Ambleside Weather Station & View Camera
Design and Implementation

Originally issued 6/11/2011

Issue 4 16/06/2015. Main features:

- Recovering from failure

- Testing scripts

- Task scheduling

The new features are described in section 7 below.

Issue 3 15/03/2014. Main features:

- More reliability issues

- Annotating with Date & Time

- Weather Station & weather reporting

The new features are described in section 6 below.

Issue 2 05/06/2012. Main features:

- New camera

- Reliability issues

- Records in daylight hours only

- Archiving & backup

- Web galleries

The new features are described in section 5 below.

This picture is taken by a webcam pointing northward, situated slightly south of the centre of Ambleside at OS grid reference NY 3753 0415, from under the eaves of our home in Birch Road. You can see the result at

http://www.abovestock.co.uk/amblesideweather.html
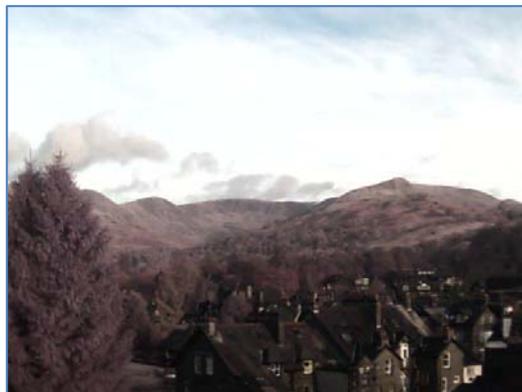
The purpose of this document is to record my experiences in designing and implementing this system, for my own benefit and perhaps to help anyone else who is considering installing a similar system. It assumes familiarity with concepts such as IP, ftp and html. Even so, it should be readable by most people up to some point in section 2.2.

1. Requirements

Primary requirement: To provide potential guests at our holiday accommodation in Ambleside, friends and relatives with a view of the fells so they can see the current weather.

There is a good view from our house at the top end of Birch road in Ambleside, facing north towards Fairfield:

- I decided to mount the camera under the eaves of our house to get the best view, which required it to be weatherproof.
- It would have been simpler to mount a camera indoors, but there is no convenient window through which to point it and get a good view.

I wanted to upload the picture to our holiday accommodation web site at www.abovestock.co.uk and to show the picture in more-or-less real time. I decided that "real time" would be satisfied by renewing the picture every few minutes:

- The cost of providing a moving picture was likely to be excessive in both my effort and broadband bandwidth
- In any case, even when the wind is strong the clouds don't move very fast. A relatively static picture would be enough to meet the primary requirement.

Availability Constraint. In order to achieve continuous availability, the system has to be automatic, with my only intervention being to change parameters or occasionally reconfigure. This is necessary because I am often away and in no position to intervene.

Secondary requirement (which occurred to me later). To be able to create an archive of pictures through the changing seasons.

2. System Architecture

The system architecture seemed likely to be dictated by the choice of camera types.

2.1 Camera Connection Methods

There are three main types of camera easily available:

USB Webcam

These are cheap and readily available. They have the following advantages:

- Plug and play – no difficulties about setting them up.
- There is software already available for uploading a picture to your web site at a chosen interval. I installed TinCam (free for evaluation and cheap to buy) with my Logitech webcam, and it worked fine.

If you can site a webcam so it is convenient both for the view and for attaching to your computer, a USB webcam is probably your best choice. I can think of one disadvantage:

- I'm not sure if TinCam allows one to collect an archive of pictures easily.

A variant on this was offered by Logitech – the Logitech DVS Outdoor Video Camera, which claimed to work using IP through the electricity mains system to provide a USB connection to the computer, with up to 100 metres range. I believe that IP through the mains is a well-proven technology. I bought one, and found that it worked fine if the camera was in the same room as me, but as soon as I plugged it in in another room, the connection failed. After correspondence

with the support people I sent it back.

