Chapter 4

Possible applications

4.1 Introduction

One of the aims of this project was the design of different applications for the multimodal interface. We have some tools, both Hardware and Software, like we could see in previous sections; and the idea is to use them for improve the Human-Machine interface, in that case the interface between the UAV or UAVs and their operator. The most applications only will be apply to UAVs but it is possible to use the station to control and monitor another type of autonomous vehicles.

In this point, it is very important the Situation Awareness (SA from now on) that is the perception of environmental elements within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. With a multimodal interface we are looking for an improvement of the SA, reducing the effects of the sensory lack inherent to the remote control; operator can be miles away the UAV and we need that this sensory lack does not blind us to control the UAV with guarantees.

In the station we have three touch screens (currently two) placed like we can see in the Figure 4.1, a camera above the central monitor, headphones and vibrators for the arms. With this elements we can use tools like Head Tracking (with the cam we can follow the face of the operator, it can be very useful) or 3D sound with our Headphones.

There are many possible applications to our system using the elements and tools described above. Then, we are going to see some of these possible applications

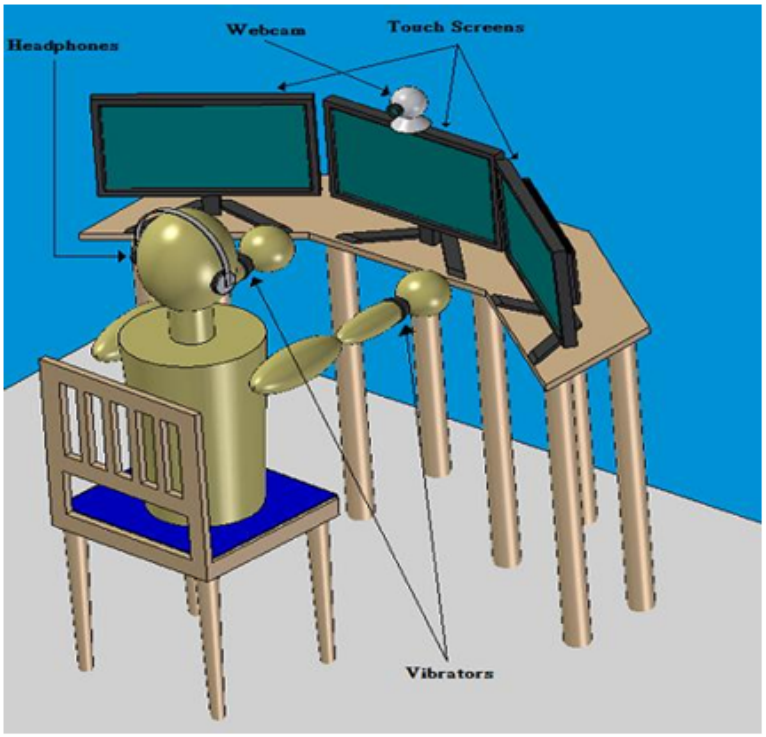

Figure 4.1: 3D representation of the station

4.2 Touch Screens: Visualization and processing of the information

The most obvious use for touchscreens in our system is visualization of the information and the ability to act accordingly. So, we can use our monitors to show the state of the UAV for example. If the UAV has cameras, we can see in the screens in different windows the images captured by these cameras. We would have many options like with the mousse or touching in one of the windows to expand the size of the window to see better the images of the selected camera.

There are many possibilities depending of the simultaneously controlled UAV. If we have only one UAV we can show with the three monitors more information about it, using the central screen to show the more critical information and the side screens to the less important information. On the other hand, if we have two or more UAV we can distribute them among the different screens or we could have different windows in the central screen and touching in them select an UAV and show the information about it (I think this is a good option if we have more than three UAV simultaneously or if we need more than a screen to see the info related to a UAV).

With the touchscreens would also be possible to implement a series of visual alarms and alerts to warn or inform the operator of the most important things that happen. Moreover we could implement possible actions in request to this alarms or alert allowing to the operator act accordingly, for this, the operator will need only touch different buttons on the screen.

