Assembly Project: Columns

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1 Instruction and Summary

1. Which milestones were implemented?

   Milestones 1, 2, and 3 were fully implemented for demonstration 1. For the final demonstration, I implemented milestones 4 and 5 using the following eight easy features:

   - Easy 1: Gravity (auto-fall each frame)
   - Easy 2: Increasing gravity speed over time
   - Easy 3: Difficulty selection (Easy/Medium/Hard)
   - Easy 4: Game Over screen + Restart (R) without retained state
   - Easy 6: Pause (P) toggle with on-screen freeze
   - Easy 10: Preview of the next column
   - Easy 11: Preview of the next 5 columns (full upcoming queue from left to right)
   - Easy 12: Save feature (save a column to be later on swapped with current column)

   Thus, I completed 8 easy features, satisfying milestone 5 requirements.

2. How to view the game:
   (a) Unit Width: 1 pixel, Unit Height: 1 pixel
   (b) Display Width: 16 pixels, Display Height: 16 pixels
   (c) Base Address: `0x10008000`
   (d) Load and run `Columns.asm` in Saturn.
   (e) Open Bitmap and click inside the bitmap window to activate keyboard focus.
   (f) Controls:
      - **W** = Rotate the column (cycle colours downward)
      - **A** = Move left
      - **D** = Move right
      - **S** = Soft drop (move down)
      - **P** = Pause / Unpause
      - **1,2,3** = Select difficulty (Easy/Medium/Hard)
      - **C** = Save/swap active column
      - **Q** = Quit
      - **R** = Restart after Game Over

3. Game Summary:

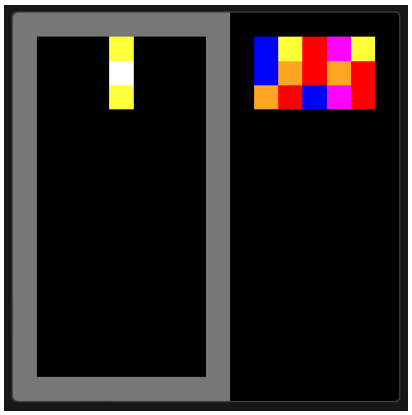

Figure 1: Static scene after launching the game

- The game runs on a 16x16 bitmap grid with a 7x14 active playfield.
- A falling 3-gem vertical column spawns at (row 1, col 4).
- Colours are randomly selected from 7 possible colours.
- Movement is handled with WASD; Q quits the game.
- Gravity is automatic, with speed based on difficulty and accelerating over time.
- A full preview panel displays the next 5 upcoming columns. The order is from left to right. The rightmost column is the next one, to the left is the one after and so on.
- A dedicated save column slot allows swapping the current column.
- Collision detection handles walls, stacks, and ground contact.
- Upon landing:
  - The column locks into the board.
  - Horizontal, vertical, and diagonal match detection removes groups of 3 or more.
  - Gravity pulls gems downward.
  - Matching and gravity is repeated until no matches remain.
- Game Over triggers when the new spawn location is blocked.
- Restarting clears all memory and generates a new game state.

2 Attribution Table

Since I completed the project alone:

Student 1 (Ediz Cagan Uysal, 1011105590)	Student 2 (N/A)
Implemented Milestones 1,2,3	N/A
Implemented 8 Easy Features (Milestone 4, 5)	N/A
Game loop, keyboard polling, movement logic	N/A
Collision detection, gravity, chain reactions	N/A
Rendering engine and memory layout	N/A
Next 5-piece preview system and save system	N/A
Pause/difficulty/game over/restart systems	N/A

3 Memory Layout

- Bitmap display starts at `0x10008000`.

- 16 units per row and 64 bytes per row.
- `CUR_ROW` and `CUR_COL` store the top gem of the falling column.
- Board state is encoded directly in bitmap memory; 0x000000 = empty.
- `NEXT1-NEXT5` store the next 5 upcoming columns.
- `SAVE_TOP/MID/BOT` store the saved piece.