I looked at the USB article in Wikipedia and it points out that the maximum cable length of about 5 metres is dictated by the round-trip time between the device and the computer, so I cannot possibly see how a USB camera could work at a longer range, which is limited by the speed of light.

Video Cable

A lot of security cameras connect to a monitor through coax video cable, but I didn't want a monitor and couldn't see how to interface this easily to my PC.

IP

Cameras are also available which offer connection to a PC through IP over WiFi. This is the connection method that I have chosen. Several are available. I bought a weatherproof Foscam WiFi Wireless IP CCTV Outdoor IR Camera FI8904W, bought on eBay from Professional CCTV, for about £70. They have given me prompt and effective support throughout.

The camera requires you to connect it to your router via an Ethernet cable in order to set it up, and can then be detached and work wirelessly. The main constraint that this imposes is that it should not be too difficult to remove it from its outdoor position in order to attach it to a cable, if ever it needs major reconfiguration[1].

2.2 Foscam

Physical Characteristics

The camera is supplied in a waterproof housing on an adjustable bracket. It has about 1 metre of waterproof cable terminating in two sockets and a push-button:

- One socket is for a 6-volt electricity supply, for which a 2-metre of cable is supplied, terminating in a standard 13-amp socket. I wanted to ease the task of weatherproofing by replacing the 2-metre cable with a much longer one, but it was impossible to obtain a compatible plug.
- The other socket is for a standard Ethernet cable, used during initial setup.
- The push-button is for reverting to factory settings – not necessary so far.

The problem of weatherproofing was solved by fixing a weatherproof box next to the camera under the eaves of the house, and housing the waterproof cable termination in it. Power was supplied by running a 240-volt cable into the loft of our house and through to a mains socket.

Setup Facilities

The system architecture is influenced by the camera facilities. The camera setup is controlled by the supplied IP Camera Tool software, which runs on a Windows PC and is invoked as an executable program, and then appears as a web browser panel. The main setup facilities of interest are:

- After initially connecting the camera to your router directly via an Ethernet cable you can provide the camera with the home router's SSID and network key. After doing that, the cable can be disconnected and the camera uses the WiFi connection to the router. I set it up

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[1] I was prepared to consider using an Ethernet cable to the camera if WiFi did not work, but have not needed to. I expect it needs a special cable quality or ducting, if it is to be used outdoors.

indoors until I was confident that the wireless connection was reliable. I took a WiFi enabled laptop to the chosen outdoor location to check that the signal strength was good enough, before installing the camera outside.

- While running the IP Camera Tool one can see a picture in real time. This is useful for adjusting the field of view and picture quality.

- The image can be inverted and/or flipped L-R. The most convenient way of securing the camera was upside down under the eaves and I had to do both transformations.

- The brightness and contrast of the picture can be adjusted. Although this nominally happens in real time, in practice the camera takes several minutes to settle its adjustment, so frequent adjustments produced unsatisfactory results. I ended up leaving brightness and contrast at the recommended normal level and this has been reasonably satisfactory.

  I think the camera integrates for brightness over the whole picture and adjusts it for low light levels, and I got an overall improvement by rotating the camera upwards to include more sky and less rooftop.

ftp Characteristics

The camera can be set to ftp a snapshot jpg picture to a host at a chosen interval. When it does this, it concatenates a fixed string (presumably the internal camera ID) and the date and time, to create a file name.

I had hoped that it would ftp a file with a fixed name to a host, in which case I could have sent it direct to my web host, without needing to do any processing on a home computer. However:

- As mentioned above, the file name has a fixed prefix followed by date and time. If I had wished to incorporate this directly into a web page, which needs a known file name for a picture if using plain html, I would have had to do a lot of processing at the host in order to identify the latest picture and display that in the web page. There would have also been the necessity to do background housekeeping regularly in order to remove old files from cluttering my web space. I don't know how to do this.

- In any case I realised (secondary requirement) that it would be useful to create a selective archive of pictures so that I and others could review the past. It would be useful to accumulate this on a home computer.