4.3 Visual alarms (Touch Screens and Head Tracking)

We can use the properties of Head Tracking to improve our visual alarm system. Like we saw in preceding chapters, Head Tracking lets us know where the operator is looking at all times. When we have an alarm or warning is possible that the operator will be looking at another screen different which the alarm was triggered. In that moment Head Tracking detect that the user has not seen the alarm because he is looking at another screen, and we could generate a new visual alarm in the screen that the user is looking at, informing him that an alarm was triggered and in which monitor it happened. Once the operator look at the correct monitor (where the original alarm was triggered) will turn off the alarm on the other screen that Head Tracking did appear.

To understand it better lett's see this example with images:

1. Operator is looking at the left screen and an alarm appears on the right screen.

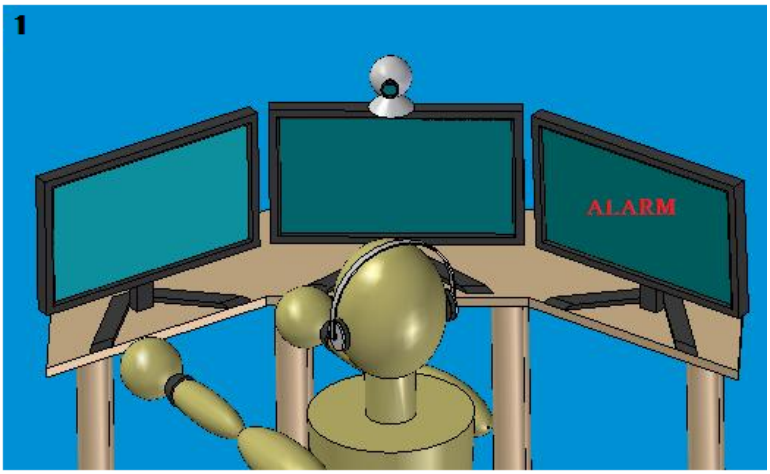

Figure 4.2: User looking at the left screen

2. When an alarm appears, our cam detects the position of the operator's head thanks to the Head-Tracking System. In this particular case, Head-Tracking System would inform us that the user is looking at the screen on the left.

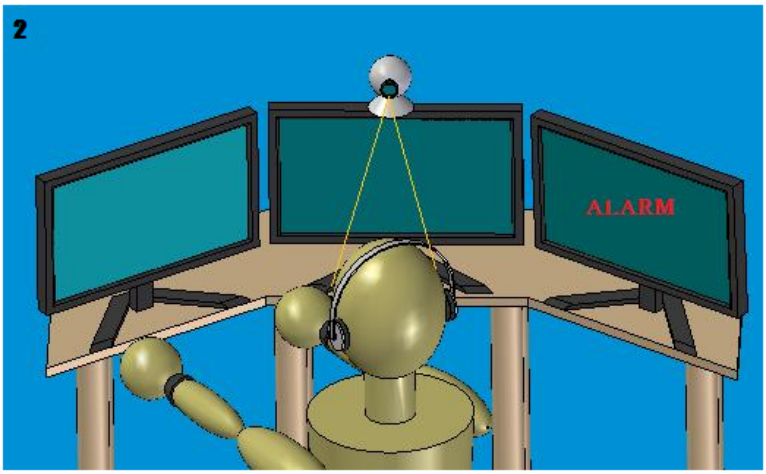

Figure 4.3: Head-Tracking system detects the position of the operator's head

3. In the example is looking at a different screen where the alarm appeared. Then, the system could make to appear a new warning on the screen that operator is looking at (left screen), indicating him that an alarm has been generating in another screen (right screen in the example).

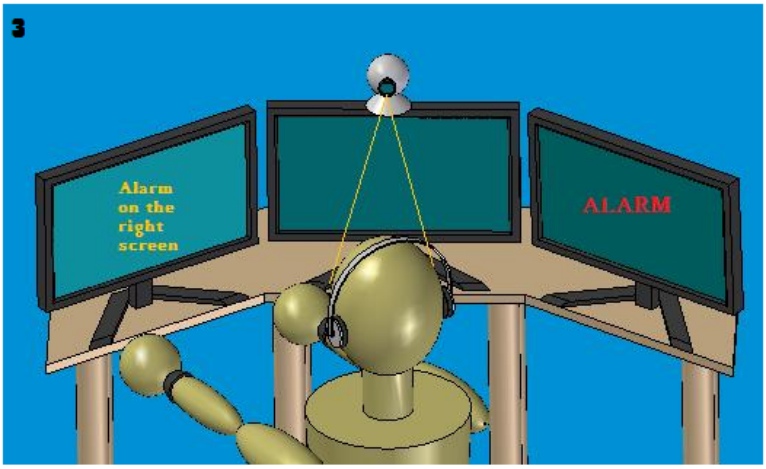

Figure 4.4: Warning appears in the screen that user is looking at

4. Finally, when operator is looking at the screen which the alarm was generated (right screen), the warning in the other screen (left screen) will disappear.

