

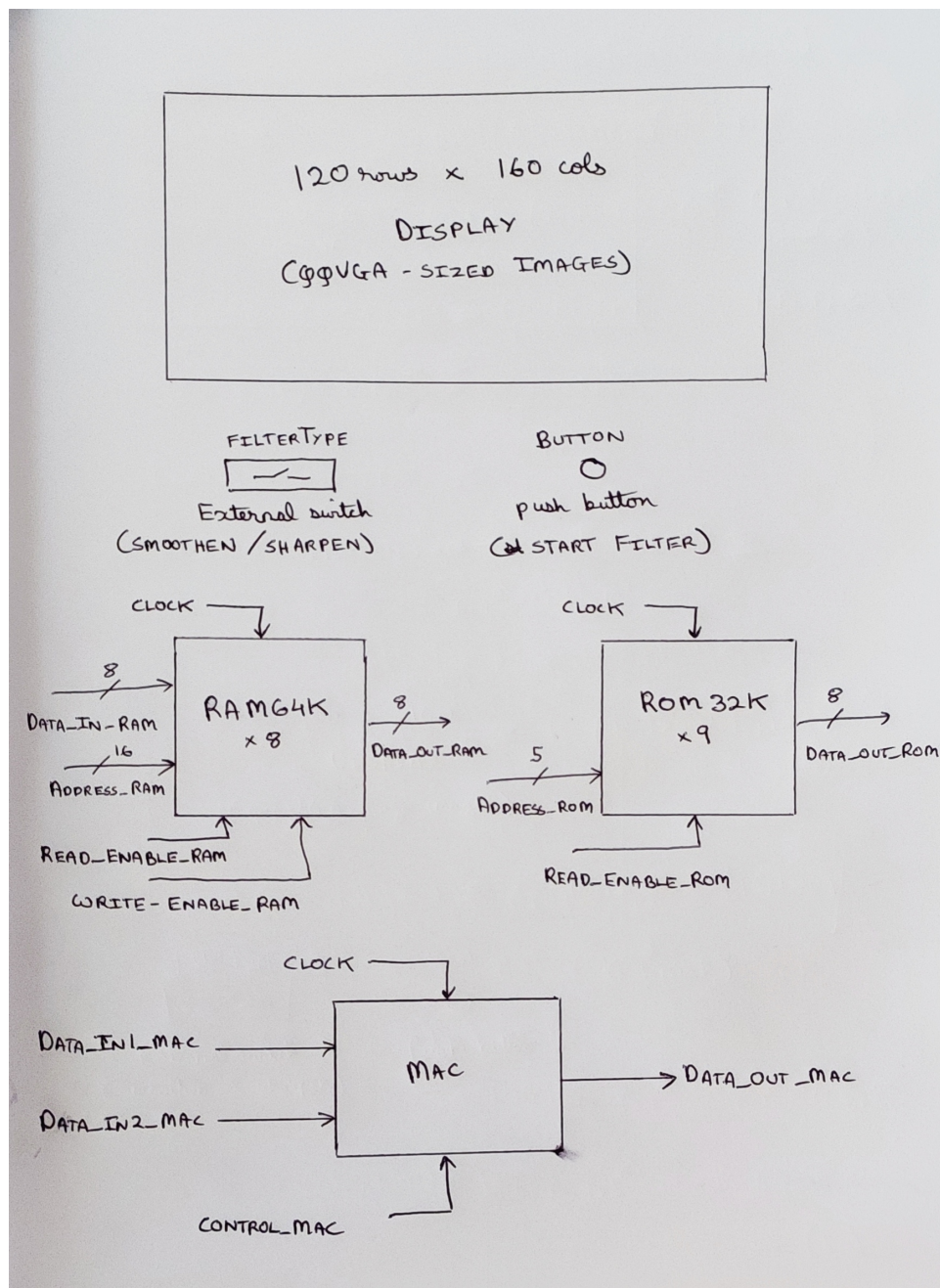
## COL 215 : Assignment 3: Digital Image Filter

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### Explanation of code:

The different signals used to communicate between the different modules and what they represent can be seen from the diagram below:



Explanation of different signals

The general functioning is divided into 3 super states, where the filtering state is further subdivided into 4 sub-states.

