**VIRTUAL LOGBOOK**

**RL EXPERIMENT – (6 MARCH – 2 APRIL)**

**17TH MARCH – 14:40 pm:**

* First RL run: LABVIEW PARAMETERS:

N\_signals = 26

Input Rate = 100Hz

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = PPO('MlpPolicy',

env,

verbose=1,

tensorboard\_log=f"{LOGS\_ROOT}/IPD\_OL/PPO",

n\_steps=500,

batch\_size=64,

gae\_lambda=0.95,

gamma=0.99,

n\_epochs=20,

ent\_coef=0.0,

learning\_rate=2.5e-4,

clip\_range=0.2,

device="cpu"

)

TIMESTEPS=500000

TOTAL\_EPISODES=100

MAX\_EPISODE\_STEPS=5000

NN SIZE: pi=[512,512], vf=[512,512]

COMMENTS: -EPISODE time too short

-no package received by PYTHON

-vibration when resetting flaps

-INTERACTION IS RUNNING!!!!

**19TH MARCH – 11:40 pm:**

* First RL run with TQC: LABVIEW PARAMETERS:

N\_signals = 26

Input Rate = 50 Hz (to match TQC update frequency)

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = TQC('MlpPolicy',

env,

verbose=1,

learning\_rate=1e-4,

learning\_starts=0,

batch\_size=64,

tau=5e-3

gamma=0.99,

train\_freq=1,

target\_update\_interval=1,

gradient\_steps=1,

buffer\_size=int(10e2)

optimize\_memory\_usage=False,

ent\_coef=auto\_0.01,

target\_entropy=auto,

)

TIMESTEPS=500000

TOTAL\_EPISODES=100

MAX\_EPISODE\_STEPS=256

NN SIZE: pi=[64,64], qf=[64,64]

COMMENTS: -drag over episodes slightly decreases from 5 to 4.59, still higher than baseline

-PYTHON got stuck after ~15 mins

-flaps tend to remain stable at maximum voltage/power to reduce drag.

-exploration can be observed during training (random vs. stable values, voltage switching from -1 to 1V)

-reward: POWER

-STUDY ACTION NOISE from common.noise (may have a potential benefit)

-for next test: change top\_quantiles\_to\_drop\_per\_net = 5

**19TH MARCH – 13:00 pm:**

* Second RL run with TQC: LABVIEW PARAMETERS:

N\_signals = 26

Input Rate = 50 Hz (to match TQC update frequency)

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = TQC('MlpPolicy',

env,

verbose=1,

learning\_rate=1e-4,

learning\_starts=0,

batch\_size=64,

tau=5e-3

gamma=0.99,

train\_freq=1,

target\_update\_interval=1,

gradient\_steps=1,

buffer\_size=int(10e2)

optimize\_memory\_usage=False,

ent\_coef=auto\_0.01,

target\_entropy=auto,

top\_quantiles\_to\_drop\_per\_net = 5

)

TIMESTEPS=500000

TOTAL\_EPISODES=100

MAX\_EPISODE\_STEPS=256

NN SIZE: pi=[64,64], qf=[64,64]

COMMENTS: -drag as low as 4.50

-the flaps stabilise for few episodes, than restart exploration.

-run for 200 episodes, not crashed

-plot the results on Monday!!!!

-evaluate the target!!!

**20TH MARCH – 10:45 am:**

* Third RL run with TQC: LABVIEW PARAMETERS:

N\_signals = 26

Input Rate = 50 Hz (to match TQC update frequency)

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = TQC('MlpPolicy',

env,

verbose=1,

learning\_rate=1e-4,

learning\_starts=0,

batch\_size=128,

tau=5e-3

gamma=0.99,

train\_freq=1,

target\_update\_interval=1,

gradient\_steps=1,

buffer\_size=int(10e4)

optimize\_memory\_usage=False,

ent\_coef=auto\_0.1,

target\_entropy=auto,

top\_quantiles\_to\_drop\_per\_net = 5

)

MAX\_EPISODE\_STEPS=512

NN SIZE: pi=[64,64], qf=[64,64]

COMMENTS: -ran until 303 episodes (then crashed)

-clear convergence, but at higher values than baseline drag

-

**20TH MARCH – 10:45 am:**

* Third RL run with TQC: LABVIEW PARAMETERS:

N\_signals = 26

Input Rate = 50 Hz (to match TQC update frequency)

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = TQC('MlpPolicy',

env,

verbose=1,

learning\_rate=2.5e-4,

learning\_starts=0,

batch\_size=128,

tau=5e-3

gamma=0.99,

train\_freq=1,

target\_update\_interval=1,

gradient\_steps=1,

buffer\_size=int(10e4)

optimize\_memory\_usage=False,

ent\_coef=auto\_0.1,

target\_entropy=auto,

top\_quantiles\_to\_drop\_per\_net = 5

)

MAX\_EPISODE\_STEPS=1024

NN SIZE: pi=[64,64], qf=[64,64]

COMMENTS: …

-moved to Chengwei’s computer

-tried to increase train\_freq, but keeps having longer steps every 5 steps.