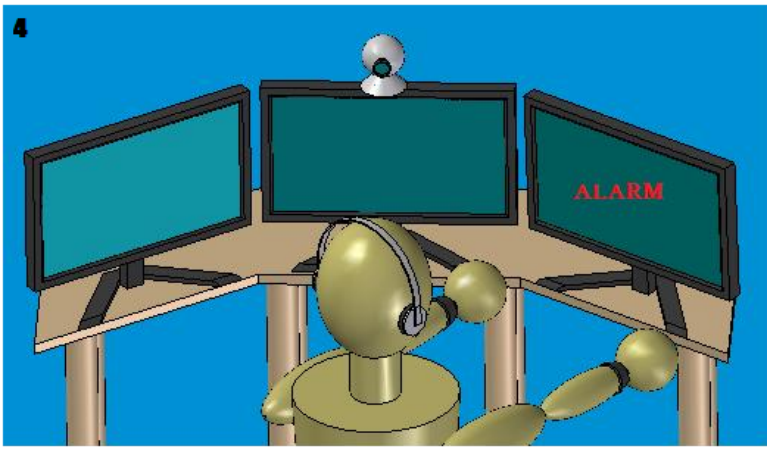

Figure 4.5: Operator is looking at right screen so alarm in the other screen disappears

4.4 Auditory alarms and warnings (Head Tracking and 3D sound)

It is possible that the operator does not see a visual alarm or warning. Because this alarm has appeared on a monitor that operator is not looking at or simply the operator is distracted. So we need to warn the operator that an alarm has occurred and if it is possible indicate where. Plus the way we saw in the previous section, we can achieve this using Head Tracking and 3D Sound together.

With Head Tracking we can know where the operator is looking at (like we saw in the previous paragraph), now using 3D Sound when an alarm or a warning happen, we can generate a sound (alarm sound) that seems to come from the monitor in which the alarm has occurred.

The example with images is very similar to the previous one, only step 3 is different (steps 1, 2 and 4 are the same in both cases, see Figures 4.2, 4.3 and 4.5) In this case this is step 3:

3. Now we are looking to a screen different which alarm appeared, with 3D sound and Head Tracking we will generate a sound (with the headphones) that seems to come from the monitor which the alarm was activated.

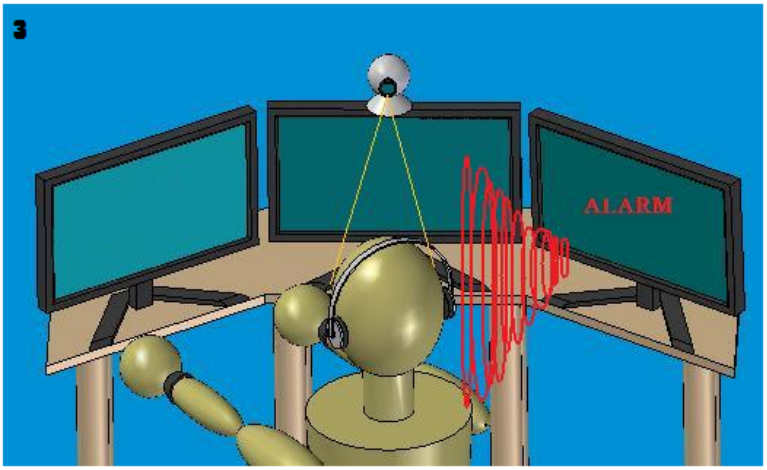

Figure 4.6: System generates an auditory warning from the screen

4.5 Vibrators for alarms

We could use vibrators to supplement the previous technology. It is possible than some alarms or warnings must be served as soon as possible, so we can use initially 3D Sound, but if you have a certain number of seconds and this alarm or warning does not attend, we can use the vibrators to advice the operator about this alarm and its importance.