#### 1. State 00: Idle

Here the system does nothing till the button is pressed. This is the default state and the different signal values are initialised here. When the button is pressed, the system checks the value of the external switch, and sets the starting address for the filters accordingly. The other signals, including the enable signals for RAM and ROM and the control signal for the MAC are initialised to 0 here. The button press triggers state change to state 1, where the main filtering process takes place.

2. **State 01: Filtering**

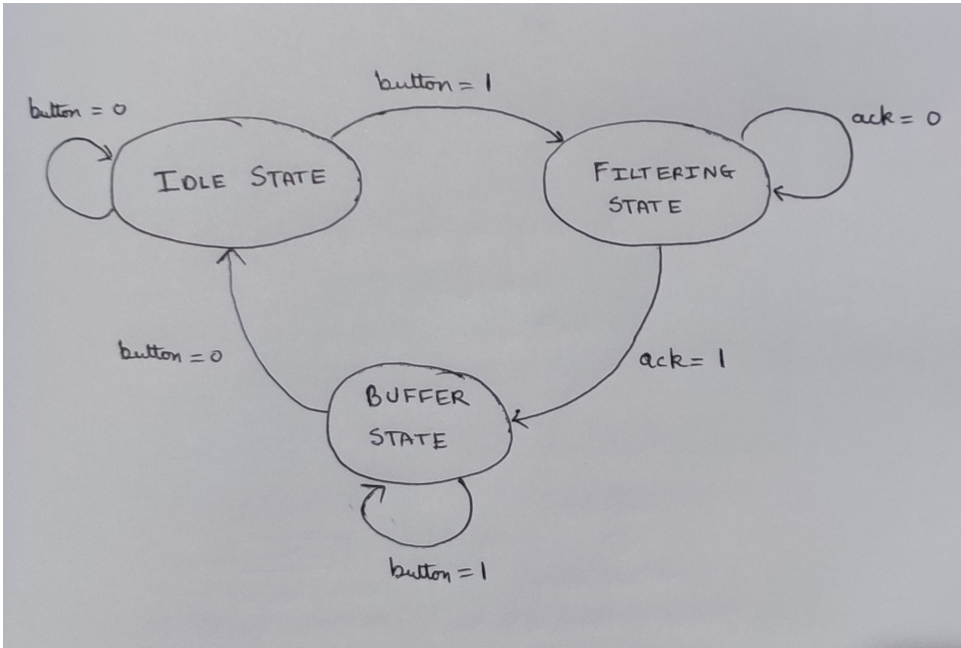
This is the main state. Whenever the user presses to button (to start filtering) this state is reached. The processes involved in this state are quite complicated, and so, they are subdivided into 4 different sub-states

- **Sub-state 00: Setting Addresses RAM/ROM** | Here the addresses to be read and write by the RAM and ROM are set, according to the position (in the filtering matrix) being considered.
- **Sub-state 01: Accessing data and performing MAC operations** | Here the data from the addresses set in sub-state 00 are accessed and operations are performed using the MAC. The pixel values are extended to 9 bits, and then passed to MAC. If the current position is the last, it goes to the next sub-state, otherwise, it goes back to sub-state 00 and the addresses for the next position are set.
- **Sub-state 10: Write Data** | Here, the value obtained by the MAC is stored in the corresponding address for the filtered image. If the value is negative, it is set to 0. After this, it goes to the next sub-state.
- **Sub-state 11: Next Pixel** | Here the next pixel in the image is considered. If there is a next pixel, it goes back to sub-state 00 and the process is repeated for that pixel. If there are no pixels left, it sets ack to '1', and the filtering process is over.

When ack is set to '1' in sub-state 11, the state changes to state 10, which is the buffer state.

