We would like to explore different ways of controlling a quadcopter UAV (Unmanned Aerial Vehicle), and to perform a comparative study of which input method is most appropriate in a given scenario. Can usability of quadcopter UAVs be improved by choosing appropriate control methods for a given scenario? That is what we aim to find out.

What are some of these scenarios? Giordano, Deusch, Lächele and Bülthoff gives us a few examples: “Use of Unmanned Aerial Vehicles (UAVs) to remotely perform tasks is an active research field. The possible applications range from dealing with hazardous environments, to search and rescue operations, and to surveillance and inspection of sites” [1]. Eisenbeiss, Lambers and Sauerbier describes “…a new system for the recording of archaeological sites based on an autonomous UAV” using “…a model helicopter carrying a CMOS camera to acquire a series of vertical aerial images for a photogrammetric recording and 3D modeling of the site and the surrounding terrain” [2]. The norwegian company Prox Dynamics has created a small helicopter UAV (Black Hornet) weighing only 16 grams, which is being used for personal reconnaissance in Afghanistan [3]. These are current, real-world applications, but only the imagination limits possible usage areas. What about filming action shots or other otherwise difficult shots for movies, maybe by using a tag-object to keep the camera focused on a certain (moving) point? Or perhaps as a distribution method of pest-deterrent over a wheat field? Autonomous surveillance bots? The possibilities are aplenty.

Which input methods are there for controlling a UAV? Input methods range from real-time interactive methods to completely autonomous control, using e.g. precalculated paths and/or assisted by AI. We will be focusing on real-time interactive control methods, using e.g. a joystick, accelerometer, voice commands, motion-tracking or a touchscreen controller.

Various 3D interaction techniques has been studied to interact with virtual objects in Virtual Reality. Although we will look at controlling a physical device instead of a virtual object some of the same interaction devices and techniques applies. Berard et al., (2009) compared 3 3D input devices against the mouse in positioning an object in 3D space without constraints. The same interaction methods could be used to position the drone. The devices tested in addition to the mouse was a depth-slide. A normal mouse in the main hand and a slider mapped to the depth axis controlled by the other hand. The second devices was the SpaceNavigator, an elastic 6 DoF mouse. The third was a free-space device that can be moved freely in space.

The particular brand of UAV we will be using for this project is an Parrot AR Drone 2.0 (http://ardrone2.parrot.com/). It has a frontal 720p camera with a 92” diagonal lens, capable of streaming over Wi-Fi in 15 fps (frames per second) or saving the footage directly in 30 fps through Wi-Fi or to a memory stick. It is built for commercial use, thus it is sturdy and user-friendly. It has a 3 axis gyroscope, accelerometer and magnetometer to help aid in stability and navigation, as well as a 60 fps QVGA camera for ground speed measurement, which aids in landing as well as keeping the drone from drifting.
The AR Drone 2.0 was built mostly with the hobbyist in mind, but has been employed in many research projects, including some by NASA (http://ardrone.parrot.com/best-of-user-videos/categories/nasa/). As its name implies, it's intended use was with Augmented Reality applications (games). There are already iOS and Android applications to control the drone, using touchscreen analog sticks and an accelerometer. There is also an SDK available which we will use for application development, but with a slightly restrictive license; “…PARROT expressly forbids the Developer:...To use the PARROT SDK and APIs to develop an application other than a Game for AR.Drone” [4]. Game as a term is very broad, and we feel confident that our application can be classified as a game.

For the purpose of this project, an undertaking such as making an AR game would be too complicated and time-consuming. Instead we will be focusing on different methods of controlling the AR drone UAV, and even that can get complicated quickly. We will thus initially limit the research span to 2 input methods and 2 scenarios. This project can then serve as a starting point for further research into the topic. If the time-frame allows it, we will expand to further input methods or more scenarios.

Who will find this interesting?
This project might be of interest to anyone involved in the particular fields of which our scenarios will represent, as well as those who would like to further this study.

Who will be involved?
In addition to ourselves, we will find people to test each scenario. Test-users might need some background knowledge and/or practice to more closely fit the personas of those in the scenarios.

Where and when
The scenarios we would like to test would mainly be outdoors. However to get comparable results between test subjects we wish to eliminate external factors like wind and perform the tests indoors. We would need a fairly big room to set up obstacle courses in. Suggestions so far have been the gym at HIOF, or the VR-room at IFE.

How
We will create an application which allows different input methods for control. We will then create obstacle courses representing each scenario, document the results and discuss them. Each scenario will have a set of parameters which will determine the score of a given input method. E.g., the speed of execution or the accuracy of certain maneuvers.

Each UAV comes with it’s own set of strengths and weaknesses. Ie, the AR Drone is pretty big and noisy, which does not lend itself well to stealth reconnaissance as well as a Black Hornet, while other quadcopters might not have the user-friendliness and stability of the AR drone. Thus, for the results to have a meaning for UAVs in general, it is assumed that the UAV shares the relevant properties of the AR
drone.

We will need to have users test each input method in each given scenario, which will certainly present a challenge. The battery life of the AR Drone is only about 12 minutes during flight, while the recharge time is 90 minutes. We have asked for 2 batteries to alleviate the problem. We will also have to take steps to make sure the people involved does not gain knowledge/experience from previous tests which will skew the results of future tests and thus produce inaccuracies.

It is possible to break potential users into two groups; Those who uses the quadcopter frequently and those who only use it intermittently. The military is an example of one that might use drones frequently (e.g, for surveillance), while a real estate agent that uses it to make marketing material might only use it once in a while.

There are still things we need to figure out before we can get started;
- Which scenarios should we use?
- Which input methods should we use?
- Which platform(s) shall the application be made for?
- Where are we going to find testers for the scenarios?
- Set up a project plan so we can make sure we will get done in time.
- Figure out the specifics of how to do the tests.

References

3. http://www.tu.no/ingeniorbraqd/2012/10/26/norsk-uav-brukes-i-afghanistan