Contents

一、实验概述 **1**

二、技术路线与方案 **1**

GameManager 1
SpawnManager 2
BlockController 3
ShadowController 4
GridManager 5
ScoreManager 7
InputManager 7
CameraController 9

三、实验效果 **11**

一、实验概述

本实验主要在于使用 Unity 框架开发一个 3D 的俄罗斯方块游戏。本人在此项目中主要负责游戏逻辑的编写。

二、技术路线与方案

我主要把游戏的逻辑分为了以下几个部分：

1. 游戏的开始与终止
2. 方块的生成
3. 方块的行为（包括方块的下落、方块的水平移动、方块的旋转等）
4. 方块影子（用于提示方块下落的位置）的行为
5. 方块的消除
6. 游戏计分
7. 玩家的键盘输入
8. 玩家视角的移动

为了实现以上的逻辑，我主要编写了以下的脚本：

1. GameManager.cs
2. SpawnManager.cs
3. BlockController.cs
4. ShadowController.cs
5. GridManager.cs
6. ScoreManager.cs
7. InputManager.cs
8. CameraController.cs

GameManager

- 用于控制游戏的开始、结束、退出等逻辑。使用单例模式实现。

1. 游戏的开始

```
public class GameManager : MonoBehaviour
{
    private void StartGame()
    {
        isGameOver = false;
        spawnManager = FindFirstObjectByType<SpawnManager>();
        if (spawnManager != null)
        {
            spawnManager.SpawnBlock();
        }
```

```
        else
        {
            Debug.LogError("SpawnManager not found in the scene!");
        }
    }
}
```

2. 游戏的结束

```
public class GameManager : MonoBehaviour
{
    public void GameOver()
    {
        if (!isGameOver)
        {
            isGameOver = true;
            Debug.Log("Game Over");
            SceneManager.LoadScene("GameOver");
        }
    }
}
```

3. 游戏的退出

```
public class GameManager : MonoBehaviour
{
    public void QuitGame()
    {
        #if UNITY_EDITOR
            UnityEditor.EditorApplication.isPlaying = false;
        #else
            Application.Quit();
        #endif
    }
}
```

除上述之外，该文件中还涉及到了一些与 Unity 的部件进行连接的方法，这里忽略。

SpawnManager

- 用于控制方块的生成逻辑，使用单例模式实现。

SpawnManager 在生成一个方块的同时，还会生成一个对应的影子，用于提示方块下落的位置。其中，方块与其对应的影子将被存储在以下两个数组中：

```
public class SpawnManager : MonoBehaviour
{
    [SerializeField] private GameObject[] blockPrefabs;
    [SerializeField] private GameObject[] shadowPrefabs;
}
```

具体的方块生成逻辑如下：

```
public class SpawnManager : MonoBehaviour
{
    public void SpawnBlock()
    {
        // Validate prefab arrays
        if (blockPrefabs == null || blockPrefabs.Length == 0)
        {
            Debug.LogError("Block prefabs array is empty!");
```

```
            return;
        }

        if (shadowPrefabs == null || shadowPrefabs.Length != blockPrefabs.Length)
        {
            Debug.LogError("Shadow prefabs array is missing or doesn't match blocks array!");
            return;
        }

        // Randomly select a block
        int randomIndex = Random.Range(0, blockPrefabs.Length);

        // Instantiate block and shadow
        GameObject block = Instantiate(blockPrefabs[randomIndex], spawnPosition, Quaternion.identity);
        GameObject shadow = Instantiate(shadowPrefabs[randomIndex], spawnPosition, Quaternion.identity);

        // Set up block controller
        BlockController blockController = block.GetComponent<BlockController>();
        if (blockController == null)
        {
            Debug.LogError("Block prefab is missing BlockController component!");
            Destroy(block);
            Destroy(shadow);
            return;
        }

        // Set up shadow controller
        ShadowController shadowController = shadow.GetComponent<ShadowController>();
        if (shadowController != null)
        {
            shadowController.SetParentBlock(blockController);
        }
        else
        {
            Debug.LogError("Shadow prefab is missing ShadowController component!");
            Destroy(shadow);
        }

        // Check if the spawn position is valid
        if (!GridManager.Instance.IsValidMove(blockController))
        {
            GameManager.Instance.GameOver();
        }
    }
}
```

