Technical Disclosure Commons

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Composable MicroLED monitors

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With advancements in microLED display technology, it will soon be possible to make microLED-based screens in smaller sizes. Just as for their larger LED-based cousins, it should be possible to eliminate bezels, and in doing so allow large displays to be constructed from smaller tiles. In such systems there is a need to simplify setup for consumers and to make the configuration obvious to the user and available to the operating system. In addition, it may be necessary to disguise the joints between adjacent panels.

Accordingly, we propose a desktop computer monitor constructed by end-users from a set of Lego-like building blocks. The blocks allowing both flat and curved monitors, in both horizontal and vertical configurations, and which, through their construction, make the mapping between screen blocks and physical displays easy for users to understand and available to the operating system. We also consider the possibility of visible joints and propose techniques to minimize those.

As will be explained below, we can support scores of different display types with only three active components: a core unit, a flat extension, and a curved extension. These are shown in figure 1 in a stylized form:
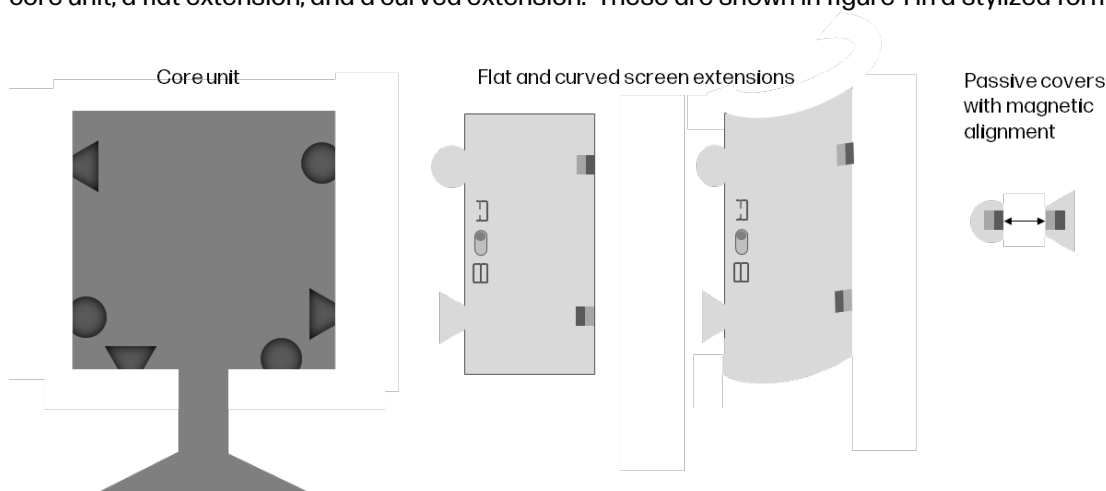

Figure 1

Having both a direct wired connection to the computer and a physical mount, the core unit can be used standalone or as a building block for a larger monitor. It is square to enable consistent side and bottom extensions. (It would of course also be possible to support top extensions, but we're trying to keep the number of configurations manageable).   The extensions connect to the core in a similar way to a jigsaw. Magnets are also available to help align adjacent displays.

As an aside, the core unit and flat extension can themselves be constructed from smaller square modules, the core unit from 4, and each extension from 2. As shown in Figure 2

Figure 2

Selecting among configurations may be complicated for users and so to simplify this we limit the possible options and use a physical switch on each extension to select if it should be contiguous or separate from its neighbor. See

Figure 3.
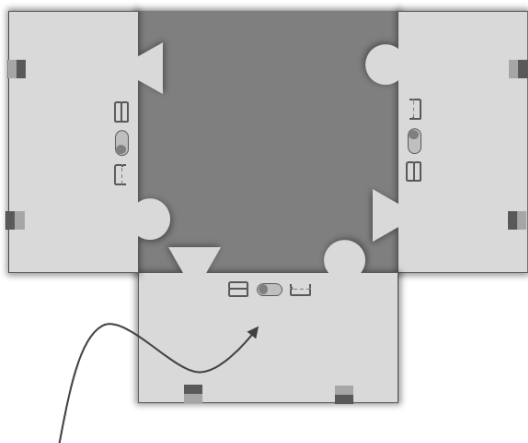
Physical switches allow a choice between a continuation of the same physical screen and a separate screen

Figure 3

The core-to-extension connection includes an electrical connection, allowing seamless connectivity to the core unit. They will only physically connect in ways that will function correctly as displays. The magnets in the passive connection covers and extension edges are strong enough to hold adjacent displays together, but not strong enough to support the weight of an extension. Since extensions require core units for support, users are prevented from creating a sequence of extensions which may be mechanically inadvisable (and which would complicate the mapping of display components to physical displays).

