

CS2311 Computer Programming, (13-14, Sem. A)

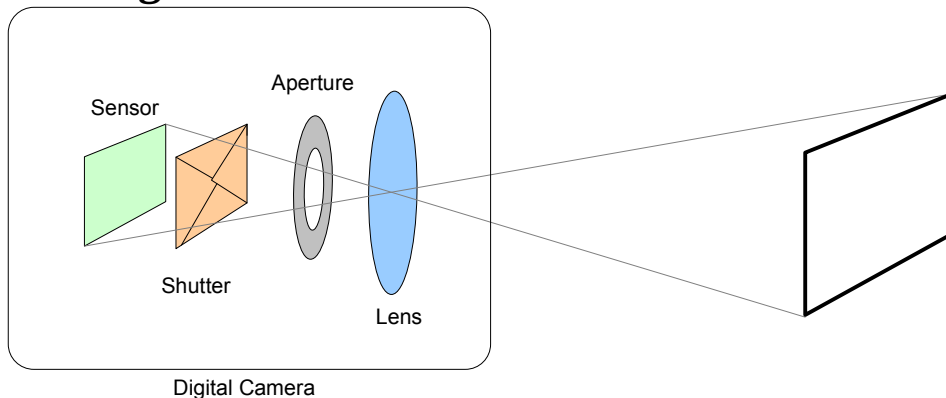
Assignment 1 – Exposure Computer

Due: Week 8, 26/10/2013, 1pm (No late submission will be accepted)

1. Aims and Objective

The objective of this assignment is to give student hand-on practice on computer programming. Students are asked to apply the material learnt in the lectures to solve a real-life problem and complete the assignment on their own. Students may also experience the pressure of finishing a bug-free problem under a tight schedule.

2. Background



Digital camera becomes very popular nowadays and people use it extensively to take photo in daily-life. In general, a digital camera consists of lens, aperture, shutter and sensor. The sensor records the color and intensity of light projected by the lens to form a photo. The amount of light (intensity) received by the sensor, generally being referred to as **exposure**, is controlled by the aperture and the shutter. To take a good photo, enough light must be projected on the sensor so that it can record the image clearly.

Aperture: The aperture of a camera is a hole that controls the amount of light reaching the sensor. The size of aperture is usually specified in discrete steps and being referred to as an f-number:

f1, f1.4, f2, f2.8, f4, f5.6, f8, f11, f16, f22, f32 and f45.

Aperture size f1 allows the most light reaching the sensor and f45 allows the least. Increasing the f-number by one rank, i.e. f1 $\rightarrow$ f1.4 or f11 $\rightarrow$ f16, will half the amount of light reaching the sensor.

Shutter: shutter is another device that controls the amount of light received by the sensor. In traditional film camera, the shutter will block all the light from reaching the film. When taking photo, the shutter will open and close shortly to limit the amount of light reaching the film. The duration of shutter keep open is called shutter speed. Faster shutter speed results in less light reaching the film and hence produces darker image. In digital camera, the shutter speed specific how long the sensor will record the image. The agreed standards for shutter speeds are

1s, 1/2s, 1/4s, 1/8s, 1/15s, 1/30s, 1/60s, 1/125s, 1/500s and 1/1000s

Exposure Value (EV): In photography, each change of f-number or shutter speed will always double or half the amount of light reaching the sensor. A reference number, call exposure value (EV), is used to denote the combination of f-number and shutter speed that produces the same exposure (same amount of light received by the sensor1).

For example all the following combinations will give exposure value (EV) of 8:

f/1.4, 1/125s

f/2.0 1/60s

f2.8, /30s

The general rule is when aperture is increased by one rank; the shutter speed should be decreased by one rank to maintain the same exposure value.

Below shows a partial EV table:

EV	<i>f-number</i>							
	1	1.4	2	2.8	4	5.6	8	11
-1	2	4	8	15	30	60	120	240
0	1	2	4	8	15	30	60	120
1	1/2	1	2	4	8	15	30	60
2	1/4	1/2	1	2	4	8	15	30
3	1/8	1/4	1/2	1	2	4	8	15
4	1/15	1/8	1/4	1/2	1	2	4	8
5	1/30	1/15	1/8	1/4	1/2	1	2	4
6	1/60	1/30	1/15	1/8	1/4	1/2	1	2
7	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1
8	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2
9	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4
10	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8

Interested students may refer to Wikipedia for more information (including the full EV table):

http://en.wikipedia.org/wiki/Exposure_value

Note that you should adopt a higher EV value if flash is used when taking photo. For example, if the original EV of a scene is 5, the ideal f-number and shutter speed could be f1.4 and 1/15s (*shaded cell in the above table*). If flash is used, the EV requirement will be increased (say, to 7), and to compensate that, new f-number and shutter speed should be used. For example:

- -f1.4, 1/60s
- -f2.8, 1/ 15s

Or any other combinations on the row of EV=7.

3. Your Task

In this assignment, you are going to implement the internal exposure computer of a digital camera. The main functions of the computer are to determine the shutter speed, aperture size (f-number) and flash power under given exposure value which determined by an EV sensor installed in the camera.