BlockController

- 主要用于控制方块的行为逻辑。

1. 方块的下落

```
public class BlockController : MonoBehaviour
{
    private void Fall()
    {
        transform.position += Vector3.down;
```

```
        if (!GridManager.Instance.IsValidMove(this))
        {
            transform.position += Vector3.up;
            LockBlock();
        }
    }
}
```

2. 方块的水平移动

```
public class BlockController : MonoBehaviour
{
    public void MoveHorizontal(Vector3 direction)
    {
        if (!IsActive) return;

        transform.position += direction;
        if (!GridManager.Instance.IsValidMove(this))
        {
            transform.position -= direction;
        }
    }
}
```

3. 方块的旋转

```
public class BlockController : MonoBehaviour
{
    public void Rotate(Vector3 axis)
    {
        if (!IsActive) return;

        transform.RotateAround(transform.TransformPoint(rotationPoint), axis, 90);
        if (!GridManager.Instance.IsValidMove(this))
        {
            transform.RotateAround(transform.TransformPoint(rotationPoint), axis, -90);
        }
    }
}
```

4. 方块的快速下落

```
public class BlockController : MonoBehaviour
{
    public void QuickDrop()
    {
        if (!IsActive) return;

        while (GridManager.Instance.IsValidMove(this))
        {
            transform.position += Vector3.down;
        }
        transform.position += Vector3.up;
        LockBlock();
    }
}
```

ShadowController

- 主要控制方块影子的行为逻辑。

方块影子的行为比较简单，基本当正在下落的方块的水平位置发生改变的时候，在实方块的位置处生成一个新的影子方块，并将影子方块落到能够到达的最底部位置。具体的实现如下：

```
public class ShadowController : MonoBehaviour
{
    private void Update()
    {
        if (parentBlock == null || !parentBlock.IsActive)
        {
            Destroy(gameObject);
            return;
        }

        UpdateShadowPosition();
    }

    private void UpdateShadowPosition()
    {
        transform.SetPositionAndRotation(parentBlock.transform.position, parentBlock.transform.rotation);

        do
        {
            transform.position += Vector3.down;
        } while (GridManager.Instance.IsValidMove(this));

        transform.position += Vector3.up;
    }
}
```

GridManager

- 游戏框体的属性，并提供添加方块的逻辑、判断方块位置是否合法的逻辑、行满判断逻辑、行消除逻辑等。使用单例模式实现。

1. 游戏框体属性

```
public class GridManager : MonoBehaviour
{
    // 用于控制框体的大小
    public int width = 10;
    public int height = 15;
    public int depth = 10;

    // 记录消除的行数，主要在分数的计算
    public int linesCleared = 0;
}
```

2. 判断方块位置（移动）是否合法

```
public class GridManager : MonoBehaviour
{
    public bool IsValidMove(Vector3[] positions)
    {
        foreach (Vector3 pos in positions)
        {
            Vector3 roundedPos = RoundVector(pos);
            if (!IsInsideGrid(roundedPos) || GridPositionOccupied(roundedPos))
            {
                return false;
            }
```

```
        }
        return true;
    }

    private bool IsInsideGrid(Vector3 pos)
    {
        return pos.x >= 0 && pos.x < width &&
               pos.y >= 0 && pos.y < height &&
               pos.z >= 0 && pos.z < depth;
    }

    private bool GridPositionOccupied(Vector3 pos)
    {
        return grid[(int)pos.x, (int)pos.y, (int)pos.z] != null;
    }
}
```

3. 行满判断与行消除

需要提到的是，对于行消除逻辑的实现，我设计的是当 X 或 Z 行被方块填满时便消除该行，并将该行上方的方块下移。

这里只给出部分的实现：

```
public class GridManager : MonoBehaviour
{
    private bool IsLineX(int x, int y)
    {
        for (int z = 0; z < depth; z++)
        {
            if (grid[x, y, z] == null)
            {
                return false;
            }
        }
        return true;
    }

    private void ClearLineX(int x, int y)
    {
        for (int z = 0; z < depth; z++)
        {
            Destroy(grid[x, y, z].gameObject);
            grid[x, y, z] = null;
        }
    }

    private void DropBlocksAbove(int clearedY)
    {
        for (int y = clearedY; y < height - 1; y++)
        {
            for (int x = 0; x < width; x++)
            {
                for (int z = 0; z < depth; z++)
                {
                    if (grid[x, y + 1, z] != null)
                    {
                        grid[x, y, z] = grid[x, y + 1, z];
                        grid[x, y, z].transform.position += Vector3.down;
                        grid[x, y + 1, z] = null;
```

```
                    }
                }
            }
        }
    }
}
```