It is helpful for the core and extensions to automatically determine their relative positions. In one example this is achieved by the core unit knowing which connections are in use. In another example the "passive" connection between core units could aid in determining the relative location. For example a connector could indicate to the core unit that it's "the left side of connector with ID #24 to one monitor, while reporting to the other monitor that it's "the right side of that connector" This information could be reported using a wired connection (for example using pogo pins), or with a wireless connection (for example an RFID reader on one side and RFID tags on the other).

Two examples of displays constructed by combining core and extension blocks are shown in Figure 4:

Two adjacent core displays may be electrically separate, each having it's own cable connection to the PC, so no switches are needed on the core units. They are connected by magnets to aid in hiding the joint between displays.
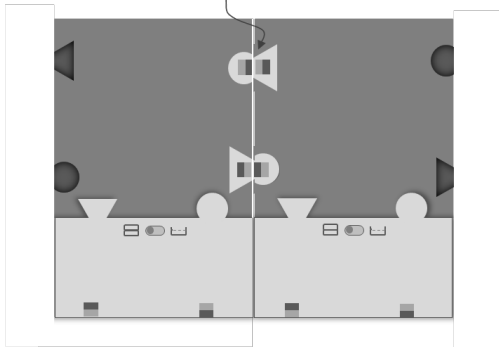
Similarly, two adjacent extensions are similarly only connected passively (this both simplifies connectivity and avoids mistakes since the magnets are not strong enough to support the extension, the user can't accidentally try and incorrectly connect multiple extensions
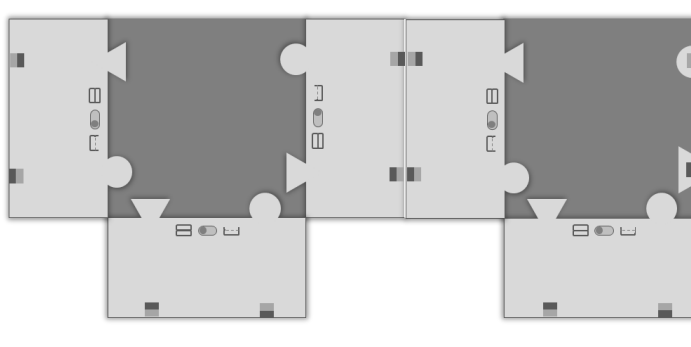
Figure 4

By combining core, flat and curved extensions we can create a wide range of different monitor sizes. In the following examples we're choosing 12" as our basic building size, so there is one main anchor piece that's 12"x12" and has a base and the wired connections to a PC, and then a flat extension that's 12"x6" and a curved extension that's 12"x6". (We don't have to use these particular sizes; however, the length of the block should be the same as both the height and width of the core to simplify extending vertically as well as horizontally.)

A range of flat and curved monitors are possible in different sizes which are shown in Figure 5. To make that manageable and easy to explain we introduce just two rules:

1. Every core unit has a direct connection to the host computer.

2. Every extension is mechanically and electrically connected to either the side or bottom of a core unit.
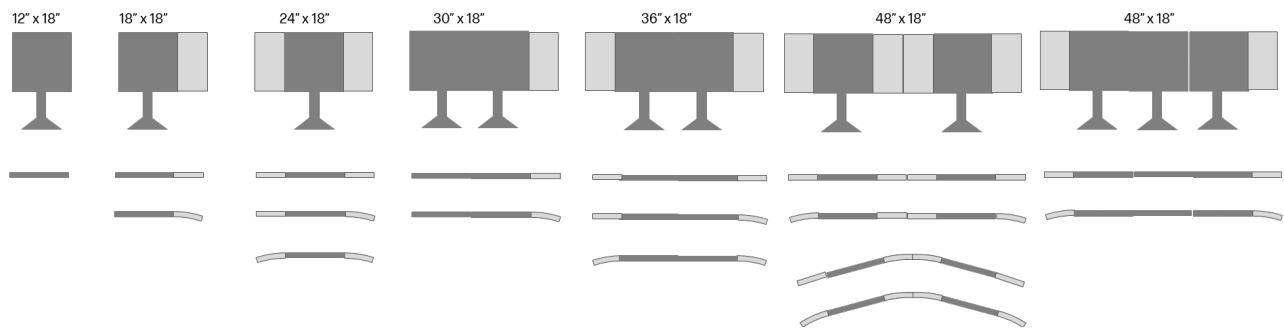
Here are some horizontal examples:

