M i c r o a v i a

Robotics Computer Vision Developer

Please provide the answers to these questions in a single PDF file.

Question 1
The jumping robot can only move forward. Only the following commands are available:

- Jump **K** metres forward;
- Jump **L** metres forward;
- Jump **M** metres forward.

The goal of the robot is to cover exactly N metres. This can often be achieved using various jump sequences.
Write a C++ program that calculates and prints out how many different sequences of jumps the robot can use to overcome the distance **N**.
K, L, M, N are integer values.

Example 1
Jump options are **K** = 1, **L** = 2, **M** = 3, distance is **N** = 3.
The robot can use 4 jump sequences: **111, 12, 21, 3.**
Program output: **4**

Example 2
Jump options are **K** = 2, **L** = 3, **M** = 5, distance is **N** = 5.
The robot can use 3 jump sequences: **23**, **32**, **5**.
Program output: **3**.

Question 2
Examine the following function, describe its functionality, fix any errors if necessary.

```
int *div(int *data, size_t size, int div) {
   int result[size];
   for (size_t i = 0; i < size; ++i) {
      Result[i] = data[i] / div;
   }
   return result;
}
```

Question 3
A layer of a Convolutional Neural Network (CNN) receives as input 3 feature maps of size 55×55. This layer contains 6 filters of size 5×5, with a stride of 3 and padding of 2.

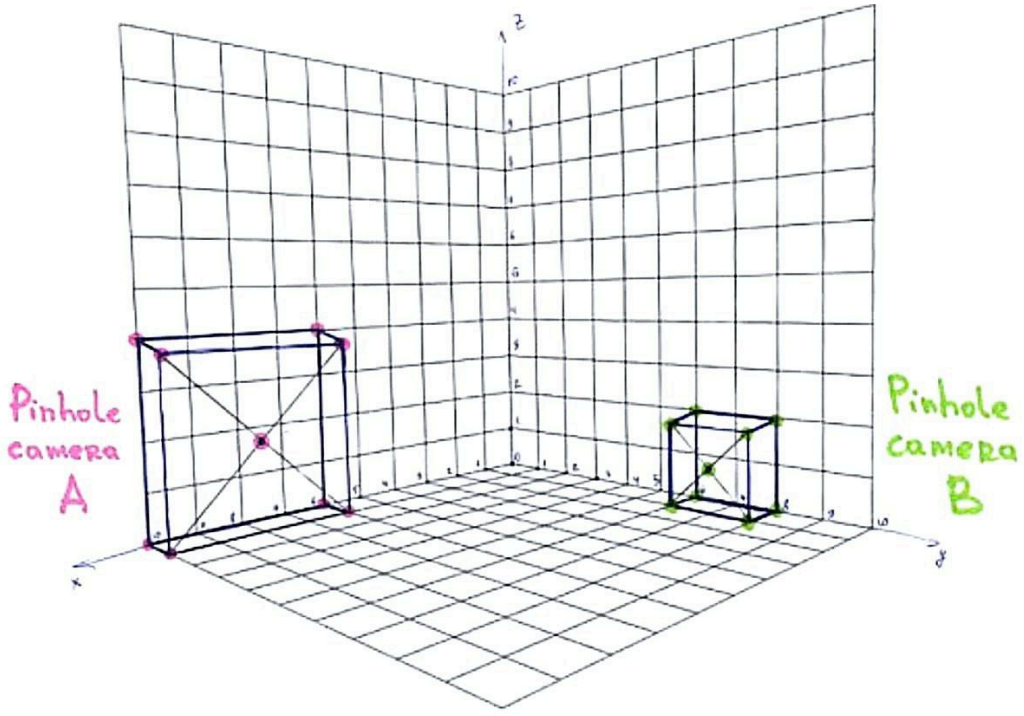
You are being asked to**:**

1. Calculate the number of variable parameters in the layer.
2. Determine the number of feature maps in the output.
3. Calculate the resolution of the output feature map.

Question 4
You are required to detect some straight lines in the image. Describe the method you would use to detect straight lines in an image.