ScoreManager

- 用于计算游戏的分数，并提供显示分数的逻辑。使用单例模式实现。

```
public class ScoreManager : MonoBehaviour
{
    private void UpdateScoreDisplay()
    {
        if (scoreText != null)
        {
            int score = GridManager.Instance.linesCleared * 100;
            scoreText.text = $"Score: {score}";
        }
    }

    private void Update()
    {
        UpdateScoreDisplay();
    }
}
```

InputManager

- 用于处理玩家的键盘输入。这部分使用单例模式进行实现。需要提到的是，在控制方块逻辑的部分，我实现了一个坐标变化，用于将方块的移动转换为相对于玩家当前视角的移动。具体的实现逻辑如下：

```
public class InputManager : MonoBehaviour
{
    private BlockController activeBlock;
    private Camera mainCamera;

    private void Start()
    {
        mainCamera = Camera.main;
    }

    private void Update()
    {
        // Find the active block if not already assigned
        if (activeBlock == null || !activeBlock.IsActive)
        {
            activeBlock = FindFirstObjectByType<BlockController>();
            return;
        }

        // Handle horizontal movement
        if (Input.GetKeyDown(KeyCode.LeftArrow) || Input.GetKeyDown(KeyCode.A))
        {
            MoveBlockRelativeToCamera(Vector3.left);
        }
        else if (Input.GetKeyDown(KeyCode.RightArrow) || Input.GetKeyDown(KeyCode.D))
```

```
        {
            MoveBlockRelativeToCamera(Vector3.right);
        }
        else if (Input.GetKeyDown(KeyCode.UpArrow) || Input.GetKeyDown(KeyCode.W))
        {
            MoveBlockRelativeToCamera(Vector3.forward);
        }
        else if (Input.GetKeyDown(KeyCode.DownArrow) || Input.GetKeyDown(KeyCode.S))
        {
            MoveBlockRelativeToCamera(Vector3.back);
        }

        // Handle rotation
        else if (Input.GetKeyDown(KeyCode.Z))
        {
            activeBlock.Rotate(Vector3.right);
        }
        else if (Input.GetKeyDown(KeyCode.X))
        {
            activeBlock.Rotate(Vector3.up);
        }
        else if (Input.GetKeyDown(KeyCode.C))
        {
            activeBlock.Rotate(Vector3.forward);
        }

        // Handle quick drop
        else if (Input.GetKeyDown(KeyCode.Space))
        {
            activeBlock.QuickDrop();
        }
    }

    private void MoveBlockRelativeToCamera(Vector3 direction)
    {
        if (mainCamera == null) return;

        // Get the camera's forward and right vectors, ignoring Y component
        Vector3 cameraForward = mainCamera.transform.forward;
        cameraForward.y = 0;
        cameraForward.Normalize();

        Vector3 cameraRight = mainCamera.transform.right;
        cameraRight.y = 0;
        cameraRight.Normalize();

        // Calculate the movement direction relative to the camera
        Vector3 moveDirection = Vector3.zero;

        if (direction == Vector3.forward)
            moveDirection = cameraForward;
        else if (direction == Vector3.back)
            moveDirection = -cameraForward;
        else if (direction == Vector3.right)
            moveDirection = cameraRight;
        else if (direction == Vector3.left)
            moveDirection = -cameraRight;
```

```
        // Round the move direction to the nearest axis
        moveDirection = RoundDirectionToAxis(moveDirection);

        activeBlock.MoveHorizontal(moveDirection);
    }

    private Vector3 RoundDirectionToAxis(Vector3 direction)
    {
        float x = Mathf.Abs(direction.x);
        float z = Mathf.Abs(direction.z);

        if (x > z)
        {
            return new Vector3(Mathf.Sign(direction.x), 0, 0);
        }
        else
        {
            return new Vector3(0, 0, Mathf.Sign(direction.z));
        }
    }
}
```