Figure 5

And we can also extend the displays vertically using the same flat and curved extensions as shown in Figure 6:
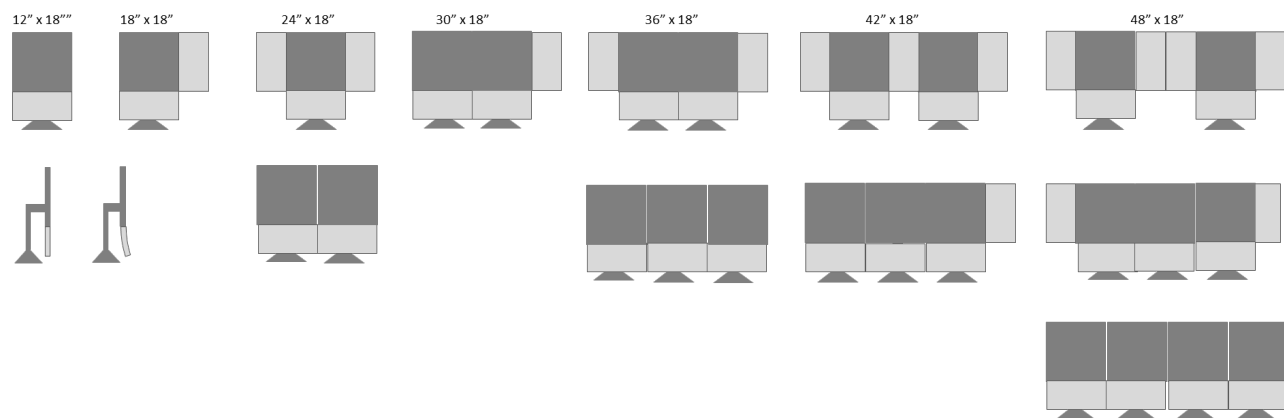
Figure 6

Other variants on this design are also possible. In a simpler case we could remove the curved extension, only allowing flat screens. In a more complicated case, we could add a curved core module and an additional doubly curved extension, allowing additional curved screens. In a yet more complicated approach, we could introduce additional sizes (for example a smaller square extension to fill in the missing corner when extensions are added horizontally and vertically.

By a combination of the connections and switches the user can choose how the operating system will treat the displays. For example, if the configuration was:
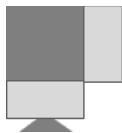
Figure 7a:Simple default configuration

Then a user could choose any of these variants in an intuitive way by simply using the switches.
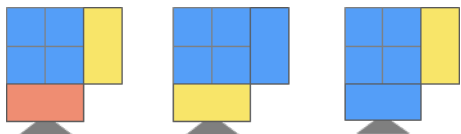

Figure 7b: Multiple configurations.

Users may prefer one of those based on their application. For example, a video editor may prefer the middle one since it has a wider screen on top for video and a smaller panel below for editing controls, while a coder may prefer the rightmost example since it has a larger vertical screen for viewing code and a side screen for viewing tasks and social media. Of course, the usual ability in most modern operating systems to combine multiple physical displays to one larger display is also available, and so the user could choose the left-most option and then alter the configuration whenever they needed using the Windows controls, or alternatively take any of those and ask Windows to "extend" them into one logical display Figure 7c:
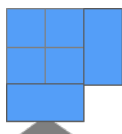

Figure 7c: logical stitching of odd shape screen.

For simplicity, core units are always disjoint (each having its own cable to the computer), so if the configuration was shown I Figure 8a:

Figure 8a

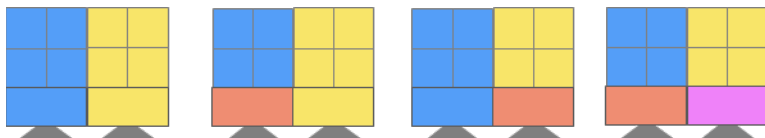then it can be configured via the switches in any of four different ways shown in Figure 8b:

Figure 8b

Recall that operating system can combine any of those disjoint physical screens into one virtual screen, for example it could give you one which acts like this shown I Figure 8c:
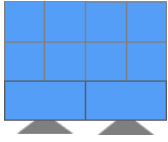
Figure 8c: Rectangular logical stitching.

In this way, by using a combination of physical affordances and Windows controls we can provide the user with a wide range of options in a simple way, and they can choose a primarily hardware-based solution (which is simpler using the physical switches) or a primarily software-based solution (which is more flexible).

To make all but the most trivial single core display we need to join blocks together and it's desirable to hide that. The simplest technique is using careful mechanical design to minimize the gap between adjacent connected blocks and just accept that users may see a thin line.