Input

The program read three parameters from standard input (keyboard) with the follow format

[EV] [A|S] [Aperture size / Shutter speed (depends on the second parameter)]

Parameters	Data type	Description
EV	Integer	The exposure value obtained from the camera EV sensor. The computer should provide a combination of f-number and shutter speed that matches this EV.
A S	Character	A single character that indicate the camera is in Aperture-Priority mode (A) or Shutter-Priority mode (S) If the camera is in Aperture-Priority, the third parameter (float) specifies the preferable f-number. * If the camera is in Shutter-Priority, the third parameter (int) specifies the preferable Shutter speed. * The preferable f-number/shutter speed should be maintained as far as possible. *Assume flash is not used.

Aperture size / Shutter speed	float / Integer	If the second parameter is 'A', this parameter will be the preferable f-number (aperture size) If the second parameter is 'S', this parameter will be the preferable shutter speed. Positive value indicates the actual shutter speed, e.g. 1 = 1 second, 2 = 2 seconds. Negative number indicates the divisor of shutter speed, e.g. -125 = 1/125 seconds, -60 = 1/60 seconds.
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Output

For each input, the program will print the final f-number, shutter speed and flash power (in term of addition EV given). If flash is not needed, this value will be 0.

[f-number] [Shutter speed] [flash-EV]

Parameters	Data type	Description
f-number	float	The final f-number the camera use to take photo under the inputted EV. (1 decimal place)
Shutter speed	String	The final shutter speed the camera use to take photo under the inputted EV. A single number if the shutter speed is greater or equal to 1 second. Otherwise, the output number will in form of 1/x, when x is a divisor of a given shutter speed. E.g. 1/30
Flash –EV	Integer	The additional EV added when flash is used.

Use of Flash

The top priority of the program is to achieve the specified EV with the given f-number (in A mode) or shutter speed (in S mode), preferably not using flash. If it is impossible to achieve the given EV with the specified f-number or shutter speed, minimal amount of flash (which increases the EV by 1, 2, 3, 4 or 5 ranks) could be used so as to achieve the EV while keeping the required f-number or shutter speed. The required f-number (in A mode) or shutter speed (in S mode) should only be changed if and only if all flash settings failed to reach the required EV. In such case, the change in f-number or shutter speed should be kept minimal.

Specifications

The following is the specifications of the digital camera used in this assignment.

Shutter speeds:	2-1/1000 sec (2s, 1s, 1/2s, 1/4s, 1/8s, 1/15s, 1/30s, 1/60s, 1/125s, 1/250, 1/500s and 1/1000s)
Aperture:	f2.8-f11 (f2.8, f4, f5.6, f8, f11)
Flash power:	+1 to +5 EV (1, 2, 3, 4, 5)

Sample Input and Output

Input vs. output	Remark
15 A 5.6 5.6 1/1000 0	EV = 15, Aperture-priority, preferable f-number = f5.6. Final f-number 5.6, shutter speed 1/1000 sec. No flash
5 A 11 11.0 2 1	Max. Shutter speed 2sec, flash is needed and the flash output should set to 1. (increase EV by 1)
7 S 1 11.0 1 0	EV = 7, Shutter-priority, preferable shutter speed = 1 sec. f-number = 11, shutter speed = 1 second, no flash
6 S -125 2.8 1/125 4	EV = 6, Shutter -priority, preferable shutter speed = 1/125 sec. f-number = 2.8, shutter speed = 1/125, flash output = 4 EV
15 A 4.0 5.6 1/1000 0	If f4.0 is used, the shutter speed must set to 1/2000 which beyond the capacity of the camera. Therefore, adjustment on f-number is needed.
5 S -500 2.8 1/125 5	If 1/500 is used, the f-number must set to 1.0 (flash = 5) which below the minimum aperture size of the camera. Therefore, f-number is set to 2.8 and adjust the shutter speed to 1/125

4. Marking

The mark of assignment is based on the level of achievement as following:

Basic Level (40%)

The computer output correct f-number and shutter speed when there is no needed to use flash or adjust the preferable f-number/shutter speed.

Intermediate Level (20%)

Without the need of changing the preferable f-number/shutter speed, the computer output correct f-number and shutter speed even flash is used.

Advanced Level (20%)

The computer output correct f-number and shutter speed even flash is used, adjustment on the preferable f-number / shutter speed is needed.

Programming style and efficiency (20%)

Programming styles like use of indention, proper naming of variables and the efficiency of the program will be marked in this part.

5. Remarks

- A working program with fewer features (lower level of achievement) tends to achieve higher marks than a buggy program with more features. You are advised to keep a copy of the last bug-free program, probably with fewer features, so that you have a copy to submit when time is running out for debugging the current version.
- Few test cases will be provided in the PASS system, but it is a good programming practice to design your own test cases. The test cases used in marking your assignment may differ from those used by PASS.
- Plagiarism is strictly prohibited in this course. Found case will be give zero mark and subjects to further punishment.
- Debugging and testing are key activities of programming. Student helpers and Instructors will not be responsible for these parts. However, you may discuss with them for hints and advices. In fact, able to locate bugs and fix them will help you write a correct code in the future.
- Students in need may also consider joining the ***Programming Clinic***, which is a Q&A helpdesk service by senior students. For information, let's refer to: <http://courses.cs.cityu.edu.hk/clinic>