- **The Dropbox option**: It would still be possible to display pictures in a Dropbox[2] gallery, by setting Foscam to upload to a folder within *My Dropbox\Photos* and publishing the URL of this folder. Viewers could then view the photos as an online gallery from Dropbox's web site. I discarded this option for two reasons:

  - The folder would fill up and require regular maintenance to clear out old pictures.

  - I wanted the picture display to be seen as an integral part of the existing web site.

2.3 Architecture & Design

I had either to accept Foscam's way of doing ftp, or start again. I therefore settled on the following architecture:

- Foscam acts as a client of an ftp host computer at my home

- This intermediate home computer acts as an ftp host to the Foscam, does some intermediate processing on the uploaded files, and then acts as an ftp client to my web server

- The web server (hosted by Fasthosts) acts as an ftp host to my home computer, and as a web host to web browsers that access it from the Internet.

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[2] Free software which runs on a PC and provides web space for sharing files

Intermediate Home Computer Considerations

I'm using a spare old laptop, running Windows 7, as the intermediate host at home. All the processing has to be done automatically and at regular intervals and therefore has to be done by Windows Task Scheduler tasks. This only appears to work under an Administrator logon, and therefore all processing is one by a User with Administrator privileges.

Also, I want the computer to be secure from external attack, and so must allow Windows Update to take place automatically to apply any security fixes. This often requires a Restart. I have therefore configured the computer to log in automatically to the Administrator User on restart.

ftp from Foscam to Home Computer

I have set up the home computer as an ftp server using Cerberus free ftp server software. Cerberus was easy to set up, and starts up automatically on a computer restart. I didn't have to consider firewall settings as the camera and the laptop are on the same WiFi network[3]. The ftp takes place every few[4] minutes, and places a new picture file in the C\:ftproot folder.

Home Computer Processing

All processing takes place within a Picture Capture task, written in VBScript[5], which is run by Windows Task Scheduler every few minutes

- The task looks for pictures uploaded from the Foscam. If there is a new one it processes it, and then deletes any other new ones that have been accumulating. It only keeps pictures in daylight hours – see paragraph 5.3.

- The processing extracts the date and time from the file name and creates a text file with this information in it. It copies the file to a folder for later archiving (see paragraph 5.4), and then changes the file name to a standard name.

- The task then uploads the picture and text files to the web server, using two separate ftp invocations.

Web page

The web page is written in simple html, with the picture included as a <picture>. The only complication was to include the Date & Time information, as there is no straightforward way to embed text into a page using standard html. However, including it as an <object> works, although I don't see why it should: the w3schools.com web site says that its purpose is to support HTML helpers (Plug-Ins). It gives different backgrounds in Google Chrome and Internet Explorer, but that should be fixable.

3. Implementation Experience

3.1 Picture Quality

The picture is 640 x 480 pixels, and quite a low quality. In particular, the colour rendering is not very good. The camera automatically adjusts for light level (sometimes with a lag of a few

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[3] Possibly another advantage of using the intermediate computer, as I did not have to learn how to get the Foscam to ftp to a remote host.
[4] Currently 1 minute for the Foscam ftp upload and 5 minutes for the Windows task, but I may change these. The interval needs to be long enough to minimise the risk of collisions (see below) but short enough to give external viewers a reasonably up to date appreciation of the weather here.
[5] A version of Visual Basic created for scripting of tasks such as this one. Details of the task coding are available on request.

minutes). As a result, a bright day can look duller than it is, and dawn & dusk glow unrealistically (but prettily). It also adjusts to get the best balance between the foreground buildings and the background hills & sky which (when you can see them) seem rather washed out.

There is only a limited range of adjustments that can be made, and the current result is as good as I can get. The picture does fulfil its primary purpose, of showing the current weather.

