

Robotics Engineering Project (LOTI.05.032)



Self - Balancing Robit
MARCH SPRINT REPORT

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01-04-2022

Sprint backlog
4 cards

TUTORIALS

REFERENCE DESIGNS

FIRMWARE

Firmware v 0.0.1 [3hrs]

Apr 1

2/5

4

ECAD

TUTORIALS

Altium tutorials. [3hrs]

Apr 1

2/6

5

TUTORIALS

REFERENCE DESIGNS

Reference EE Designs Study. [3hrs]

Apr 1

3/3

5

+ Add a card

Doing
4 cards

4 / 4

FAB

Internal mechanics FAB & ASY [3hrs]

Apr 1

1

7/11

5

TUTORIALS

REFERENCE DESIGNS

FIRMWARE

FAB

1st iteration w/ Nucleo & Steppers [3hrs]

Apr 1

1

6/12

5

REFERENCE DESIGNS

FIRMWARE

1st iteration: Digital PID Controller [3hrs]

Apr 1

3/7

5

+ Add a card

Feedback
1 card

1 / 3

+ Add a card

Testing
1 card

+ Add a card

Done 🐛
12 cards

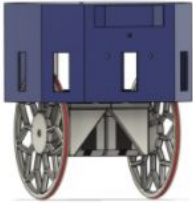
Understand fundamental motion dynamics involved. [5hrs]

Apr 1

4

1

5



REFERENCE DESIGNS

CAD

model (preliminary) motor mounts & wheels [3hrs]


Apr 1

3

1

3/3

3



* **Progress on all of the cards of the sprint** ⇒ ~75% (worked on cards in backlog + doing [checklists!])

** **time spent** ⇒ 48 hrs (not incl meetings)

** **number of cards you started with** ⇒ 20

** **number of cards currently in each column** ⇒ backlog: 4 | doing: 4 | done: 12

** **number of cards that matched the original time estimate, overspent, needed less time than initially planned**

met original time estimate: 1

overspent: 19

needed less time than planned: 0

* **Two of your best cards - where you felt that you set out to do something and it got done in reasonable time**

> *understand self-balancing robot design tips & general requirements*

> *model (preliminary) motor mounts & wheels*

* **Two of your worst cards - which were hard to or impossible to complete with explanation to why was that**

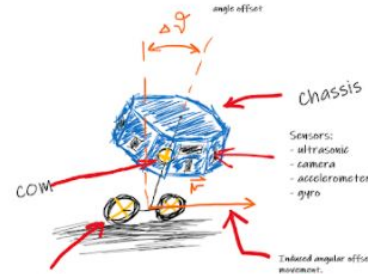
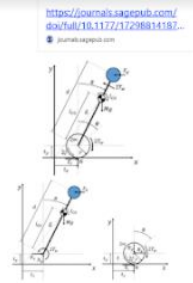
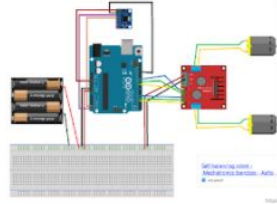
> *Collect & measure all parts ⇒ insufficient upfront understanding of infrastructure (part procurement protocol)*

> *model (preliminary) main truss structure ⇒ added too many features to model, should have split card up*

* **You are free to add more information, aim to be done in ~6 minutes to leave room for discussion**

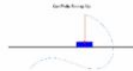
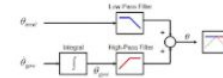
summary: overspent time doing all the cards,

Research



- Wheels:
- good friction
 - support pressure, fast corrections
 - rapid direction changes
 - low slip rate

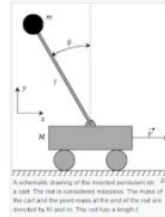
"That, because of the characteristics of the self-balancing robot, the robot has to move its wheels and tilt its body to keep balance. It cannot stay in one place while responding to an external force. It is obvious that the longer the distance, the more the robot moves."