We have also considered alternatives, and we discuss those here:

An ideal solution would require that rays originating from pixels near the boundary between adjacent panels would propagate across the boundary without any distortion caused by reflection or refraction. This could happen if the boundary planes are coated with the appropriate IR coating, and the space between boundaries was filled with the appropriate material compensating difference in dielectric constants (possible – there are optical greases that could be used). However, this is not a practical solution (who wants to grease side of the panel). Ray crossing the boundary between adjacent panels will behave as shown Figure 9a, 9b, 9c and 9d:
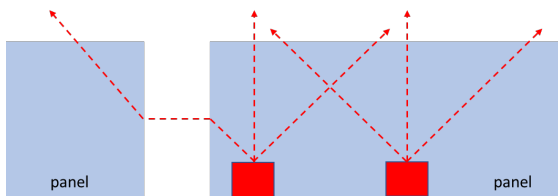

Figure 9a

Alternatively, effect of different dielectric constants could be minimized by bringing the boundary planes closer than fraction of the wavelength (practically, less than ¼ wavelength – ray doesn't "see" that it is passing through the region with different dielectric constants – see below). This is not a practical solution either – spacing between the panels would have to less than ~ 0.1um – 0.2 um.
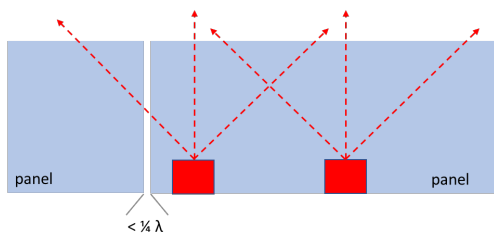

Figure 9b

Using angled or overlapping boundaries could somewhat reduce the challenge but the distortion may still be visible:
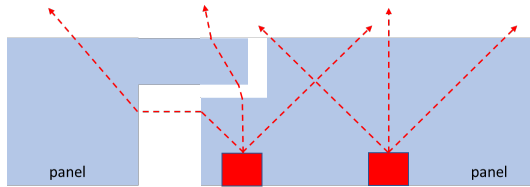
Figure 9c

One possible solution is to use materials with continuously variable refractive index in a way to compensate for distortion caused by the boundary, as shown below. This solution is not easy to implement but possible.
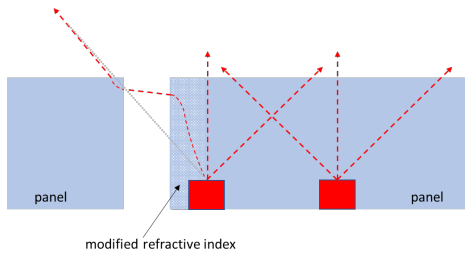

Figure 9d

Yet another approach, which could be combined with solution shown in Figure 3, is to mask distortion caused by the boundary by appropriately distorting displayed image (problem solution in software). In this case a solid computation engine would need to be added to adjust displayed image along the edges in a way that takes out physical image distortion with the adjusted image This would not be an easy computation). This could be done by overlapping the original image with the appropriate image of rays along the edges obtained by from the calculation.

In addition, we note that the displays "know" their connectivity and so, if necessary, they can modify the display of edge pixels to try and minimize visible joints. For example, the LEDs along a connected edge may be assigned a higher brightness to compensate for light lost due to the joint, or the image near the edge may be distorted to pre-compensate for any distortion introduced by the edges. In an extension, any distortion/compensation could be varied based on the user's head position and/or gaze.

While totally hiding the joint between panels is challenging, perhaps nothing needs to be done. There are large TV sets made of panels where edges are hard to see, and they don't appear to use any special tricks. So, with panels fabricated with high enough accuracy and a mechanical design which aids alignment, we may not need any special treatment.

In an additional embodiment, the extensions need not be displays, but could provide different functionality, for example, lights or cameras or speakers/transducers. In these cases, it could be especially helpful to know the relative positions of those via the same mechanism used for determining the relative position of monitors. For example, a single speaker extension could be used on both the left and right and reported as such for correct stereo or spatial sound.

In an additional embodiment, an extension could be a different display technology, for example eInk or OLED, allowing additional options.

Advantages

Allows a wide range of different monitors to be constructed using only 2 active components (for flat screens), or 3 active components (for some partially curved screens). The design makes it impossible for the user to construct a monitor which is mechanically unsound, or one where some portion lacks an electrical connection. The switches provide an intuitive mechanism for controlling the mapping between display components and screens as seen by the Operating System. It is also easy to explain and understand.

To differentiate from prior work, we have this combination of features:

- specifically, for microLED computer displays which do not require a bezel.

- combines core units (each of which has connectivity to the host PC) and extensions (which have connectivity only to a core unit)

- has a switch on each extension to control if it should appear to extend or be a separate display when exposed to the host operating system.

- provides mechanical connectivity via an asymmetrical jigsaw-type connection which prevents incorrect assembly of a single monitor and uses magnets for alignment between adjacent monitors.

- provide mechanisms which may minimize the line between display components.

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