How-To Guide for SDL and HDMI Output

This is a How-To-Guide to set up a C program on the BeagleY-AI for HDMI output to an LCD screen via the Simple DirectMedia Layer (SDL) library. The context relating to this How-To-Guide involves our project: our project implements a Nintendo GameBoy Emulator for use on the BeagleY-AI hardware. The emulator was written in C, using external buttons and a joystick for input control and the micro-HDMI port of the BeagleY-AI to display the emulated GameBoy screen.

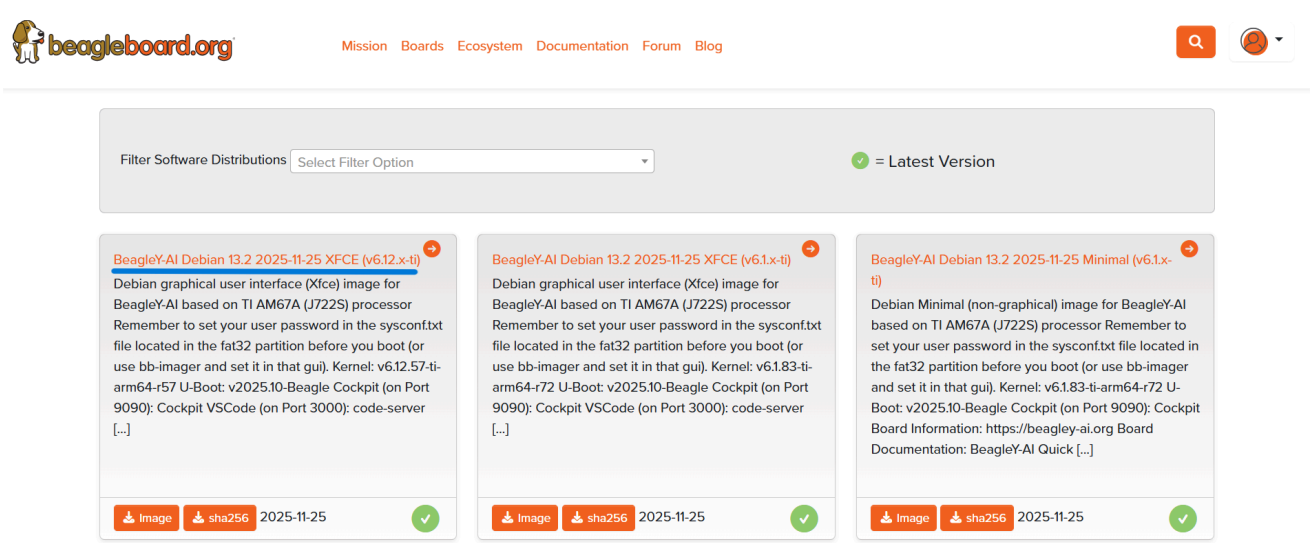
Display functionality was managed using SDL3 [1]. SDL3 is a cross-platform library that provides a hardware abstraction layer for managing display and audio. It is written in C and must be compiled and deployed separately on both the target and host.

The main sections of this guide are:

1. Install the Graphical User Interface BeagleBone Software Image
2. Cross-Compile SDL3 on Host (Debian VM)
3. Install SDL3 on BeagleY-AI target
4. Troubleshooting

Install the Graphical User Interface BeagleBone Software Image

1. Visit the official BeagleBoard website [2] and select the latest graphical user interface (Xfce) image for the BeagleY-AI:



2. Install the image and follow the course guides to properly set up.
3. Verify that the graphical user interface is enabled when you connect the BeagleY-AI to a monitor (micro-HDMI), keyboard (USB), and mouse (USB).

