SentiBots– smart centimeter-sized robots

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INTRODUCTION

This project aims to achieve a hardware and software optimized swarm flight platform that allows for swarm developers to have an easier time developing and using swarm platforms in real life applications.

HARDWARE OPTIMISATION

SIZE

The innovative small bean shaped shell design combined with the single motor propulsion system allows for the SentiBot to retain the form factor of a small drone. By enabling the SentiBot to remain small we allow for it to fly in close proximity to one another without having aerodynamic interactions and without protruding props from the frame, we allow for them to fly in closer proximity and collaborate much better. In comparison to the similar projects which use a single motor and 4 props like the Spherical Flying Vehicle, this robot is able the achieve this size due to its Electric Ducted Fan motor which generates a lot more thrust per space it occupies allows us to implement it in a smaller form factor.

SCALABILITY

The scalability of a system refers to the ability of the system to be able to scale up in terms of cost efficiency and in terms of manufacturability. Using a single motor, this robot has an advantage over a quadcopter in which the cost is up to 25% lesser due to the motors and ESC's. This allows it to be scalable. The fact that the custom frame design is completely 3D printed also allows for scalability in terms of manufacturing.

MODULARITY

The system can be easily added on to due to the Edison board and the ATMEGA 328 which allows for sensor expandability which is important for a platform like this as it offers the ability for each robot to multitask with different sensors. The SentiBot can easily be hacked into and more sensors can be added or modifications can be made to the power system or intelligence electronics.

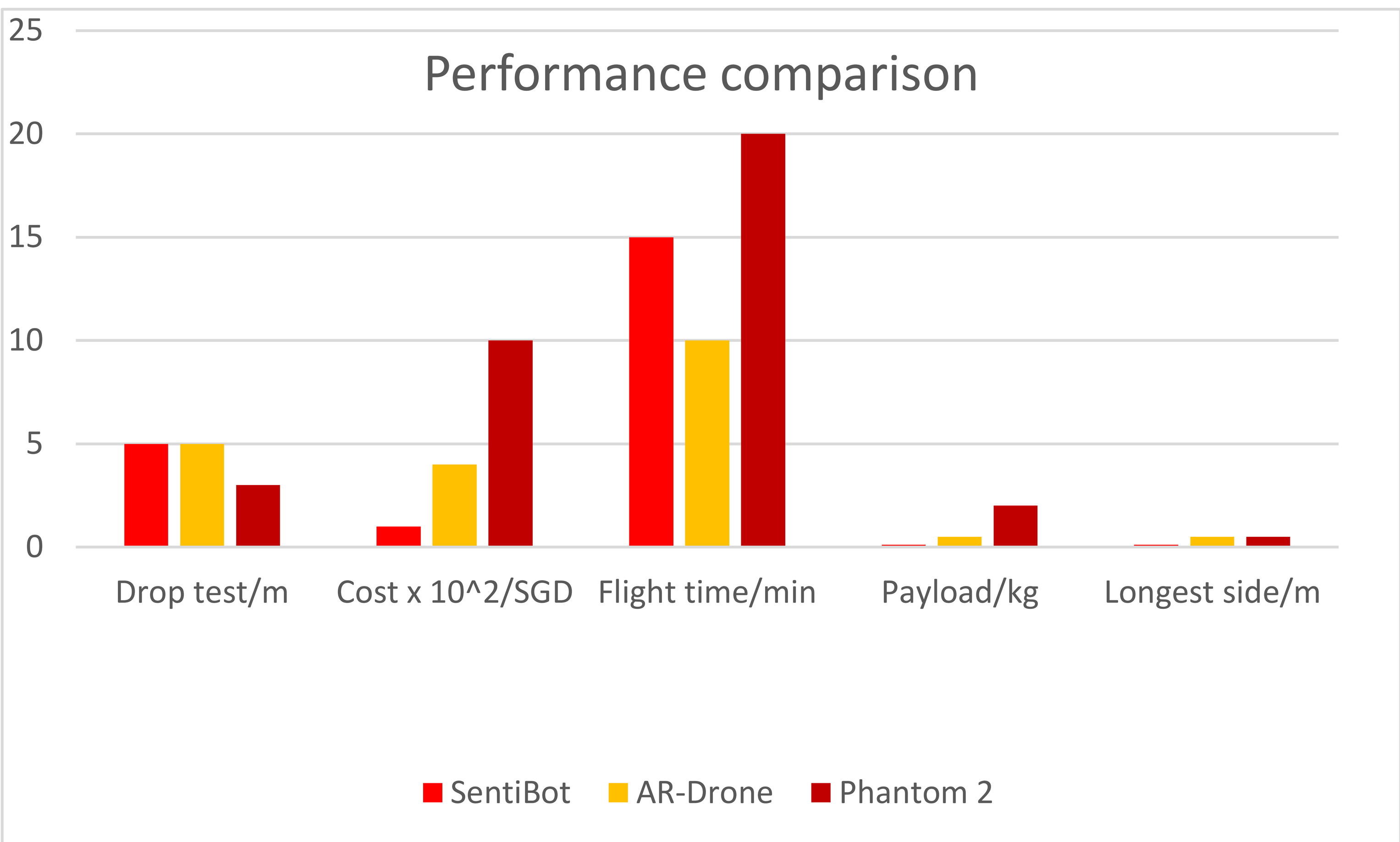

Figure 2: Performance graph*

Figure 1: Picture of the SentiBot *

SPECIFICATIONS:

Dimensions: 100mm x 100mm x 250mm

Flight time: 10 - 15min

Motor thrust: 450g

Payload weight: 100g

Top speed: 20km/h

SOFTWARE OPTIMISATION

ALGORITHMS

The bot is stabilised by a PID Loop in the Arduino. The vison system uses the mono front facing camera and feeds it to the Edison to do **S**imultaneous **L**ocalisation **A**nd **M**apping (**SLAM**) to navigate and create a 3D map . The 3D map is only shared between the swarm to minimise the amount of information needed to be communicated.

