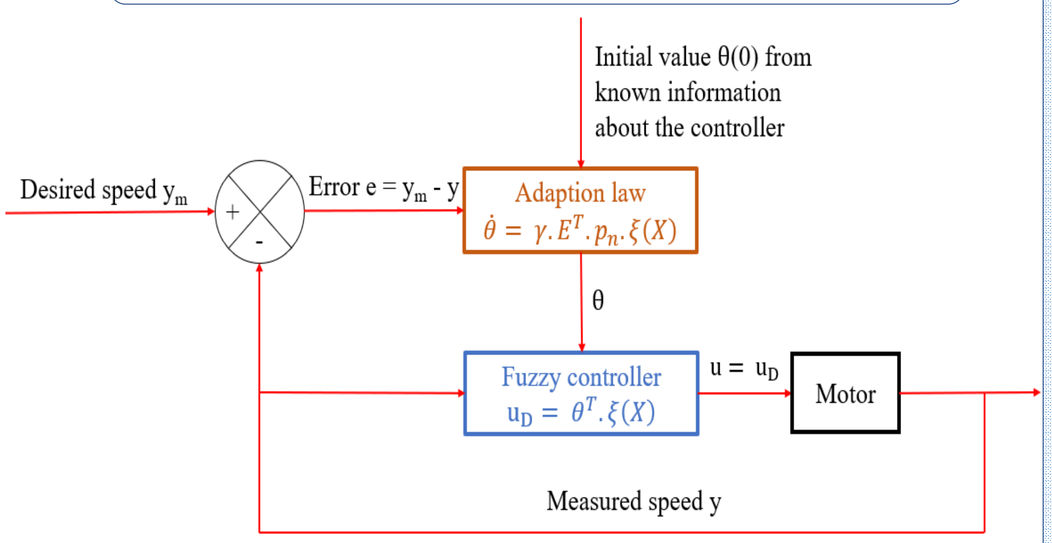

Figure 5. General layout diagram of direct adaptive fuzzy controller

IV. SIMULATION AND RESULTS

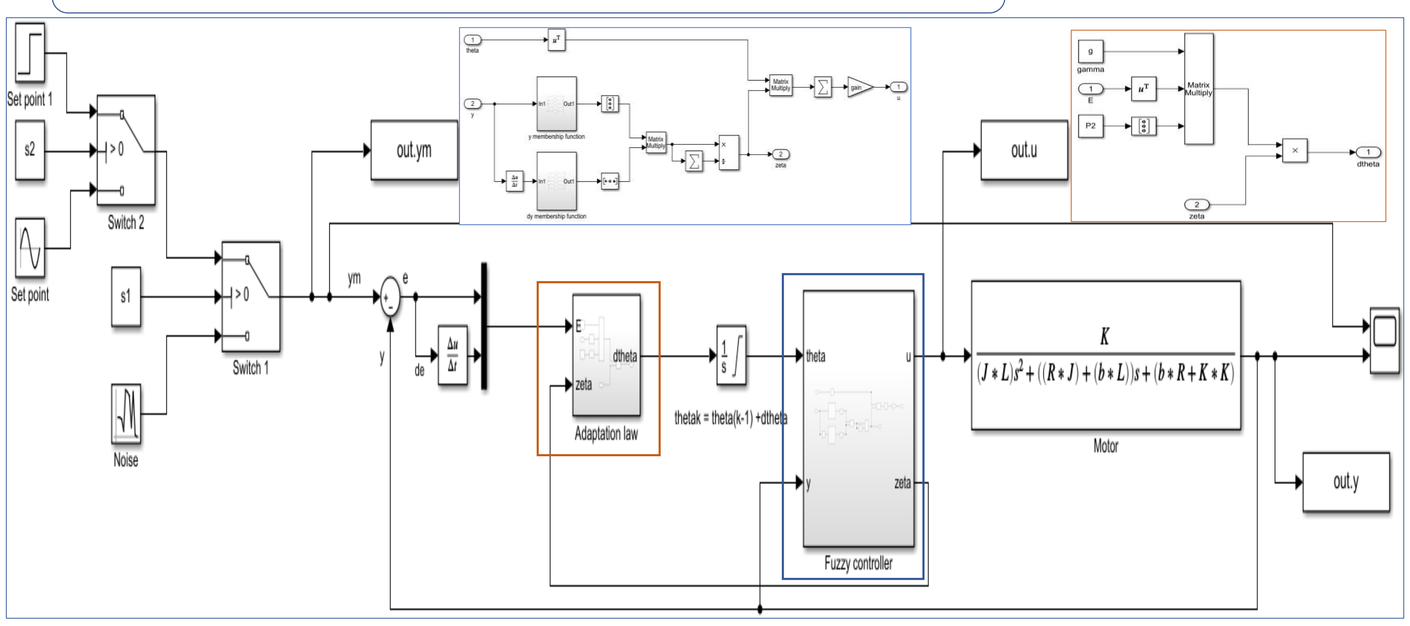

Figure 6. Simulink block diagram in Matlab

App designer to create user interface

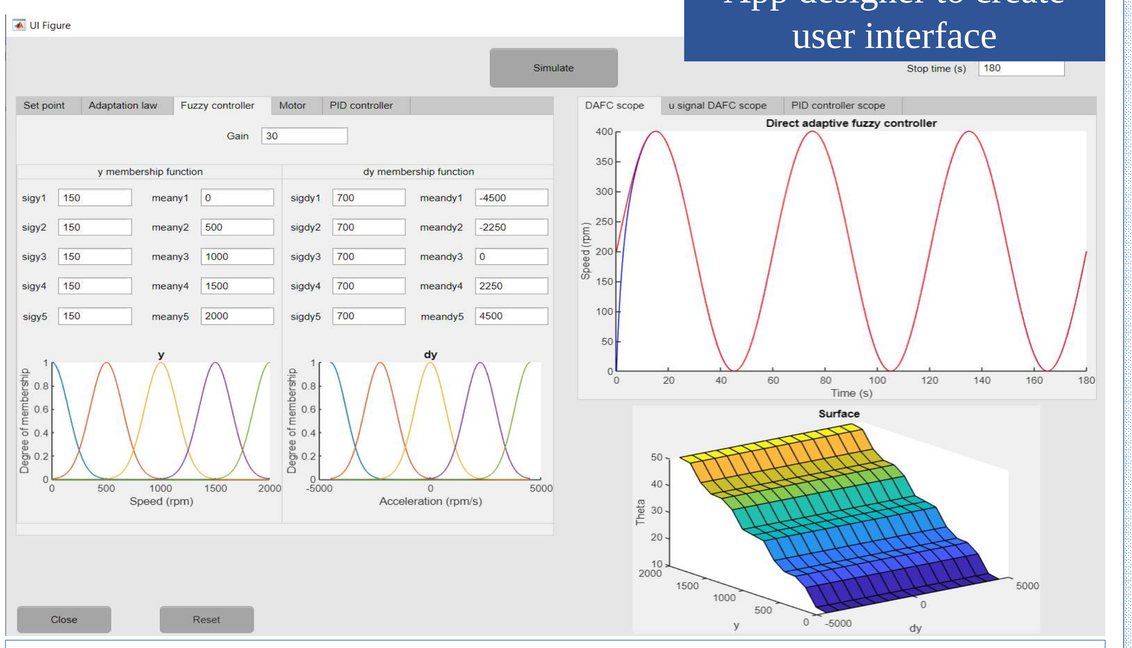

Figure 7. Creating App designer

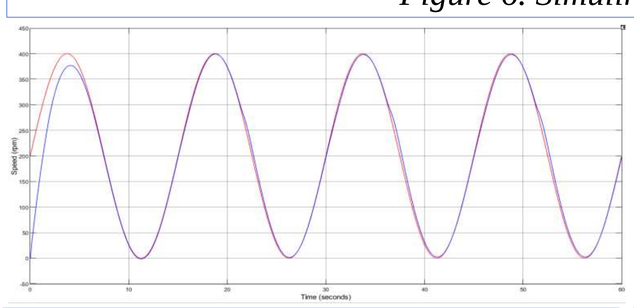

Figure 8. Speed signal of DAF controller when changing input parameters