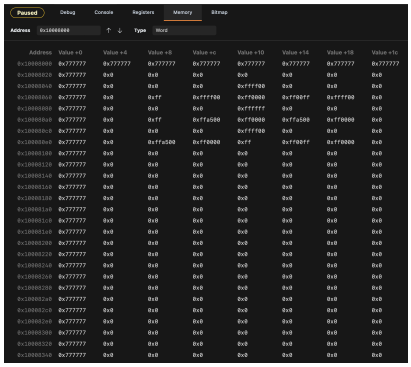

Figure 2: Memory visualization of the playing field

4 Milestones

Milestone 1

- Implemented static border and full bitmap rendering.
- Spawned initial column and preview.
- Verified memory layout with graph-paper design.

Milestone 2

- Implemented polling keyboard input.
- WASD movement + rotation.
- Q to quit.
- Full redraw every frame with 1 ms sleep.

Milestone 3

- Left/right collision detection.
- Vertical collision detection → lock block + spawn new one.
- Full match detection (horizontal, vertical, diagonal).
- Gravity simulation on board.
- Repeat until stable.
- Game Over when spawn location is blocked.

Milestone 4 & 5 (8 Easy Features)

- Gravity timer + acceleration.
- Difficulty modes (Easy/Medium/Hard).

- Pause system.
- Game Over screen + restart.
- Next 5 upcoming columns preview.
- Save / Swap column system.

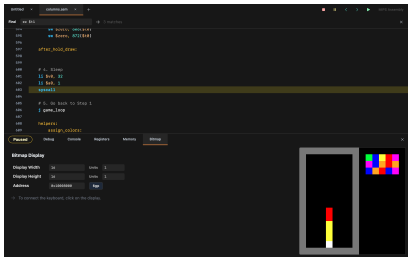

Figure 3: Before matching

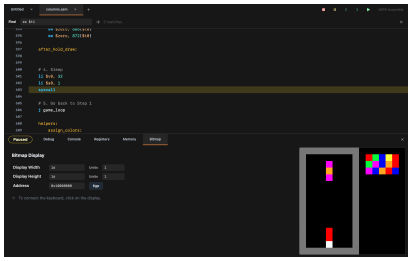

Figure 4: After matching + gravity

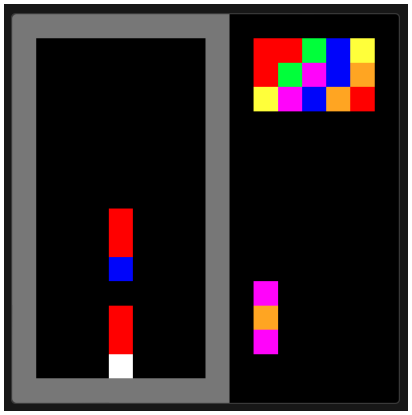

Figure 5: After saving the current column

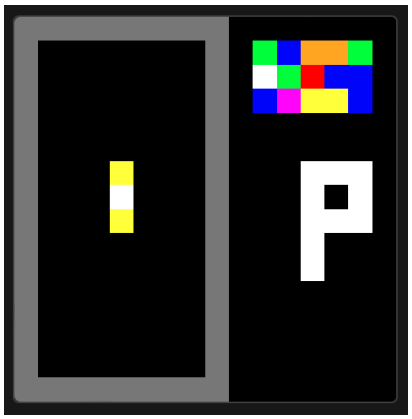

Figure 6: After game is paused

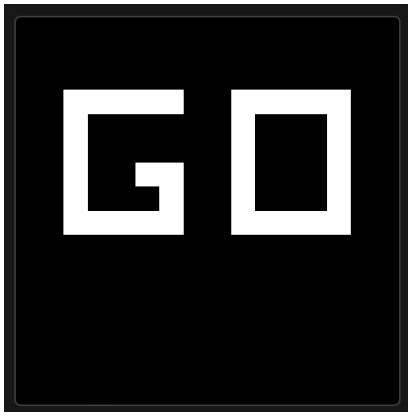

Figure 7: Game over screen

5 How to Play

- Move the falling column with A/D.
- Rotate colours with W.
- Drop faster with S.
- Press P to pause or resume.
- Press 1/2/3 to change difficulty.
- Press C to save/swap the current column.
- Press Q at any time to quit.
- After Game Over:
  - Press R to restart,
  - Press Q to exit.