

**MSc Project**

**-Robust Flying Sphere-**

With reference to currently available flying platforms, it is very difficult to navigate an autonomous vehicle in any close quarter environments. In order to do so would entail integrating complex collision avoidance systems. In very dense and unstructured environments even the most costly avoidance systems might not solve the problem. Another approach to solving this problem is to make a platform robust enough that it can handle the impact of flying into or bumping obstacles in its path.

The Japanese Ministry of Defence developed what they have called the flying sphere1. Built using only *off the shelf* components, they have developed such a device that can withstand collisions with its environment. Their platform has the ability to do a vertical take-off but also by using its flaps it can control the airflow and fly like a single rotor plane, thus dropping power consumption and improving flight time. During its horizontal flight the flaps also act as wings, thus providing the necessary lift to keep the vehicle flying.

Unfortunately this flying sphere has only been able to obtain 8 minutes worth of untethered flight time and with a negligible pay load.

A platform that can navigate these dense complex areas is a very powerful tool for mapping out areas that have been previously inaccessible. Of course for the vehicle to be useful it needs to be able to fly stably and unmanned for an extended period of time, thus enabling it to obtain all the necessary information.

For the reasons mentioned above I propose to begin the development of a vehicle with similar abilities, but with characteristics more suitable to longer term survey missions. The base platform will potentially be based on the flying sphere although research into understanding the most robust and efficient mechanical structure will be conducted. The lift power of the device will also need to be designed so that it can accept a payload of standard mapping sensors, assumed at a maximum of around 1kgs. I will be designing the electronics on board to ensure the lowest cost and power consumption possible. Power consumption as well as battery design will be a huge consideration in the project, to ensure that the device can reach the quota of at least half an hour of flight time. Once the electronics and mechanical design have been embedded together, research into the control algorithms will be done to ensure that it can fly stably and be controlled wirelessly. In the control algorithms the transition from vertical flight to horizontal flight will also be considered and implemented.

Once the above concept has been proven the device can be used by both the Mechatronics group here at the CSIR, as well as the Electronic Systems Laboratory at the University of Stellenbosch. The platform will allow both units to conduct mapping of previously inaccessible or hard to reach environments.

The Mechatronics unit at the CSIR has been given the mandate for automation and mining innovations. The above platform will be a very powerful tool for conducting mapping deep into mines and mine shafts, where currently miners are risking their lives in extremely dangerous conditions. Additionally to the mapping, the device can potentially carry a payload of sensors designed to detect toxins in the air and give early warning to miners before they are even exposed to deadly gases and possibly even prevent unwanted explosions caused by volatile fumes.

Another option is the use by South Africans Police Service (SAPS), currently our group is involved in a CSIR flagship project involving SAPS where such a device could be used to assist in hostage situations; as well as search and rescue missions to navigate into treacherous areas.

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CSIR

Material Science and Manufacturing

Mechatronics and Micromanufacturing