Experiment 4 (digital)
ASTROPHOTOGRAPHY I (MOON) - OBSERVATION

In modern astronomy, it is not sufficient simply to look through the eyepiece of a telescope in order to study an object. By taking a photograph, the astronomer captures a permanent image of a celestial object for later, more detailed study. Furthermore, the "detector" used (such as a CCD or, in the old days, a photographic plate) is much more sensitive than the human eye, especially when exposed to light for long times. In this experiment, we will observe and capture images of the Moon using a small telescope. The CCD inside a converted webcam will be used as the detector.

Apparatus

telescope
KPU Mk II CCD camera
Notebook or netbook computer

Procedure

Examine the camera, telescope and other equipment that will be used. Attach the camera to a USB port on the computer and make sure an image can be seen on the screen. (Note: until the camera is mounted on the telescope, the image will not be focused but you will be able to tell dark from light.) Take a sample image and save it in the folder assigned to your group to familiarise yourself with the operation of the equipment and software.

Repeat and discuss these procedures with the instructor and fellow students until they are understood and familiar, as they will need to be done in semi-darkness when working at a dark site.

The date and time for observations have been determined by the instructor, keeping in mind such things as the rise and set times of the Moon and Sun. As with most ground based observations, weather can be an unpredictable factor.

Before Observing (20 min.):

1) In your laboratory notebook, record the following information and set up a data table (example below) for recording relevant information about each frame you will take.

Date:______________________________________

Object:_____________________________________

Telescope (name and type):____________________

Detector:____________________________________

Weather:____________________________________

Frame #	**Time**	**File Name**	**Location on Grid**	**Notes and Comments* .**
1				
2				
3				
.				
.				

***** record any irregularities that will help you analyse the pictures later such as change in sky conditions, camera getting bumped, missed frames, etc.

2) Draw a full-page sketch of what the subject (i.e., the Moon) looks like (this should show the approximate phase of the Moon without much detail). Be sure to indicate the orientation (e.g. up/down, East/West). You will be using this sketch to orientate your pictures in the analysis portion of the lab.

3) Make a plan on how your group will cover the face of the Moon. A rectangular grid of slightly overlapping images is normally used.

Each group will be allowed 20 min. to complete observations, as follows:

4) Mount the camera on the telescope by taking the eyepiece lens off and inserting the camera in its place. Locate the Moon in the camera and thus the computer screen and focus the image.

5) Using the fine control knobs of the telescope, point the telescope to the part of the Moon corresponding to your first frame. Take a frame, then record its approximate position in a diagram (e.g. see Figure 1.). Make an entry in your data table.

6) Move to your next lunar location, making sure your images overlap recognizably. Continue until the entire visible face of the Moon has been imaged.

7) Briefly summarize your observing session. Make note of any events which occurred during your observations that would influence the quality of your pictures, as well as any comments you have about the observations or the equipment.

