Design of a Weather Shield for Fixed Dome Cameras

Rasmus Anderberg & Sofia Beets
Machine Design, Department of Design Sciences LTH
Lund University
P.O. Box 118
SE-221 00 Lund, Sweden

Abstract

Axis Communications AB is a Swedish company that delivers solutions for network surveillance for professional installations. One of their product groups, fixed dome surveillance cameras, may suffer from a decreased image quality due to different weather conditions if they are placed in an outdoor environment. This might hinder them from fulfilling their purpose and some kind of protection is therefore desirable to have.

The aim of this project was to create a weather shield concept for wall mounted fixed dome cameras that would protect the camera without compromising its functionality.

Introduction

Fixed dome cameras are characterised by their cylindrical body with a dome on top that contains the optics. During rain or snowfall precipitation may hit and stick to the dome which make the image blurry. Some of Axis' fixed dome cameras may be equipped with a sun shield that protects the dome from rain to some degree but it is not its purpose and it is not very efficient. Therefore a more suitable design is sought after.

To find new and suitable designs this project has been performed using the Double Diamond method that consists of the four phases Discover, Define, Develop and Deliver [1]. In the initial Discover phase research phase was conducted to get to know the challenges that a weather shield faces and this information was then used to produce a design brief and function analysis in the second phase. This was followed a concept generation phase and subsequent prototyping and testing where the concepts were evaluated using methods from Ulrich and Eppinger´s development process, called concept screening and concept scoring [2, pp. 150-157]. In the final phase one concept was recommended for further development as the one with the most potential. The project lasted 20 weeks with the main part of work conducted at Axis' office in Lund, Sweden.

Identifying the Difficulties

The main purpose of a weather shield is to protect the camera image. Apart from the problem with precipitation sticking to the dome several other factors have to be taken into consideration during its design. Rain and melting snow could during the right circumstances form icicles which could disturb the image and also be a potential danger to people and property below the camera. The shield must withstand impacts from hail and vandals and stresses caused by for example vibrations and wind. Heat may cause damage to the sensitive electronics, which is why the heat generated inside the camera should not be trapped inside the shield and solar radiation should be averted from reaching the dome. Insects nesting inside or near the camera may cause problem with the camera image but they also pose a potential threat to unaware repairmen.

In addition to these difficulties Axis also had a few wishes for the new product. They put a lot of work into the installation process to make it as easy and safe as possible for the installers and they want the new weather shield to be in line with this ambition. This is why it should follow their mounting standards. The shield should also fit in with the Axis brand and the product portfolio and be aesthetically pleasing. If the product could fit more than one camera model while fulfilling all of the mentioned criteria it would be exceptional [3].

Concept Generation

Information about all of the listed difficulties were gathered and summoned up in a brief and a function analysis that expressed what the product should achieve without saying how it should do it. This was then used as targets and inspiration during the concept generation phase. Hundreds of ideas were generated and narrowed down to only ten. Through an evaluation according to some of the identified criteria these ten ideas were narrowed down yet again to only three; the Eyelid+skin, Frankenstein and Cacke. These concepts were then developed further and made into physical prototypes.

The Eyelid+skin (figure 1) is a further development of Axis current sun shield. By making it bigger and giving it a sharper edge around the brim it was believed to perform better than the current solution during rain and it felt like a natural evolution of it.

Figure 1 Eyelid+skin

Frankenstein (figure 2) has an adjustable shield that could rotate 20 degrees to give better protection. It is attached to a bracket behind the camera and easy to install.

Figure 2 Frankenstein

Cacke (figure 3) is the third concept chosen for further development and it differs from the other two since the camera is mounted in an angle instead of directly onto the wall. This concept is made to fit several camera models which makes it big but its size also gives a great advantage when protecting against rain.

Figure 3 Cacke

Tests and Simulations

To decide which of the concepts had the most potential for even further development tests were performed on the prototypes. The first test was made to see how well the concepts handle water. One by one the three prototypes and the original sun shield were mounted on wooden boards and hosed down with water from a shower nozzle directed from different angles. Cacke was by far superior in this test, but all of the concepts were better than the original shield. The drip edges were made to be thin and sharp on all concepts to allow the water drops to fall off more easily which was proven to work during this test.