3.2 Availability and Reliability

After running the system for a few weeks, the picture is available on our web site, and up to date, almost all of the time. There are several factors that affect availability and reliability:

- *Communication links.* Occasionally I cannot access the Foscam, even using the IP Camera Tool. I have no reason to believe that the camera itself fails, but I know that the WiFi link does sometimes. Occasionally also the router loses Internet access or the web server is unavailable.
- *Intermediate Computer.* The computer itself and Windows 7 are very reliable but it is rebooted, and therefore unavailable, periodically for Windows updates.
- *Collisions.* I do not know the internals of the Windows file system, but it seems probable that the Foscam upload process and the Windows task interfere with each other when accessing the same folder. This could account for occasions when only half a picture is uploaded to the web page or the Date & Time are nonsensical. It seems likely that collisions will increase with the frequency of each of the processes, which is one reason for not making them too frequent[6].

4. Conclusions

You can see the result at http://www.abovestock.co.uk/amblesideweather.html

Feedback, especially any practical suggestions for improvement, will be welcome, to my email address.

Future Changes
- Several minor alterations are needed to the web page, to improve the user interface
- I have not yet started creating an archive, but I believe this will be straightforward.

5. Issue 2 05/06/2012. Main features

5.1 New camera

The colour balance, and performance in bright light, of the old camera was very poor. I bought a new Foscam FI8904W and installed it in April. Although it is the same model number (costing about £70), it has improved software, and the view in bright weather is much better. It also shows the detail of clouds better, and discriminates between bright sky and snow.

It still performs like a £70 camera, but I would have to pay a lot more to get a better picture.

5.2 Reliability issues

Mostly, after failures in the ISP or web host, it recovers itself automatically. Occasionally I have

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[6] If it becomes a problem I could implement a crude simulation of random back-off by defining the frequency of one of the processes to be an irregular number of seconds, such as 298, to ensure that they are out of phase with each other.

to manually reset the router, but generally it works OK provided I leave it alone. There have been two major outages, both connected with my absence on holiday:

- In February there was a long power failure within a few hours of my departure for a fortnight. My intermediate computer is a laptop, and it closed down completely when the battery was drained. I have since set it to go to sleep more quickly when the power fails, with the aim of enabling it to survive a longer outage.

- In early May I went way again for a week, and switched off one switch too many when departing. It still doesn't survive for a week without mains power!

5.3 Daylight hours recording

It now records pictures only between one hour before sunrise and one hour after sunset, partly because it uses about 3 Gb per month of the broadband allowance if it runs all the time; restricting it to daylight hours saves over 1 Gb per month on average. It uses the Solar Calculator spreadsheet from the US Department of Commerce National Oceanic & Atmospheric Administration web pages at http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html. It can be configured for any latitude or longitude, but it is necessary to make a separate adjustment for summer time.

For ease of automation I created a hierarchy of Year\Month\Day folders within the Archive folder and wrote a separate sunrise.txt file to each folder to give sunrise and sunset times for that day. The day's sunrise file drives the decision in the Picture Capture program, to keep or discard picture files.

5.4 Archiving & Backup

An archive task runs once a day (at 3 am) to preserve one picture file every 15 minutes, and discard the remainder. Pictures are placed in the appropriate Year\Month\Day folder. An average of 56 files / day @ 25 Kb (= 1.4 Mb per day= 0.5 Gb per year) is an acceptable amount.

Continuous backup is achieved by placing the Archive folder within a Dropbox folder; it should be possible to retrieve the archived pictures even if the intermediate computer fails completely.

5.5 Web galleries

In order to get off the ground I decided to use the Dropbox picture gallery feature, and a program is run daily, after the archiving program, to copy files into the appropriate Dropbox Photos folder. It was then only necessary to place the relevant link in the web page, and clicking on the link brings up the relevant gallery. Fortunately Dropbox appears to do no pre-processing of the files, so the link works even though the files in the folder are updated daily.

At present there are two galleries: one shows the weather at mid-day for the last 20 days (Dropbox puts 20 thumbnails on a page); and the other shows the weather every hour from before sunrise until after sunset.

