카메라 모듈 제어

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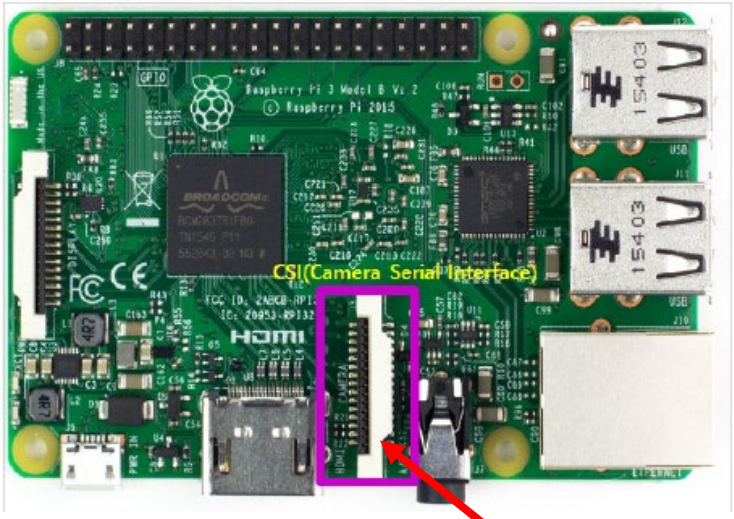
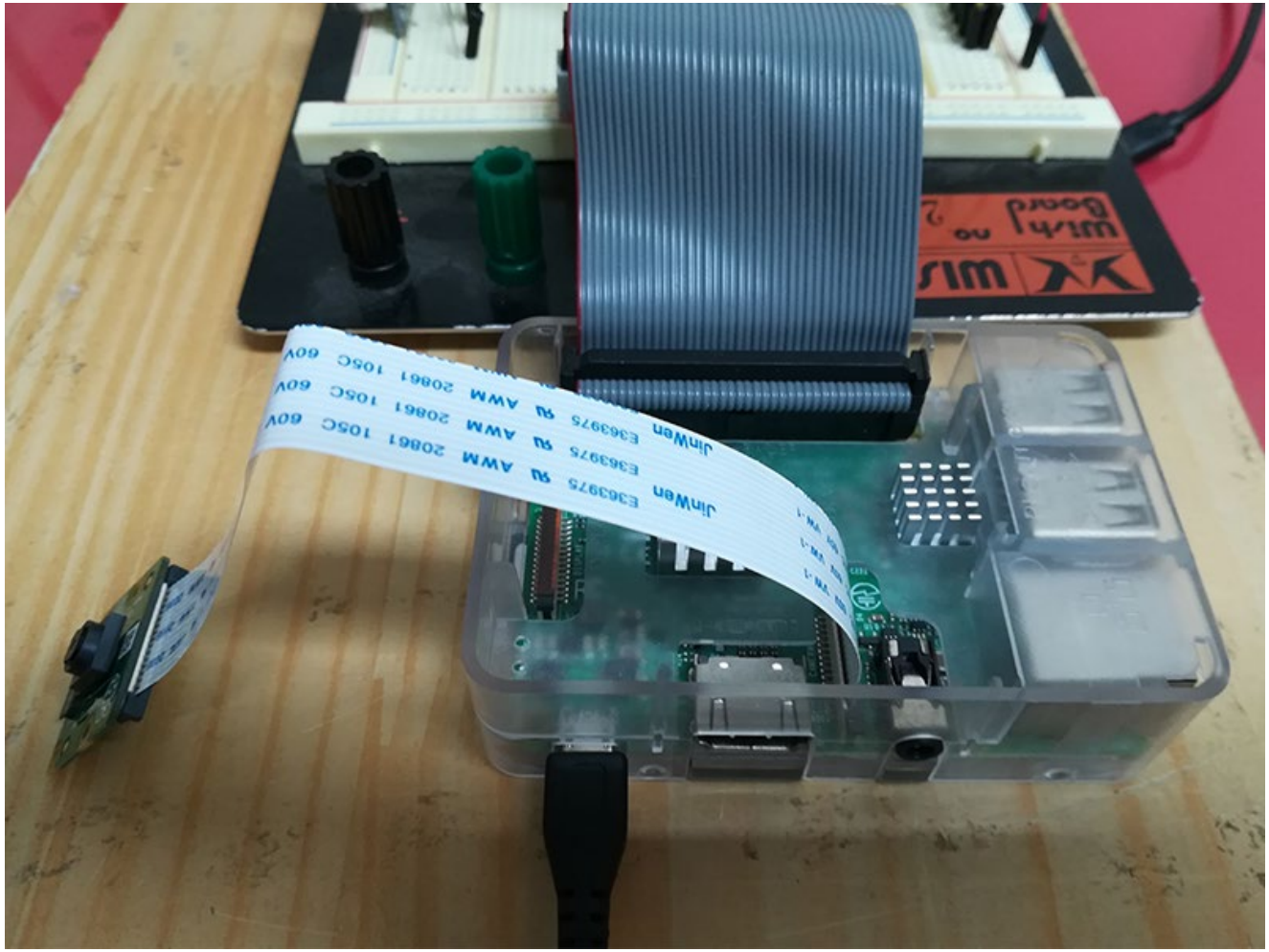
라즈베리 파이 카메라 모듈