Cross-compile SDL3 on Host (Debian VM)

1. Install the dependencies of SDL3 using the built-in apt package manager:

```
(host)$ sudo apt-get update
(host)$ sudo apt-get install git cmake make pkg-config \
            libasound2-dev libx11-dev libxext-dev libxrandr-dev \
            libxi-dev libxcursor-dev libxinerama-dev libxss-dev \
            libglu1-mesa-dev libwayland-dev libxkbcommon-dev \
            libdrm-dev libgbm-dev libudev-dev
```

2. Clone and build SDL3 for aarch64:

```
(host)$ cd ~
(host)$ mkdir -p src && cd src
(host)$ git clone https://github.com/libsdl-org/SDL.git
(host)$ cd SDL
(host)$ mkdir build-aarch64 && cd build-aarch64

(host)$ cmake .. \
  -DCMAKE_BUILD_TYPE=Release \
  -DCMAKE_SYSTEM_NAME=Linux \
  -DCMAKE_SYSTEM_PROCESSOR=aarch64 \
  -DCMAKE_C_COMPILER=aarch64-linux-gnu-gcc \
  -DCMAKE_CXX_COMPILER=aarch64-linux-gnu-g++ \
  -DCMAKE_INSTALL_PREFIX=/opt/aarch64-sdl2

(host)$ cmake --build . --parallel 2
(host)$ sudo cmake --install .
```

Install SDL3 on BeagleY-AI Target

1. Install the dependencies of SDL3 using the built-in apt package manager:

```
(byai)$ sudo apt-get update
(byai)$ sudo apt-get install git cmake build-essential \
            libx11-dev libxext-dev libxrandr-dev libxi-dev \
            libxcursor-dev libxinerama-dev libxss-dev libxtst-dev \
            libxxf86vm-dev libxfixes-dev \
            libwayland-dev libxkbcommon-dev \
            libdrm-dev libgbm-dev libudev-dev \
            libasound2-dev libpulse-dev libjack-jackd2-dev \
            libsamplerate0-dev libsndio-dev \
            libdbus-1-dev libibus-1.0-dev \
            libgl1-mesa-dev libgles2-mesa-dev libegl1-mesa-dev
```

2. Build and install SDL3 on BeagleY-AI:

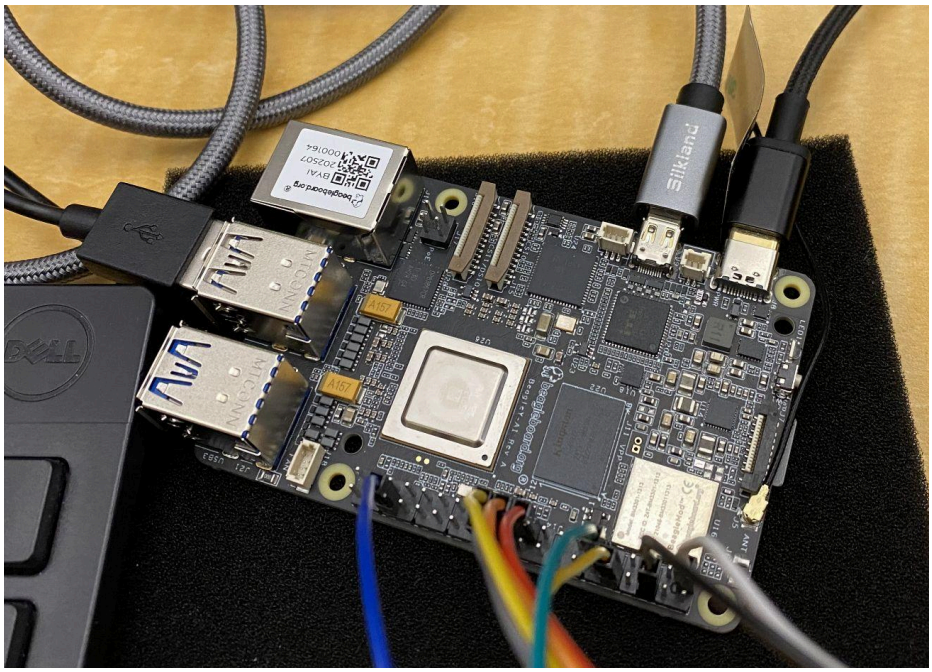
```
(byai)$ cd ~
(byai)$ git clone https://github.com/libsdl-org/SDL.git
(byai)$ cd SDL
(byai)$ mkdir build && cd build

(byai)$ cmake .. -DCMAKE_BUILD_TYPE=Release -DCMAKE_INSTALL_PREFIX=/usr/local
(byai)$ cmake --build . --parallel 2
(byai)$ sudo cmake --install .
(byai)$ sudo ldconfig
```