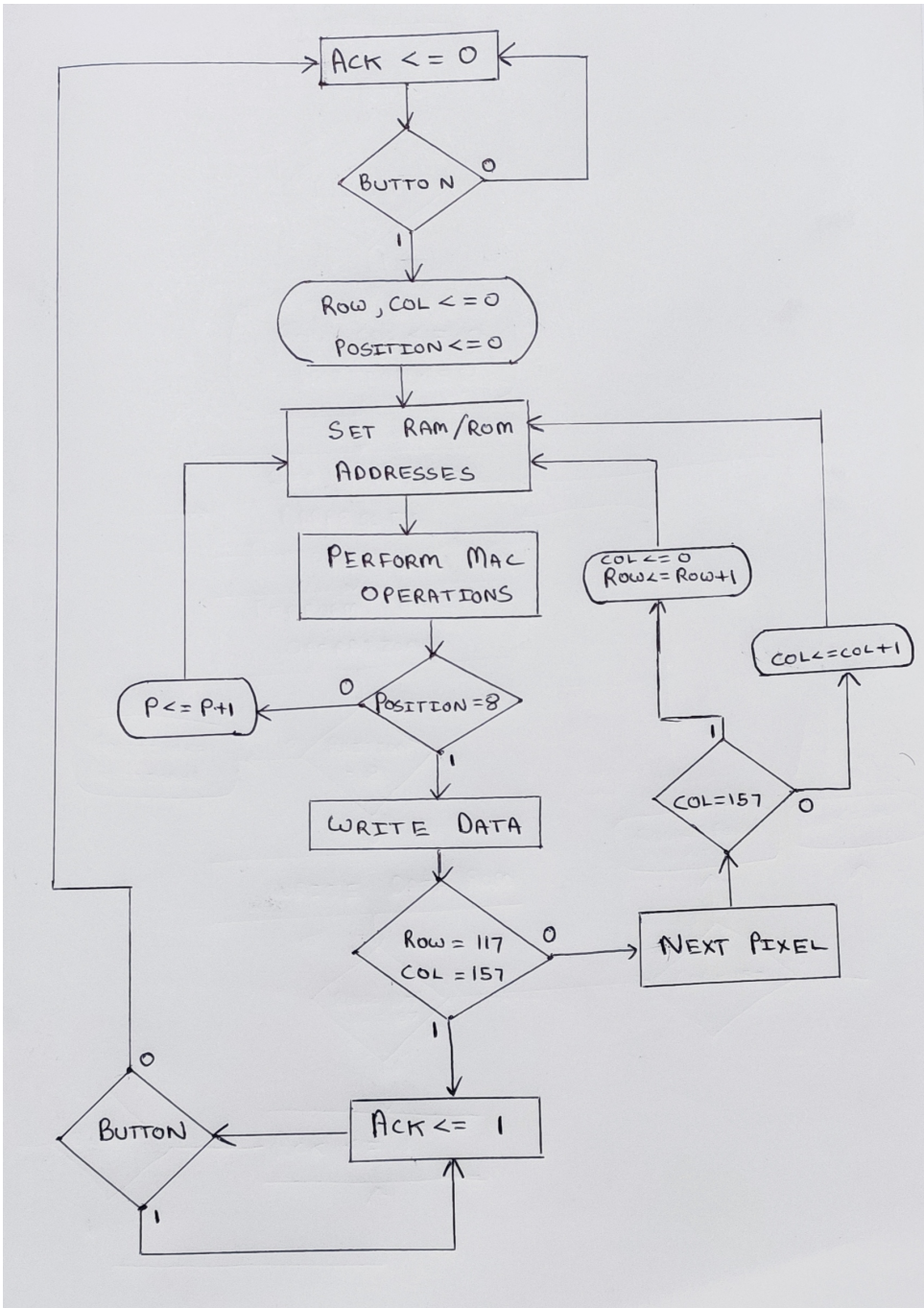
3. **State 10: Buffer** This is simply a buffer state to stop the system from performing filtering multiple times if the button stays pressed for many clock cycles. As soon as the button is released, the state is changed to the idle state, where it again waits for the button to be pressed.

The different processes involved and the states (super-states) can be summarised in the FSM below.



FSM for super states

The complete description along with the ASM having the sub-states can be seen below.



ASM containing all sub-states