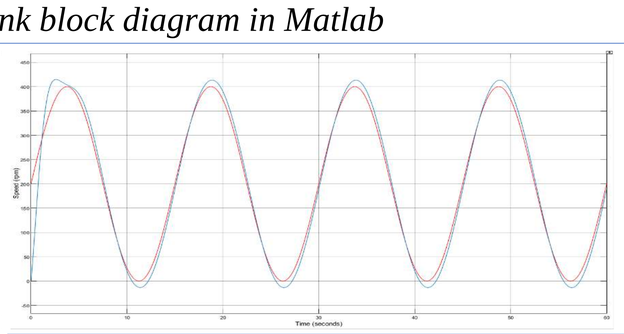

Figure 9. Speed signal of PID controller when changing input parameters

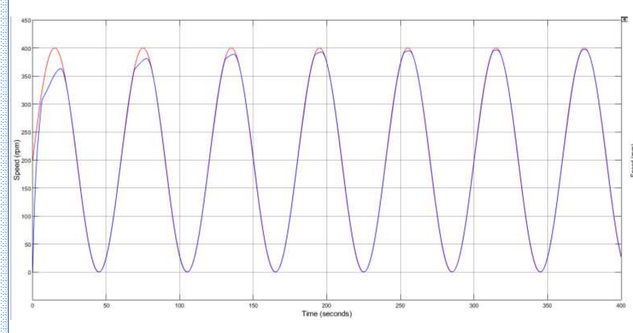

Figure 10. Speed signal of DAF controller when chaging motor's parameters

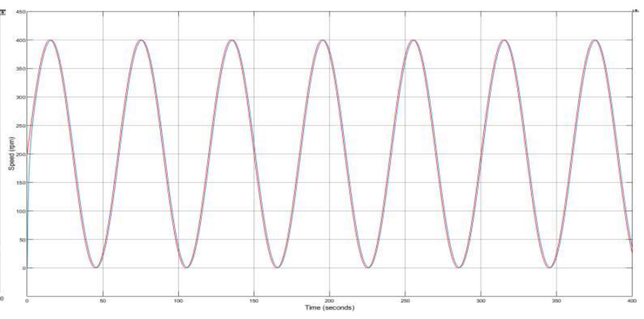

Figure 11. Speed signal of PID controller when changing motor's parameters

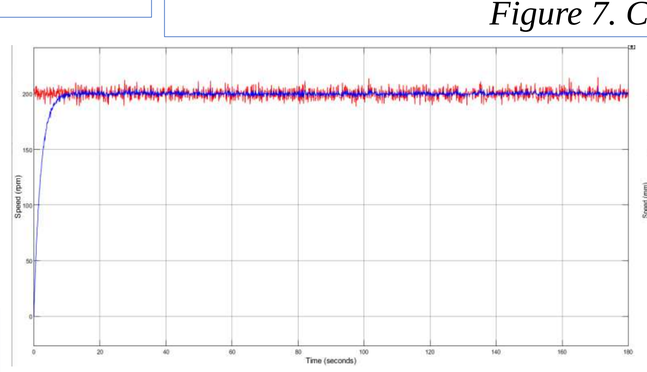

Figure 12. Speed signal of DAF controller when adding noise