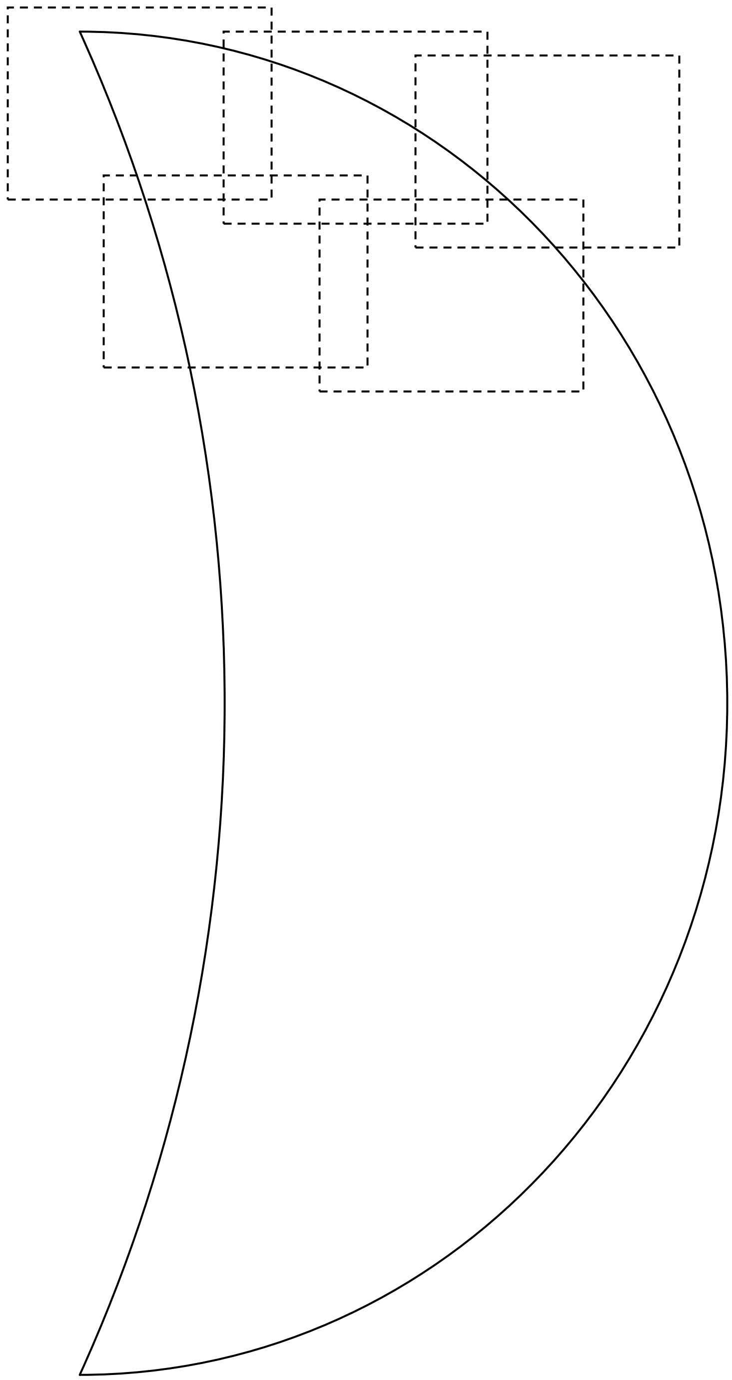

Figure 1.

Constructing a mosaic image of the Moon.

Experiment 5
ASTROPHOTOGRAPHY II (MOON) - ANALYSIS

An observational astronomer typically spends two or three weeks of the year actually observing at an observatory. This "telescope time" could be split into two or more sessions. The rest of the year is spent on analysing the data obtained during these short "observing runs."

In Experiment 4, we photographed the Moon on a series of CCD frames using a telescope. These images constitute our data. In this exercise, we will conduct an analysis of these data.

In the unfortunate event that the astronomer is prevented from making the observations during her assigned telescope time due to poor weather (actually, this happens routinely), she must wait until the next year to re-attempt the observations. Often, this requires her to make another application for the desired telescope time. For us in Astronomy 1100, we will reschedule observations within practical limits.

<u>Apparatus</u>

Moon globe and/or map of Moon,
map of any part of Earth, preferably local

Observation Report

1) Open the image processing software on your computer. Using your notes as a guide, place the individual frames in such a way that a mosaic image of the Moon is constructed.

2) Briefly describe your photographic results and describe any difficulties you experienced. For example, was light pollution or telescope vibration a problem? Again, you can add this information to the table you made at the time of photography.

3) Identify the "terminator" on the photographs. What effect does the terminator have on the visibility of the features seen? Were there notable effects of the Moon's motion?

4) Tape or paste your mosaic image into your notebook, labeling it with any lunar features visible in your image (compare your image with a map or a globe of the Moon to identify the visible features).

5) How do your image compare with those taken by others in the class under similar conditions? What differences are reasonable and what should be cause for concern?

Detailed Analysis: Sizes of Lunar Craters

It is possible to measure the sizes of objects on the Moon (or on Earth, for that matter) by measuring the length of its image on the photograph. In this exercise, we will make measurements of crater sizes.

1) First, we need to establish a distance scale. There are many possible methods but a fast way is to use the Moon itself, provided your mosaic image is "round." Look up the diameter of the moon in a reference or text book. Record the diameter (call it D) in kilometres. Now measure and record the diameter of the Moon on your mosaic image, in centimetres (label this P). This might be challenging if less than half the Moon appears in your photograph, but there are established techniques to deal with this. Ask your lab instructor if necessary. The ratio D/P is the "plate scale" or the distance scale in km/cm.

2) Now select a crater (or any other visible feature) whose size you wish to measure. It should be a feature that is clearly seen in the mosaic image. Also, features that are face on are more suited for this analysis, since you do not have to make allowances for the fact that they appear skewed. Larger craters are easier to measure and this will yield a more precise result. Identify and label the feature chosen directly on the photograph (or provide a sketch for this purpose).

3) On your mosaic image, measure the size of this feature in centimetres and record it in your notebook. Multiply this value by the plate scale. The result is the size of your chosen feature.

4) For comparison, list an object or feature on Earth that has a similar size. If a photograph of the Earth were taken from the Moon, such an object might look similar to what you see in your photograph.

5) Repeat steps 2, 3 & 4 for another visible feature on your photograph.