3. Verify SDL3 installation:

```
(byai)$ ldconfig -p | grep SDL3
# Should show: libSDL3.so.0 => /usr/local/lib/libSDL3.so.0
```

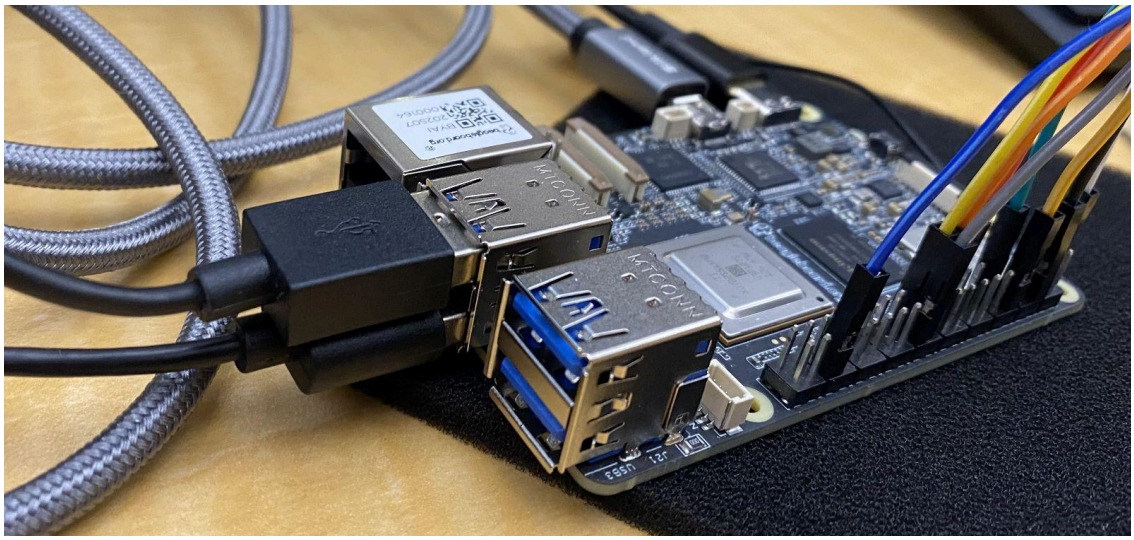
Hardware Connections



The top right corner of the above image shows two input cable connections into the BeagleY-AI: the left silver-colored input cable is a micro HDMI to HDMI display cable (micro HDMI plugs into the BeagleY-AI; HDMI plugs into the monitor), and the right cable is a USB-C to USB-A cable used for power (USB-C plugs into the BeagleY-AI; USB-A side plugs into your laptop). The colored wiring into the pins of the BeagleY-AI can be ignored.

The image above shows the HDMI side of the micro HDMI to HDMI display cable plugged into the monitor's HDMI port.

The Image above shows the USB-A side of the A-to-C cable plugged into the USB port on the laptop. Since this cable is only for power, you can alternatively use a C-to-C cable.



In the above image, the 2 USB cables plugged into the BeagleY-AI from the left side are the keyboard and mouse. The order and specific USB port does not matter.

Once the connections are done, you should be seeing a similar display that shows the GUI of the Debian system that is installed on your BeagleY-AI. Your mouse should be fully functional, and when you open the Terminal Emulator application your keyboard should be functional as well.

Troubleshooting

If you encounter any problems while setting up SDL3 and the BeagleY-AI graphical user interface, you can try some of the steps below:

- **Error cloning the SDL repository:** Refer to the Networking guide on the course website to ensure that your host and target each have internet access enabled.
- **BeagleBone crashing when running `cmake --build command`:** Try running this command without the `--parallel 2` flag.
- **Missing packages:** Ask ChatGPT or another chatbot of your choice for assistance with installing the correct packages.
- **Other:** First try consulting AI (it helped us immensely with this setup) and then speak with a TA or classmates who may be able to help.

References

[1] "SDL3 Front Page," *SDL Wiki*, [Online]. Available: https://wiki.libsdl.org/SDL3/FrontPage. [Accessed: November 29, 2025]

[2] BeagleBoard.org Foundation, "Latest Software Images," BeagleBoard.org. https://www.beagleboard.org/distros (accessed Dec. 2, 2025).