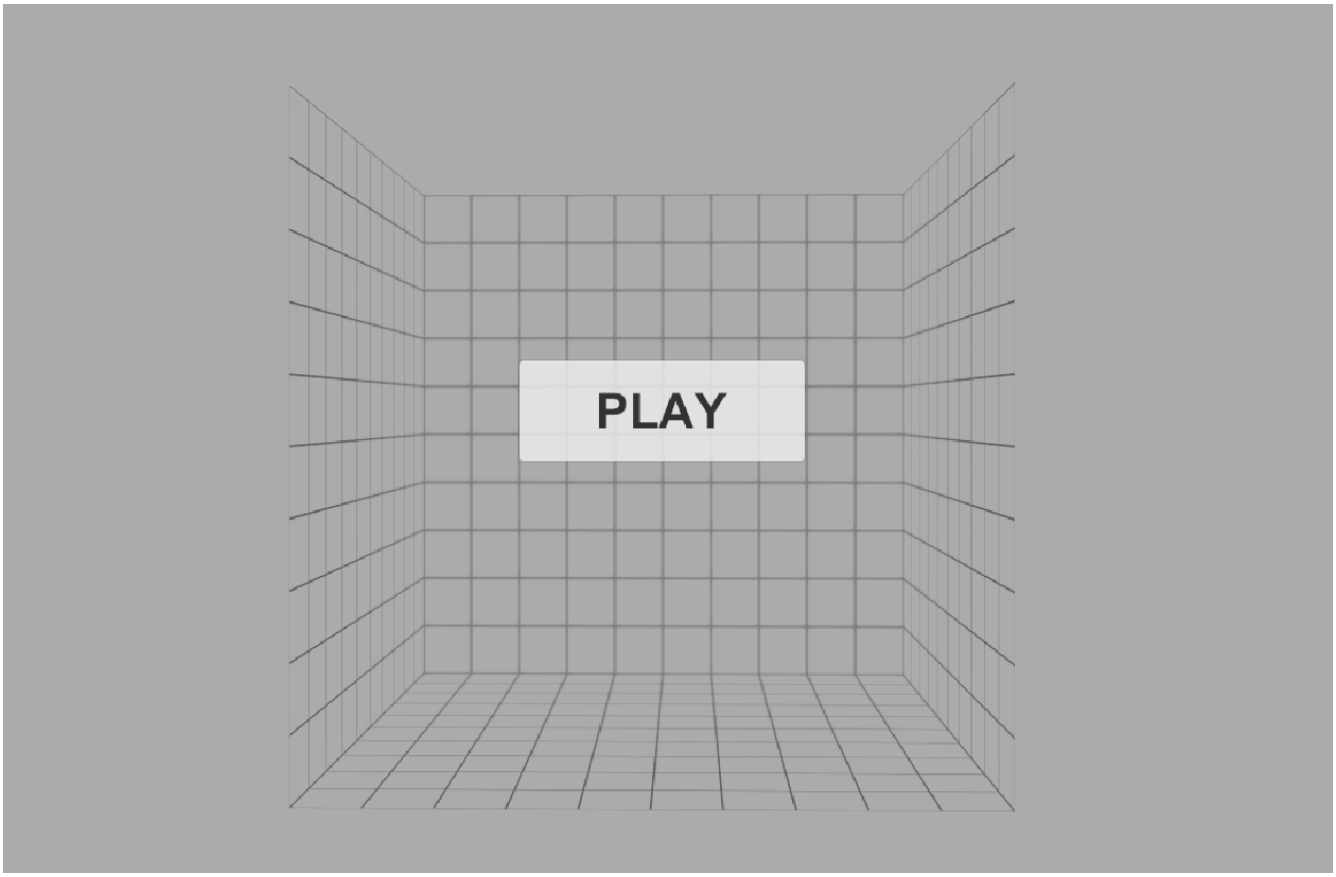
CameraController

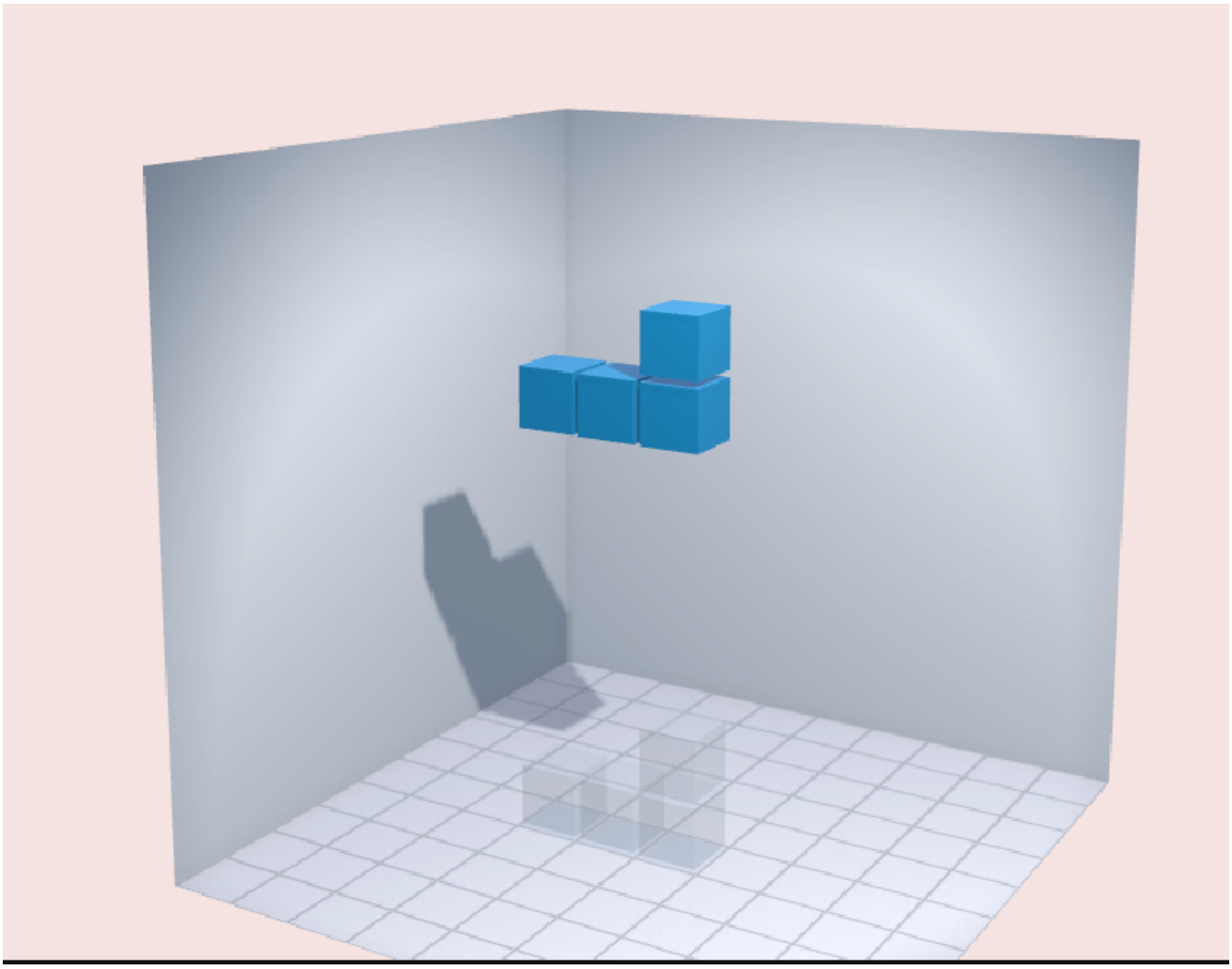
- 用于控制玩家视角的移动。这部分使用单例模式进行实现。视角的控制主要通过捕获用户的鼠标操作来完成，具体的实现如下：