Question 5
Given the world coordinates of an object that a camera is observing, you need to calculate the pixel coordinates of this object in the camera frame. Explain the process and formulas you would use to calculate the pixel coordinates from the world coordinates.

Question 6



In the figure, you can see two pinhole cameras, also called camera obscura. Camera obscura is a box with a small hole in the front side. The image is projected at the back side of this box.

The illustration also defines the coordinate system XYZ.

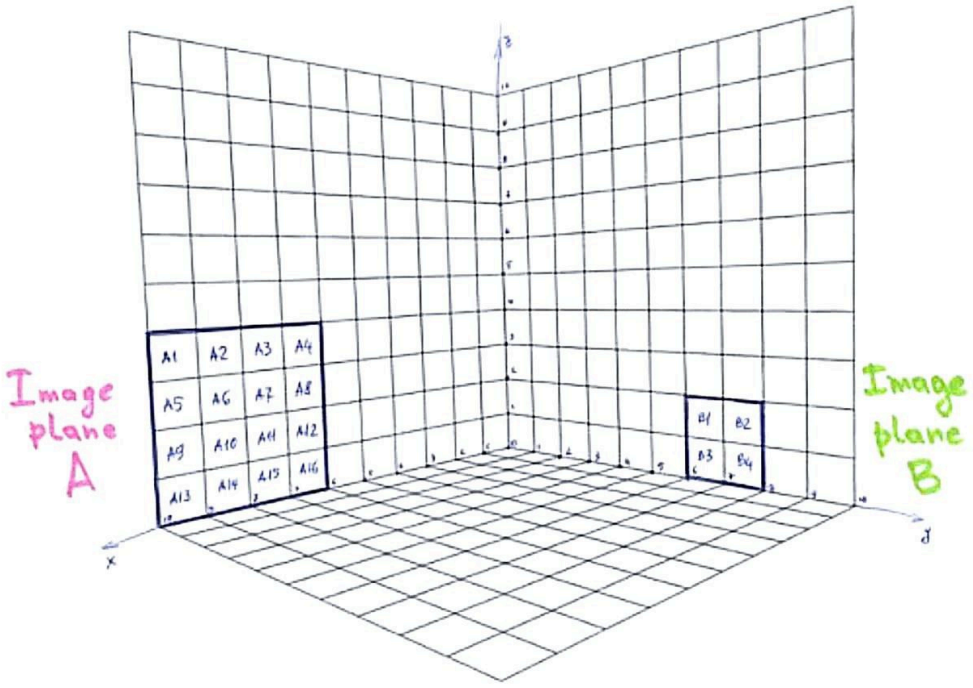
The coordinates describing camera A are marked with red dots in the scheme.

- Vertices: (6, 0, 0), (10, 0, 0), (6, 0, 4), (10, 0, 4), (6, 1, 0), (10, 1, 0), (6, 1, 4), (10, 1, 4)
- Pinhole: (8, 1, 2)

The coordinates describing camera B are marked with green dots in the scheme.

- Vertices: (0, 6, 0), (0, 8, 0), (0, 6, 2), (0, 8, 2), (1, 6, 0), (1, 8, 0), (1, 6, 2), (1, 8, 2)
- Pinhole: (1, 7, 1)

These two cameras “can see” each other.



Thus, these two cameras have image areas as shown in the figure above. This is similar to the sensor in modern cameras, where objects in the real world that are within the field of view are projected.

1. Which of the A1...A16 cells in image area A will contain the projection of the camera B (“green” camera)? Which cells are empty?
2. Which of the B1...B4 cells in image area B will contain the projection of the camera A (“red” camera)? Which cells are empty?
3. How many points describing camera B (green dots) will be projected onto the area A?
4. How many points describing camera A (red dots) will be projected onto the area B?
5. What are the XYZ coordinates (in area B) of the projection of camera-A’s pinhole (the central red dot)?
6. What are the XYZ coordinates (in area A) of the projection of camera-B’s pinhole (centre green dot)?