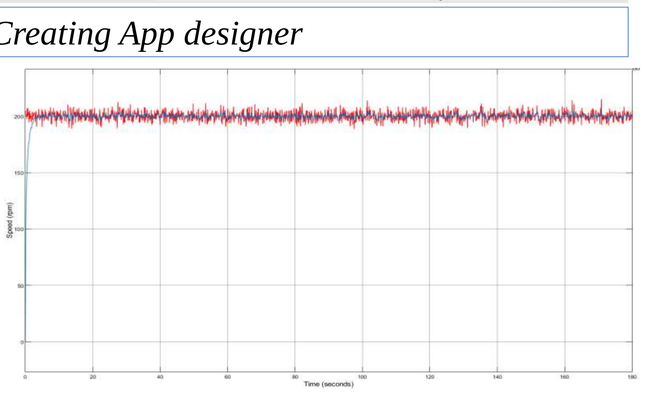

Figure 13. Speed signal of PID controller when adding noise

CONCLUSION

- Satisfied:
  - ✓ Good control quality
  - ✓ The structure is simple
  - ✓ The system achieves high stability
- Unsatisfied:
  - ✓ Has not yet solved the optimal control problem
  - ✓ The excess quality sometimes unsatisfactory
  - ✓ It is necessary to have a solution to adjust the update coefficient