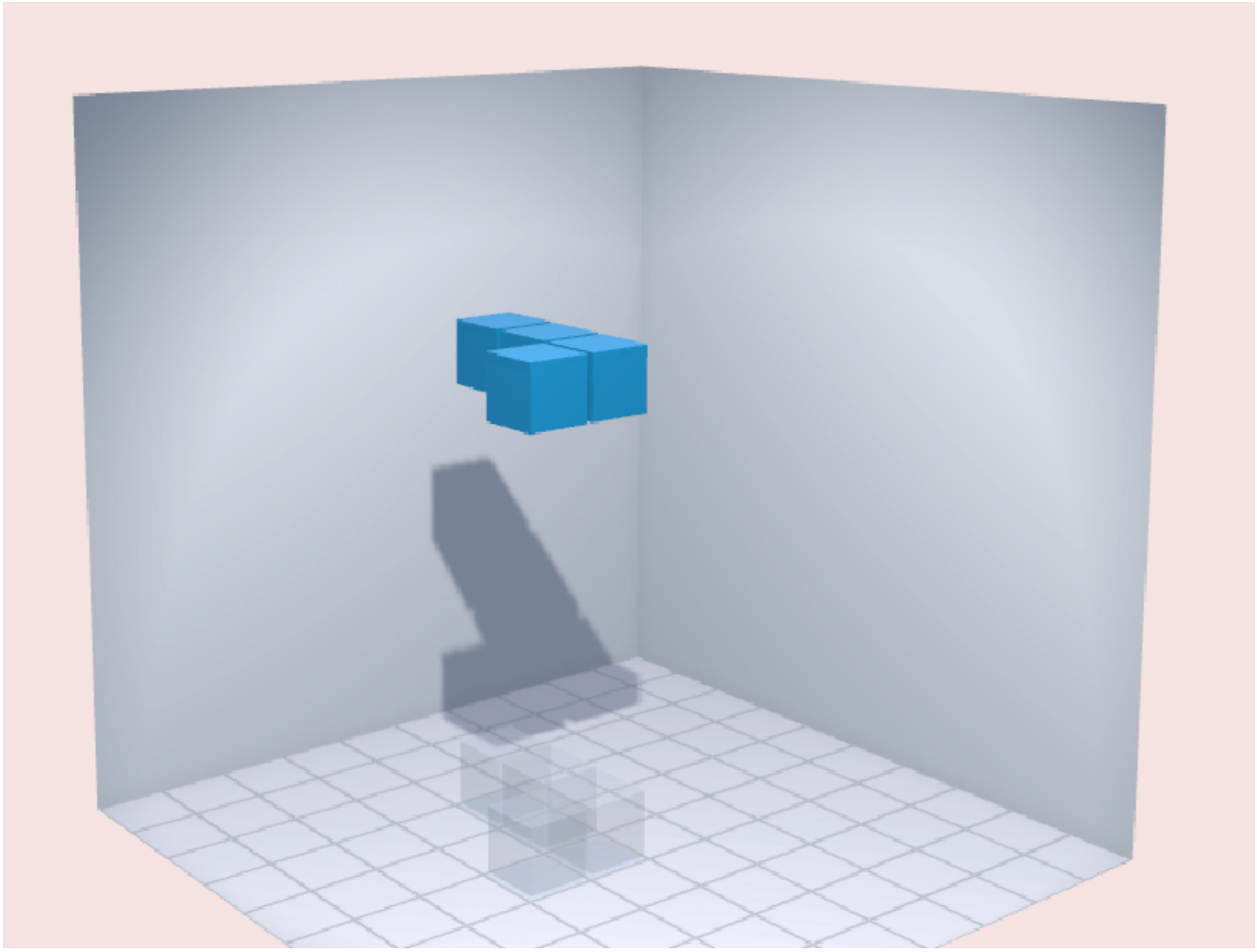
```
public class CameraController : MonoBehaviour
{
    [SerializeField] private float sensitivity = 5.0f;
    [SerializeField] private float smoothSpeed = 30.0f;
    [SerializeField] private float minVerticalRotation = -30f;
    [SerializeField] private float maxVerticalRotation = 60f;
    [SerializeField] private float distanceMultiplier = 1.5f;
    [SerializeField] private float minDistance = 30f;
    [SerializeField] private float maxDistance = 50f;

    private Vector3 centerPoint;
    private float orbitDistance;
    private Vector2 currentRotation;

    private void Start()
    {
        GridManager gridManager = GridManager.Instance;
        if (gridManager == null)
        {
            Debug.LogError("GridManager not found!");
            return;
        }

        centerPoint = new Vector3(
            gridManager.width * 0.5f,
            gridManager.height * 0.5f,
            gridManager.depth * 0.5f
        );

        float maxDimension = Mathf.Max(gridManager.width, gridManager.height, gridManager.depth);
```