COMPUTER POOLING

The computer pooling model optimizes the swarm performance by allowing them to act as a supercomputer. This is done by making each bot a node in a system that forms the basis of a supercomputer which is connected via Wi-Fi. This pooled computing power therefore allows the swarm to make complex decision as a whole. This allows the swarm to think as a whole where the sensor data can be pooled to allow the swarm to survive as a whole.

RESULTS AND CONCLUSION

RESULTS

The results of initial testing were quite positive. The SentiBot is able to remain in constant flight even without any PID stabilization algorithms and remain in relatively oscillation free flight when there is PID stabilization.

CONCLUSION

The SentiBot project set out to bring a solution to swarm researchers worldwide. The results seem to indicate that we have made considerable progress towards that goal but there is further testing and tweaking to be carried out in the following years. The results also seem to indicate that the hardware side of swarm research is just as important as the software side as the hardware optimization solved many problems with current flying swarms. We hope that this report can act as a kick starter for hardware development in the field swarm research.

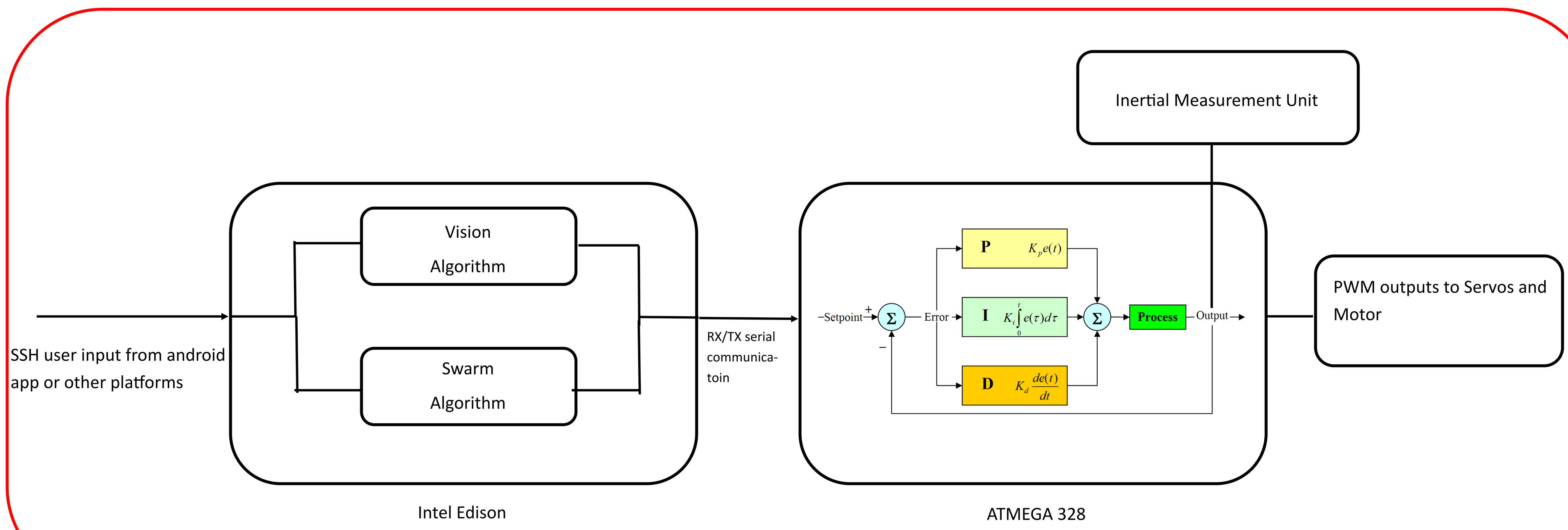

Figure 3: Software Flowchart*

REFERENCES

OSU UAS. (2012). *UFRO.* Available: https://unmanned.okstate.edu/ufro Last accessed 29/12/2015.

Miwa Suzuki. (2011). *Japanese inventor develops flying sphere drone.*
Available: http://phys.org/news/2011-08-japanese-inventor-sphere-drone.html. Last accessed 12/11/2015.

Christopher M. Cianci, Xavier Raemy, Jim Pugh, Alcherio Martinoli. (2007). Communication in a Swarm of Miniature Robots: The e-Puck as an Educational Tool for Swarm Robotics. *SpringerLink*. 4433 (1), pp 103-115.

Gerardo Beni. (2005). From Swarm Intelligence to Swarm Robotics.*SpringerLink*. 3342 (1), pp 1-9.

*All images were self generated except for the PID loop of the flowchart (https://en.wikipedia.org/wiki/File:PID-feedback-loop-v1.png)