For example, in our station we can have three screens, we would have two vibrators (one on each arm). If the alarm is on the right screen, the right-arm vibrator activates. If the alarm is on the left screen, the left-arm vibrator activates. And if the alarm is on the central screen both vibrators activate.

This application improves the performance of its predecessor. It is a very good support measure that will get all major alarm and alerts are always served. Combining this application with 3 we will have a very robust system.

4.6 Mobile cameras (Head Tracking)

It is very usual that autonomous vehicles like UAVs are incorporated one or more cameras. These cameras allow to the user to have a better idea about the state of the robot. If the camera (or cameras) in the UAV is mobile, we can use the tool Head Tracking to move this camera. Like I said before, we have windows in our touch screen with the images that the camera is capturing. Now we can select in the screen one of these cameras and increase its size. Now we could define a button in the screen that activates a new tool. This new tool let us to move the camera as the same way as our head; for example, if I turn my head to the right the camera in the UAV turn to the right; or if I look upwards the camera looks upwards. When we reach to desired position we must to deactivate this tool with a button (in another way it would be very uncomfortable).

It is possible that we can not arrive to the desired position with this tool, for example if we need that the camera shows that it is right behind. In this case we need activate the tool and rotate the camera as much as possible, deactivate it, and again activate it to rotate the camera even more. We can repeat this process as much as we need to reach any desired position.

Another potential way to reach camera positions placed behind the current view of the camera for example, is scaling the Head-Tracking System response. As we saw in the Head-Tracking chapter, head movements are expressed in three different angles: roll, pitch and yaw. When Head-Tracking system makes a measure, returns three values for each angle above. If we scale these angles we could reach any position in the space. For example, we need to turn the UAV camera more than 90ž to the right, in normal conditions is impossible to do that with Head-tracking, because we would need to look at the right and we could not look to the screen. But we can schedule the system so that a turn of user's head 20 degrees is one of 80 degrees in the camera of the UAV. And we only need to multiply by 4 the measurement of Head-tracking.

4.7 Mobile cameras (Touch Screens)

The same way as before, we want to move a mobile camera in the UAV to a desired position, but this time we are going to use the properties of our touch screens. We have some windows in our screen which show the images captured by different cameras again. We can select one of them (touching with our fingers or with the mousse on the screen) and that window grows in size. Now we can activate a new tool that let us move the camera, but in this case we only need to press with our finger in a point of the window and the camera will move to focus where we have indicated.

This method has certain advantages over its predecessor. First, it is more comfortable, you only need touch the screen to move the camera. Second, it is not necessary deactivated the tool when we reach to our aim which makes it much more comfortable and easy taking the camera to the desired position.

4.8 3D Sound

We can use the properties of the 3D sound if our UAV has different sound transmitters and receivers. We could simulate the sounds that receive the UAV with the operatort's headphones. Although it does not seem too useful but we could use our UAV like a sonar system and It would be useful when we fly low in low visibility conditions, like fog or heavy rain; in this way we would not be blind and we could detect dangerous obstacles to the UAV. With 3D Sound the operator could know where the obstacles are and act accordingly.

4.9 3D maps (Touch Screens)

It is possible take advantage of the features of the touch screens to explore 3D maps. Thanks to them we could go and create paths, for example we could define way points to our path or we could see if two path of two different UAV intersect (last property is very important in the prevention of collisions between UAVs).

To do that we need a new interface in our touch screen, we have a window with the 3D map and three bars that let us move in the three dimensions of the space (this bars use the touch properties and if we touch in them we move in one of the dimension of the space). These three bars will be placed on the left of our screen forming a classical coordinate system for a more intuitive use (like we can see in the Figure 4.7). But, it is not only necessary to move in each dimension, we need to look around. This could be solved by focusing the 3D map view where clicking with the finger in a similar way as we moved the camera in the fifth application (mobile cameras, touch screens).