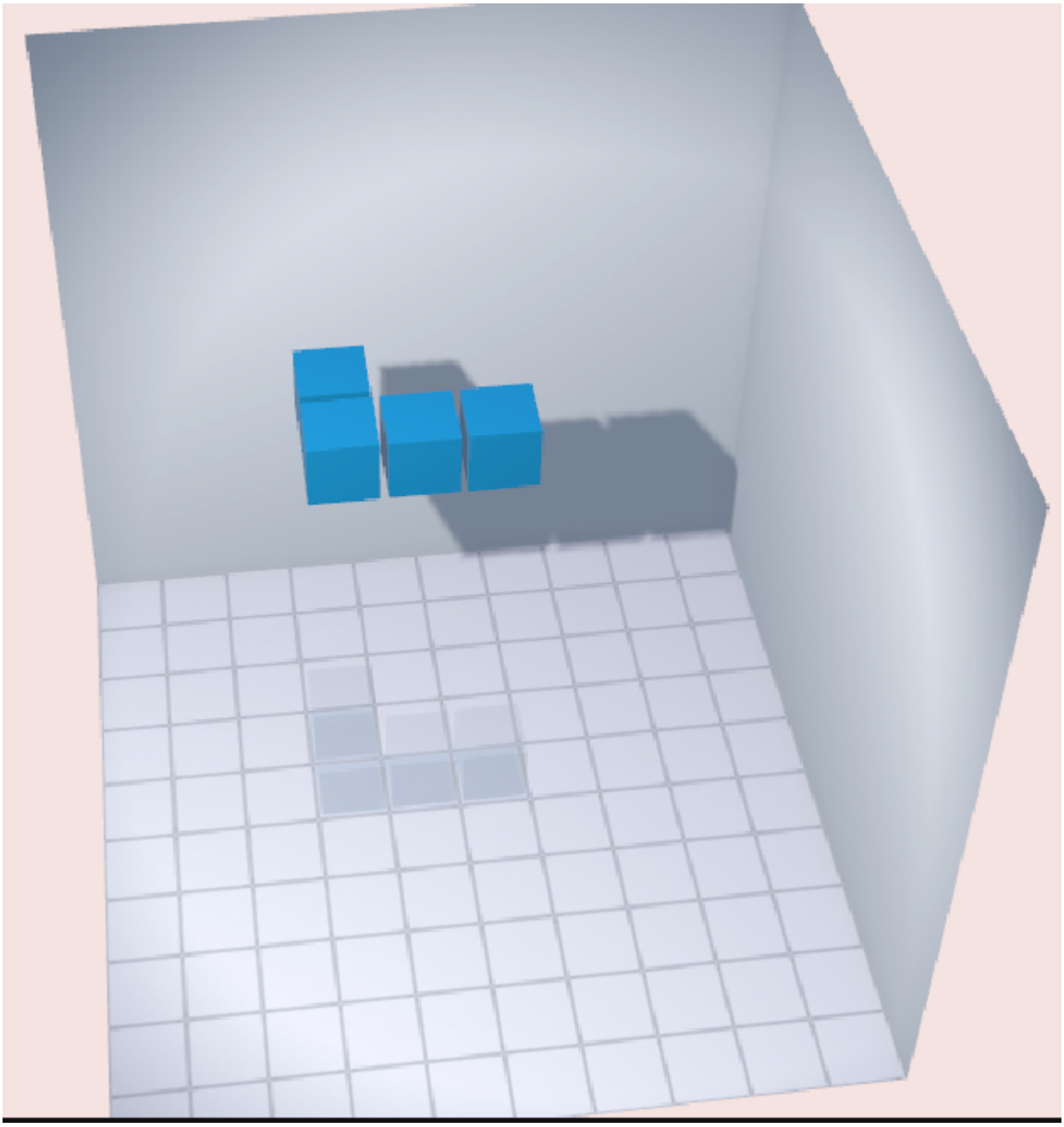
```
        orbitDistance = Mathf.Clamp(maxDimension * distanceMultiplier, minDistance, maxDistance);

        Vector3 directionFromCenter = (transform.position - centerPoint).normalized;
        currentRotation.x = Mathf.Asin(directionFromCenter.y) * Mathf.Rad2Deg;
        currentRotation.y = Mathf.Atan2(directionFromCenter.x, directionFromCenter.z) * Mathf.Rad2Deg;

        UpdateCameraPosition();
    }

    private void Update()
    {
        if (Input.GetMouseButton(1))
        {
            float mouseX = Input.GetAxis("Mouse X") * sensitivity;
            float mouseY = Input.GetAxis("Mouse Y") * sensitivity;

            currentRotation.x = Mathf.Clamp(currentRotation.x - mouseY, minVerticalRotation, maxVerticalRo
            currentRotation.y += mouseX;

            UpdateCameraPosition();
        }

        float scroll = Input.GetAxis("Mouse ScrollWheel");
        if (scroll != 0)
        {
            orbitDistance = Mathf.Clamp(orbitDistance - scroll * 5f, minDistance, maxDistance);
            UpdateCameraPosition();
        }
    }

    private void UpdateCameraPosition()
    {
        float verticalRotation = currentRotation.x * Mathf.Deg2Rad;
        float horizontalRotation = currentRotation.y * Mathf.Deg2Rad;

        Vector3 targetPosition = centerPoint + new Vector3(
            Mathf.Sin(horizontalRotation) * Mathf.Cos(verticalRotation),
            Mathf.Sin(verticalRotation),
            Mathf.Cos(horizontalRotation) * Mathf.Cos(verticalRotation)
        ) * orbitDistance;

        transform.position = Vector3.Lerp(transform.position, targetPosition, smoothSpeed * Time.deltaTime

        transform.rotation = Quaternion.Slerp(
            transform.rotation,
            Quaternion.LookRotation(centerPoint - transform.position),
            smoothSpeed * Time.deltaTime
        );
    }
}
```

