Coordinate Conversion: A SCOMP Peripheral

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Introduction

(individual submission)

Device Functionality

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TABLE 1

PERIPHERAL IO ADDRESS MAP

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IO Address	Name	Write	Read
0x00A0	COL	Desired 8-bit column value	Current column's 8-bits value concatenated with 8-bits error condition
0x00A1	ROW	Desired 8-bit row value	Current row's 8-bits value concatenated with 8-bits error condition
0x00A2	NEO_IDX	N/A	8-bits NeoPixel index
0x00A3	MAX_COL	Desired maximum number of columns in 8-bit	N/A
0x00A4	MAX_ROW	Desired maximum number of rows in 8-bit	N/A

First, the user must define the dimensions of the display by setting MAX_ROW and MAX_COL. This feature is useful in adapting to displays with different dimensions. Now, the user can specify ROW and COL of the NeoPixel display, then read from NEO_IDX.

Error Condition (errno)	Description
0x00	No error
0xFF	Index out of bounds error

In the current design, errnos read from COL and ROW IO addresses indicate the validity of the inputted row and column coordinates respectively. Errnos in general can be helpful for debugging and our peripheral has the capability to add more errnos in the future.

Design Decisions and Implementation

Intuition

To our knowledge, addressing screens starting from the top left is the standard convention so we set that as our origin. The two-axis coordinate system was chosen because the NeoPixel display can easily be seen as a grid, and users are more accustomed to indexing rows and columns for positioning on a grid.

Mathematical Model

We mathematically modeled the base implementation because it was straightforward to verify in simulation and implement in hardware. A math model could also parameterize the equations using the specified dimensions of the screen, as needed by our extended functionality.

Developer Experience

We recognize the importance of useful debugging tools. Therefore, we wanted to provide debug information to be read from our peripheral. We deemed the specified row/column information and errno to be relevant debug information.

Data Format

Our data sizes are centered around SCOMP's 16-bit IO bus, so it was natural to designate eight bits for the row and eight bits for the column such that they could be packed onto the bus at the same time. However, we later modified that since it defers the data formatting responsibility to the programmer. So, we designated a unique IO address for each of the column and row information. Similarly, we utilize distinct IO addresses for the max dimensions. The 8-bit row/column information leaves eight bits for errnos on the IO bus. We intentionally assigned the least significant bits to the errno because it can only be determined in hardware, prioritizing its importance. Generally, an errno of zero implies no issues and anything non-zero can uniquely identify a certain issue.