-the infer works perfectly at 100Hz

**22st MARCH – 15:00 pm: (BEST ONE SO FAR) – Run4 for RT/ESP, 15\_00 for reward, Run6 for restart.**

First successful PPO run -stuck after ~70 mins: LABVIEW PARAMETERS:

N\_signals = 22

Input Rate = 50Hz

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = PPO('MlpPolicy',

env,

verbose=1,

tensorboard\_log=f"{LOGS\_ROOT}/IPD\_OL/PPO",

n\_steps=1024,

batch\_size=64,

gae\_lambda=0.95,

gamma=0.99,

n\_epochs=20,

ent\_coef=0.0,

learning\_rate=2.5e-4,

clip\_range=0.2,

device="cpu"

)

TIMESTEPS=1500000

TOTAL\_EPISODES=1500

MAX\_EPISODE\_STEPS=1024

NN SIZE: pi=[512,512], vf=[512,512]

COMMENTS: -negative angles/voltages preferred (makes sense, as it tries to reduce converge the flow instead of diverging it.

-got stuck after 196 episodes (Saved in PPO\_2)

-at 5:30 pm, restarted with the last model loaded, ran another …. Episodes -> the baseline drag is now changed, hence a drop in drag is observed when starting the new learning (Drag=4.336)

- first run managed to reduce drag, but not below the newly-found baseline drag (the first run had as baseline drag the old value D=4.48 from 20th March).

-observed an almost-sinusoidal action evolution, PPO is not “lazy” as TQC, prefers to explore and keep the voltage close to 0.

**22nd MARCH – 14:30 pm: TQC – Run4 for RT/ESP, 14\_30 for reward**

TQC -stuck after ~45 mins, restart for 45 mins: LABVIEW PARAMETERS:

N\_signals = 22

Input Rate = 50Hz

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

model = TQC('MlpPolicy',

env,

verbose=1,

learning\_rate=2.5e-4,

learning\_starts=0,

batch\_size=128,

tau=5e-3

gamma=0.99,

train\_freq=1,

target\_update\_interval=1,

gradient\_steps=1,

buffer\_size=int(10e5)

optimize\_memory\_usage=False,

ent\_coef=auto\_0.1,

target\_entropy=auto,

top\_quantiles\_to\_drop\_per\_net = 2 )

MAX\_EPISODE\_STEPS=512

NN SIZE: pi=[64,64], qf=[64,64]

COMMENTS: -not satisfactory, didn’t show any convergence and decided to drop TQC for the moment

**22nd MARCH – 17:30 pm: RNN\_PPO – Run5 for RT/ESP, 17\_30 for reward**

PPO -stuck after…: LABVIEW PARAMETERS:

N\_signals = 22

Input Rate = 50Hz

Acq time = 100000 s

NumofWarmupIters = 500

Size fifo = 500

Period NCL = 1000 ms

Timeout FIFO Read = 100

Size Sent Array = 100

PYTHON PARAMETERS:

model = RecurrentPPO('MlpLstmPolicy',

env,

verbose=1,

tensorboard\_log=f"{LOGS\_ROOT}/IPD\_OL/PPO",

n\_steps=512,

batch\_size=64,

gae\_lambda=0.95,

gamma=0.99,

n\_epochs=10,

ent\_coef=0.0,

learning\_rate=2.5e-4,

clip\_range=0.2,

device="cpu"

)

TIMESTEPS=1500000

TOTAL\_EPISODES=1500

MAX\_EPISODE\_STEPS=1024

NN SIZE: pi=[512], vf=[512]

N\_lstm\_layers=1

Lstm\_hidden\_size=64

COMMENTS: - updating time after each episode -> updated n\_epochs, n\_steps and NN SIZE to reduce the updating time of NNs <5.0s, as the UPD will be stopped after 5 s

-ran for ~3 hours, restarted 3 times, showed a converging trend and decreased lower than baseflow before and after the training

-however, base flow is not accurate enough and model is not aligned: on Friday, realigned based on pdf and COP plots.

-evaluation showed very small amplitude actions around an equilibrium point of low drag, may need dynamics to be introduced in the model.

-overall, good performance in terms of reducing the drag and avoiding random actions, but still not a proper reduction in drag.

**23rd MARCH – morning**

**-tests to realign the model and observe bistability in the flow**

**-CAD model finished and cut**

**-shifted to Linux and GPU, runs will be performed on Monday**

**-Chengwei: what else have you tried in the evening?**