- 카메라 모듈을 이용해 사진 및 영상을 고화질로 촬영할 수 있음.
- 카메라 모듈과 라즈베리 파이의 CSI 카메라 포트를 FFC 케이블로 연결함.



FFC: Flexible Flat Cable
CSI: Camera Serial Interface

카메라 모듈 연결



라즈베리 파이와 카메라 모듈의 통신

- 카메라 모듈의 제어는 I^2C 통신을 통해 이루어 지고, 데이터의 전송은 병렬 통신을 통해 이루어짐.

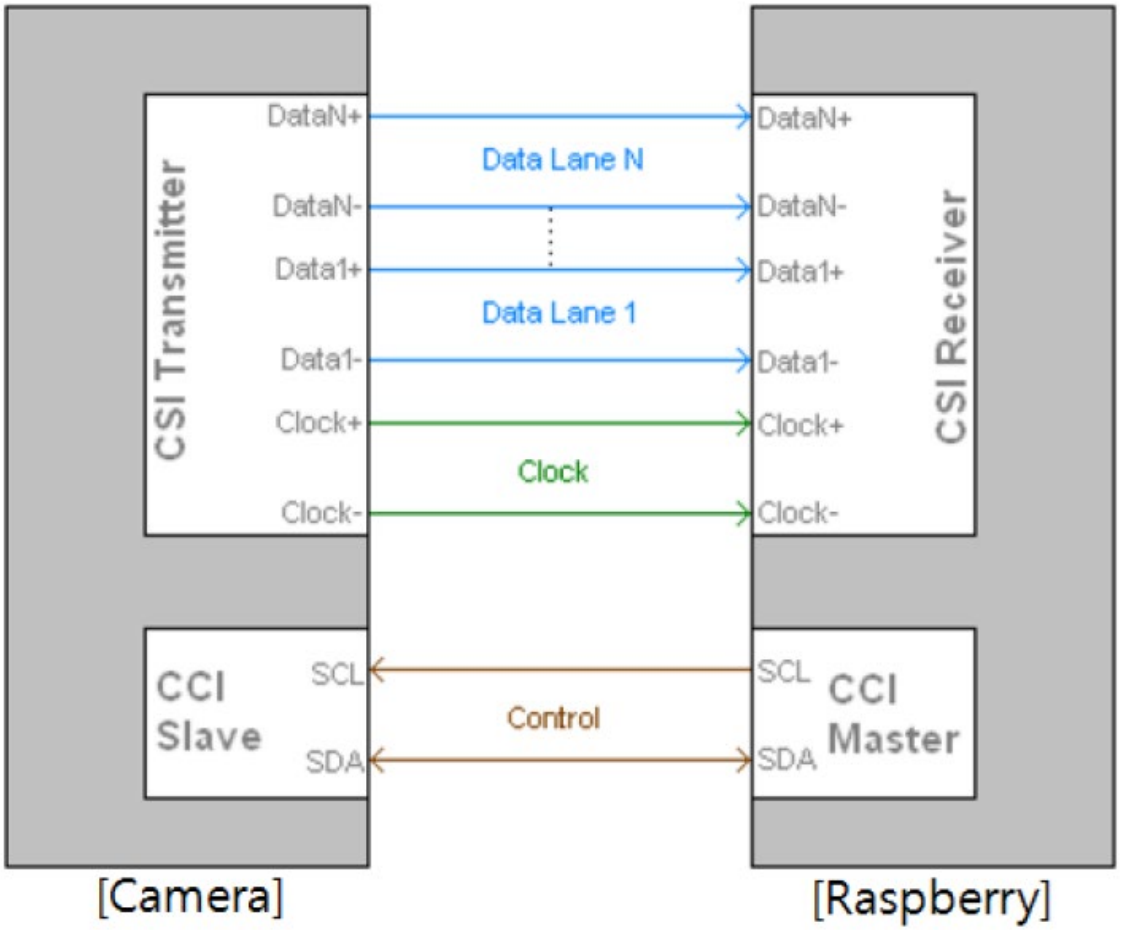


사진 촬영 명령어

- libcamera-still 명령어는 카메라 모듈을 이용해 사진을 촬영하는 명령어임.
- 명령어 사용법

  $ libcamera-still [option]
    - 다양한 옵션을 붙여 사진을 촬영할 수 있음.
- 사용 예

  $ libcamera-still -o test.jpg
    - 사진을 촬영한 후, test.jpg라는 이름으로 사진 파일을 저장함.