There are clearly disadvantages to the way that I do it at present, because Dropbox's gallery features are very simple, and each new picture selection has to be hard coded. In principle I should write my own gallery generation program to run on the host, and use a relational database such as MySQL for flexible selection. This may come later.

6. Issue 3 15/03/2014. Main features

6.1 More reliability issues

Often, only half a picture was transmitted from the camera to the intermediate computer[7]. I thought it was probably because the WiFi connection was unreliable. I installed a weatherproof Ethernet cable[8] direct from the camera to the router, and the problem has not recurred.

I still get unexplained failures, particularly missing annotation (see below) and I suspect that one factor is that the intermediate computer is rather slow. There are several processes now going on concurrently: download the picture from the camera; processing of pictures including annotating (see 6.2); saving to the Dropbox archive; uploading the picture to the Above Stock web site; downloading data from the weather station; and uploading it to the Wunderground host.

Although the available bandwidth should easily cope with this traffic, I suspect that the CPU can't. I haven't any hard evidence for this, but I shall buy a faster machine and see if this helps. I can then also try segregating the weather station processing onto the existing machine.

6.2 Annotating with Date & Time

I regarded a record of the date & time of the picture as important, so as to be able to check whether it was up to date. I now realise that the archive picture of today and yesterday every hour provides an adequate check. In view of this I am not going to put a lot of effort into getting ImageMagick into doing what I want. The rest of the section is only of interest if you are thinking of using ImageMagick yourself.

I previously used a very clunky method of showing the date & time of the picture (see 2.3, Home Computer Processing):

- The text containing the date & time had to be saved as a separate file;

- It was uploaded with a separate ftp invocation;

- It was embedded in the web page as an Object. This is a method that is deprecated by WWWC and produces different results on different browsers.

I decided to embed the date and time in the image. It turns out that it is quite difficult to find command-line software for this purpose; although software such as Picasa and Photoshop can do this easily, they cannot be used to invoke individual actions at the command line, which is necessary for an automated action.

The only software I could find was freeware called ImageMagick[9]. It is an excessively powerful Open Source (cooperatively developed) piece of software, which includes the ability to place text annotations into a picture, and a hundred or so other capabilities. Once I had found my way around its syntax it did what I wanted (mostly).

The way that I have used it is by extracting the date & time from the picture's metadata, and doing a command-line execution of ImageMagick to annotate the picture with them.

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[7] I know that this was the link that failed, as this fault occurred even when I was viewing the picture from the intermediate machine, whose connection to the router is by Ethernet cable.

[8] Weatherproof Ethernet cable is availalble cheaply on Ebay; its only disadvantage is that it is stiffer and a little thicker that standard cable, and cannot be bent through so tight a radius.

[9] http://www.imagemagick.org/

There are a few commercial software offerings, but they cost real money and their documentation give very little information about their capabilities.

The major problem that I found was that it works satisfactorily in debug mode, one step at a time, but when I ran it normally it showed very peculiar behaviour: it saved the annotation in the file that I was processing, but the annotation disappeared from any copy that I made of that file. I could not reach an understanding of what was going on, but eventually cobbled together a fix that seems to work. Alternate invocations of the Picture Capture task do two different activities: one invocation does the picture capturing activity, and the next one archives the picture and ftps it up to the web host. The task keeps track of what it should be doing by means of a flag that is set in one mode and unset in the other, and the task does different things according as the flag is, or is not, set. The flag itself is a file of a known name that is created (set) in one mode and deleted (unset) in the other, in each case after testing it.

In addition to this consistent, but unexplained problem, the annotation sometimes, but not very often, appears on the live web site picture and often, but not always, on the archived pictures. This could be related to the fact that if I invoke ImageMagick direct from the command line, it usually reports an error in the file format, but still goes ahead and makes the required alteration. It seems to have different ideas from Foscam about what constitutes a valid jpg file.

Maybe the text file method wasn't so clunky after all!