In this video from youtube we can see something similar that we want: http://www.youtube.com/watch?v=0jkedcmdHcM

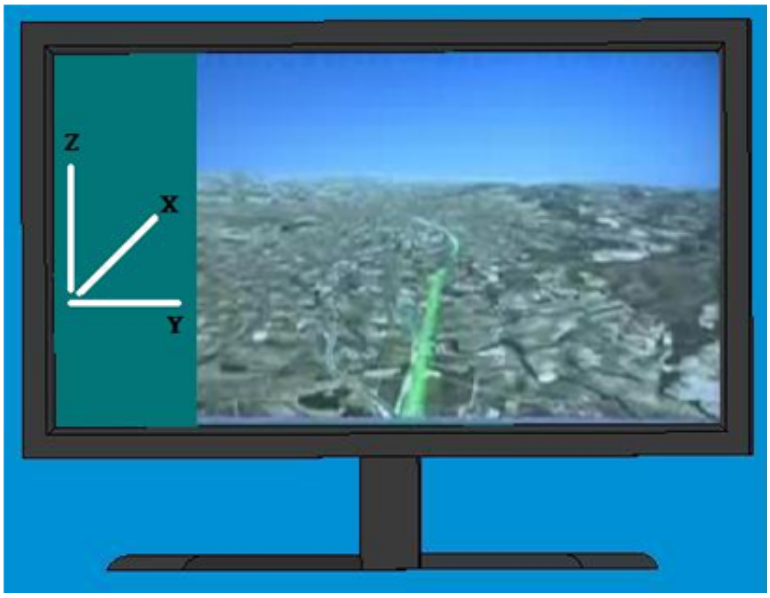

Figure 4.7: Exploring 3D maps with tocuhscreens

4.10 3D maps (Hybrid technology: Touchscreens and Head Tracking)

Now, we want to explore 3D maps using and hybrid technology, this time we are going to implement Head-Tracking with the properties of touchscreens. For that, we will move at the same way as the previous paragraph, using the same system (three bars system), but when look around is when we use Head Tracking. We would need a button to activate a new tool which let the operator move his head and move the center of the image where the operator is looking at in that moment, after reaching the desired position will be necessary to deactivate this tool.

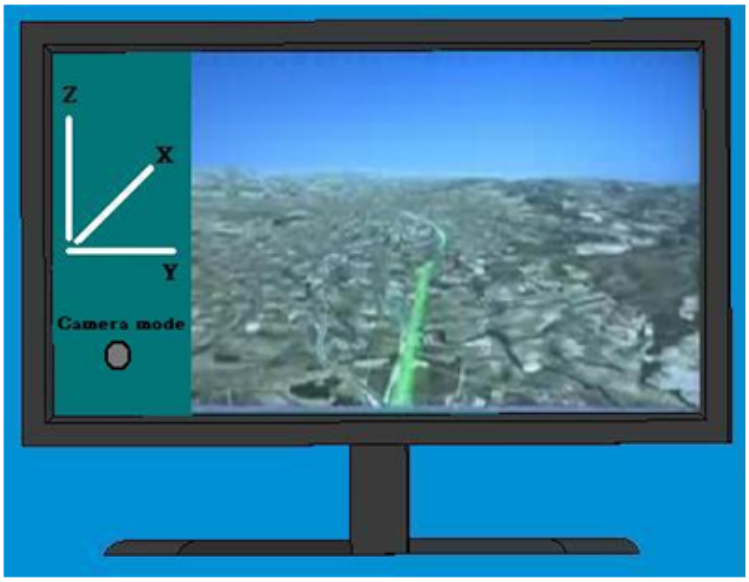

Figure 4.8: Exploring 3D maps using Head-Tracking and touchscreens

Like we can see in the picture, now we will have a new button in our touch screen that let us activate a new tool, called "camera mode". As I explained before when this tool is activated we can move the map view using our head. It will be necessary push in the same button to deactivate the "camera mode".

4.11 Head Tracking with mouse

It is possible that we need a mousse to carry out more difficult tasks, task that we cannot do with tools we have. But, when we have multiple monitors to use the mousse can be problematic, when mousse need to change between monitors difficulties may arise in some systems. We can use Head Tracking to solve this problem. Using Head Tracking we can know which monitor is looking at the operator and the mousse will be appear only in the monitor that operator is looking at in that moment.

As an example we can see this video from youtube:
http://www.youtube.com/watch?v=Jt5nhQiL4pY&hl=es