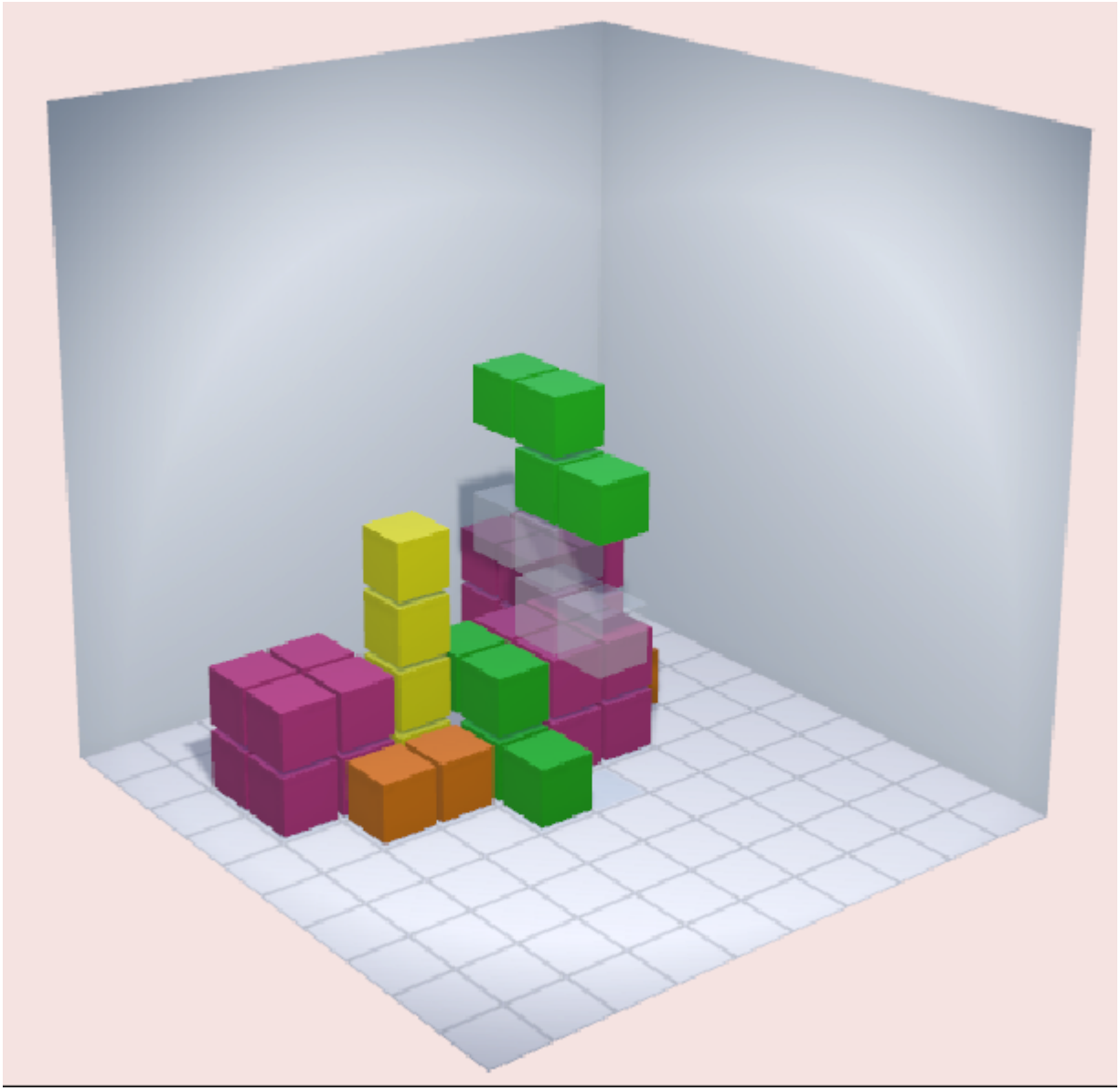
三、实验效果












GAME OVER!
PLAY AGAIN
QUIT