EQUATIONS OF MOTION
[INVERTED PENDULUM]

Stationary Point

- angular velocity $\dot{\theta} = 0$
- angular displacement $\theta = 0$ ($\theta = 0 \Rightarrow \ddot{\theta} = 0$)
- \Rightarrow no friction
- \Rightarrow no resistance to movement
- \Rightarrow mass m
- \Rightarrow 2D movement



$$\ddot{\theta} = \frac{g}{l} \sin \theta$$

the inv. pend. will accelerate away from the vertical... This acceleration is inversely proportional to the distance between the wheels and the pend. mass...

THE TALLER THE PENDULUM, THE SLOWER IT FALLS!

tons of example projects

key stuff i learned:
model characteristics, model behaviour,
key variables, example PID setups,
example movement PID error inducers,
other self-balancing implementations

OG chassis

wheels

CAD

truss

motor brackets

wheels wheel "wire-tires"

brackets

part models

truss mounting

1st printouts

reaction wheel / flywheel

FAB

simplified, reinforced motor brackets

Iterative design

firmware prototype

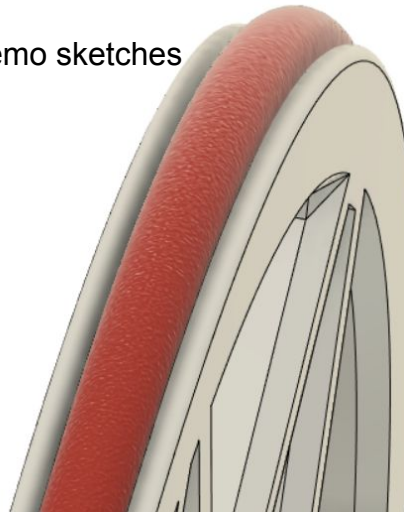
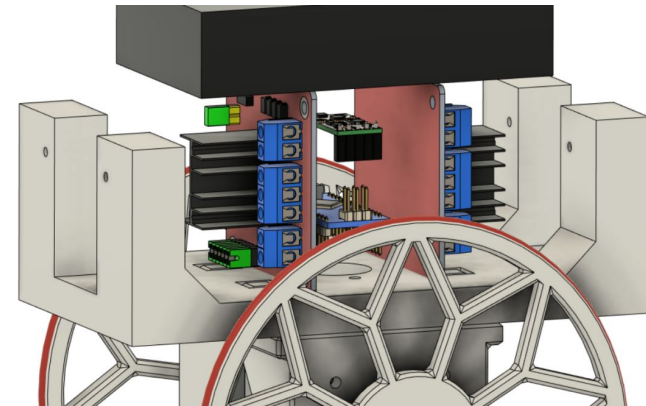
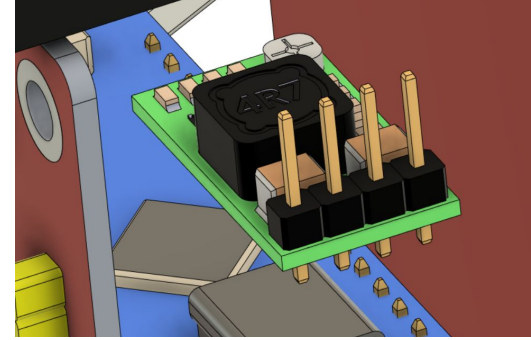
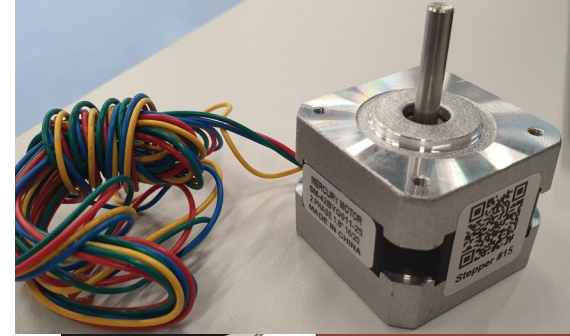
reinforced truss

collected all key components

firmware playground

arduino nano refresh

stepper demo sketches



what's next?

IMU demo sketch

firmware v1.0

remote control?

IoT?

battery mount dampeners

working reaction wheel / flywheel
or another form of self-starting

IMU mount dampeners

working demo

ECAD 101