6.3 Weather Station & Weather Reporting

Separately from the webcam activity, I have acquired a Davis Vantage Vue weather station, and erected it on the fence in the back garden of our house. It is an industrial quality weather station (with a price to match), and its advantage over cheaper stations is that its format is widely supported. Its main features are:

- It continuously records temperature humidity, rainfall and wind speed & direction.
- It uploads this data to a controlling box. You can see the information directly on this if you can master the user interface.
- This box can be connected to a PC by USB or Ethernet cable, and Davis provide software to store the data and display the information on your PC screen.

I wanted to upload this information to our web site. Davis provide a detailed file specification if you want to do it yourself, but someone told me about the Weather Underground worldwide network of weather stations – see http://www.wunderground.com/. I have become a member of this network, and now Wunderground does the data display for me. To do this I had to:

- Join Wunderground
- Install a Wunderground access module in the weather station software on my PC
- Configure this module
- Add the weather station to my Wunderground profile.

You can now see my weather data, either by going to their web site and searching for Ambleside or by going directly to http://www.wunderground.com/personal-weather-station/dashboard?ID=IENGLAND554.

The display is much more comprehensive that I could do.

7. Issue 4 16/06/2015

7.1 Recovery from Computer Failure

The intermediate computer gave me some warning that its hard disk was about to fail: various intermittent errors occurred. Eventually it refused to boot one day, in any mode at all. Since I

had bought a replacement computer a while ago since this one was running very slow, I was able to recover relatively easily. I had all the archive pictures backed up on Dropbox and had copied the VBS scripts to the new computer as well as having a Dropbox backup.

I rebuilt the system on the new computer.

7.2 File Structure

I changed the file structure on the new computer, which led to some delay as I had to change and retest the scripts on the new one. The reason for making the change was that, as good security practice, I had originally set up the system with as much function as possible in a Webcam user account.

Unfortunately, the Foscam camera was reluctant to ftp to any folder that was not directly descended from the C: drive and the ftp host similarly was happiest with the ftp root being a sub-folder of C:, so I set it up so the pictures went to C:\ftproot\webcam. Also, I could only get Task Scheduler to work from an Administrator account. So I put the scripts in the Admin account. This then all worked, but I had added complexity and had nullified most of the security advantages of the proposed setup.

Since the computer is not used for any other purpose than testing and running the webcam and weather station, I felt there was little risk in running everything within an Administrator account, and that is what I now do.

7.3 Testing Scripts

Developing and testing scripts has become considerably easier once I came across VBSEditor – freeware if you can tolerate the ads, but it only costs about $10 to have the ad-free version, and I felt it was well worth the money. It provides a reasonable quality script editor, and a good debugger.

7.4 Task Scheduling[10]

I've set the Foscam to upload pictures to the ftp host on the intermediate computer every 5 minutes

There are four scheduled tasks in Task Scheduler:

- Every 10 minutes Picture Capture looks for uploaded pictures, keeping only the latest, which it uploads to the web site and copies to the Today Pictures folder.

- Every hour on the hour, Update Today Files looks for the latest picture in Today Pictures and, provided it is in the last quarter of the hour, copies it to the Today Every Hour folder in Dropbox\Photos. Dropbox automatically creates a Today Every Hour album and provides a link to it which enables the album to be viewed on the web site.

- Every day at 00.30 Clean Archive copies files from Today Pictures, for each 15 minutes, to the Dropbox Archive folder and to a backup folder on hard disk[11]. It then deletes all pictures from Today Pictures.

- Every day at 01.15 Update Gallery Folders copies the files in Today Every Hour to Yesterday Every Hour and copies the mid-day picture to Mid Day for the Last 20 Days, deleting any

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[10] I'm mostly including this for my own future reference, for next time I get a disk crash.
[11] The latter is probably OTT, as it wouldn't actually matter if Dropbox went mad and deleted all the archive, which is probably of little interest.

picture from that folder if it is more than 20 days old. Links to these two albums are similarly provided by dropbox

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