Another test was performed in a climate chamber at LTH to investigate how the three concepts affect the internal heat of the camera. Each shield was mounted on a board together with a running camera. Three temperature probes were place in each camera, two inside the lens body and one outside of it but still inside the camera housing. The boards were then placed in the climate chamber that was set to hold 40ºC and 40% humidity in front of a compact source iodide lamp working as an artificial sun. The lamp generated intensities around 700 W/m^2 at the distance where the boards were placed. This test showed that all three concepts lowered the temperature at all probe locations with at least three degrees, but up to ten degrees in some instances, compared to a camera without a shield. All of the three concepts showed similar results and none of them were therefore set as the winner.

The final test conducted was a test to see how much of the viewing angle the shields covered in comparison with the original sun shield. When set to look forward there were no real difference between the shields, but Axis' current shield had the best viewing angle when looking sideways and Cacke was the worst.

Air flow simulations were also conducted on digital models of the three concepts to see how wind would affect them when coming from different directions. Flow trajectory plots showed that Cacke created the biggest amount of turbulence around it. Since this model was also affected by the largest forces it was hinted that the aerodynamic performance was the worst out of the three concepts. The other two concepts showed similar results but Frankenstein was slightly worse than the Eyelid+skin.

Conclusions

The most important criteria identified were used to evaluate the concepts after the tests in order to eliminate two of the three concepts and find the design with the most potential. Since the primary task of this project was to design a weather shield that would protect the dome against precipitation this criterion was given the highest weight. This is the main reason why Cacke prevailed as the concept with the greatest potential. Its level of innovation is high considering that it is dissimilar to anything else on the market and it did well in many of the tests conducted on it, especially in the rain test.

Some of the criteria listed in the beginning of this article are hard to test and only assumptions can be made of how Cacke would be able to tackle them. Since only basic prototypes were made during this project no impact test could be made. It is however assumed that a more developed construction would be able to withstand large impacts. It would be preferable if the top surface had a steeper slope so that snow would fall of more easily. It would also make it harder for vandals to throw stuff around or on it to block the view or to destroy the camera.

More tests have to be made to evaluate Cacke's ability to withstand stress caused by vibrations and wind. Since it protrudes from the wall it is possible that it will be more affected by these kinds of strains than the other two concepts. This is also the case of the resistance to wind as showed by the simulations and therefore a further study of the aerodynamic performance is needed.

It is also hard to predict whether insects and spiders would nest inside or around the camera. The ventilation holes are currently made to hinder common wasps from entering, but no guarantees could be made about this.

Since the construction needs to be robust and stable to be able to hold and protect the camera fixed to it, it currently uses a lot of screws for fastening which could be very time-consuming to mount. A way to simplify this for the installer while still keep the robustness is therefore desirable to find before the product is ready to launch.

Cacke has the ability to house different sizes of camera models which is another of the wishes Axis had. This makes it large and small cameras might look out of place in it. An alternative solution was made to fit only the smaller camera sizes (figure 4).

Figure 4 A large and a small version of Cacke

Improvements could also be made on the aesthetics of the concept. It is purely subjective but it has been perceived as boxy and bulky and even though it follows the design guidelines of Axis a further shape exploration would be desirable.

This project has successfully created a weather shield that is in many ways better than the current solution, especially when it comes to rain. It is believed that it will protect the camera well and with small alterations it could become a well performing product.

References

[1] Sauder School of Business at University of British Columbia, Design Processes (Electronic) URL: http://dstudio.ubc.ca/toolkit/processes/, (2014-02-21)

[2] Ulrich, K.T. & Eppinger, S.D. (2012), Product Design and Development, 5th ed. The McGraw-Hill Companies, New York, USA.

[3] Åhman, Daniel, design lead at Axis Communications AB, personal conversation 21 January 2014