libcamera-still의 다양한 옵션 (1/5)

$ libcamera-still -h

- 카메라 공통 옵션

```
Valid options are:
  -h [ --help ] [=arg(=1)] (=0)         Print this help message
  --version [=arg(=1)] (=0)             Displays the build version number
  --list-cameras [=arg(=1)] (=0)        Lists the available cameras attached to the system.
  --camera arg (=0)                     Chooses the camera to use. To list the available indexes, use the
                                        --list-cameras option.
  -v [ --verbose ] [=arg(=2)] (=1)      Set verbosity level. Level 0 is no output, 1 is default, 2 is verbose.
  -c [ --config ] [=arg(=config.txt)]   Read the options from a file. If no filename is specified, default to
                                        config.txt. In case of duplicate options, the ones provided on the command line
                                        will be used. Note that the config file must only contain the long form
                                        options.
  --info-text arg (=#%frame (%fps fps) exp %exp ag %ag dg %dg)
                                        Sets the information string on the titlebar. Available values:
                                        %frame (frame number)
                                        %fps (framerate)
                                        %exp (shutter speed)
                                        %ag (analogue gain)
                                        %dg (digital gain)
                                        %rg (red colour gain)
                                        %bg (blue colour gain)
                                        %focus (focus FoM value)
                                        %aelock (AE locked status)
                                        %lp (lens position, if known)
                                        %afstate (AF state, if supported)
```

libcamera-still의 다양한 옵션 (2/5)

```
--width arg (=0)                    Set the output image width (0 = use default value)
--height arg (=0)                   Set the output image height (0 = use default value)
-t [ --timeout ] arg (=5sec)        Time for which program runs. If no units are provided default to ms.
-o [ --output ] arg                 Set the output file name
--post-process-file arg             Set the file name for configuring the post-processing
--post-process-libs arg             Set a custom location for the post-processing library .so files
-n [ --nopreview ] [=arg(=1)] (=0)  Do not show a preview window
-p [ --preview ] arg (=0,0,0,0)     Set the preview window dimensions, given as x,y,width,height e.g. 0,0,640,480
-f [ --fullscreen ] [=arg(=1)] (=0) Use a fullscreen preview window
--qt-preview [=arg(=1)] (=0)        Use Qt-based preview window (WARNING: causes heavy CPU load, fullscreen not
                                    supported)
--hflip [=arg(=1)] (=0)             Request a horizontal flip transform
--vflip [=arg(=1)] (=0)             Request a vertical flip transform
--rotation arg (=0)                 Request an image rotation, 0 or 180
--roi arg (=0,0,0,0)                Set region of interest (digital zoom) e.g. 0.25,0.25,0.5,0.5
--shutter arg (=0)                  Set a fixed shutter speed. If no units are provided default to us
--analoggain arg (=0)               Set a fixed gain value (synonym for 'gain' option)
--gain arg                          Set a fixed gain value
--metering arg (=centre)            Set the metering mode (centre, spot, average, custom)
--exposure arg (=normal)            Set the exposure mode (normal, sport)
--ev arg (=0)                       Set the EV exposure compensation, where 0 = no change
--awb arg (=auto)                   Set the AWB mode (auto, incandescent, tungsten, fluorescent, indoor, daylight,
                                    cloudy, custom)
```

libcamera-still의 다양한 옵션 (3/5)

```
--awbgains arg (=0,0)           Set explict red and blue gains (disable the automatic AWB algorithm)
--flush [=arg(=1)] (=0)         Flush output data as soon as possible
--wrap arg (=0)                 When writing multiple output files, reset the counter when it reaches this
                                number
--brightness arg (=0)           Adjust the brightness of the output images, in the range -1.0 to 1.0
--contrast arg (=1)             Adjust the contrast of the output image, where 1.0 = normal contrast
--saturation arg (=1)           Adjust the colour saturation of the output, where 1.0 = normal and 0.0 =
                                greyscale
--sharpness arg (=1)            Adjust the sharpness of the output image, where 1.0 = normal sharpening
--framerate arg (=-1)           Set the fixed framerate for preview and video modes
--denoise arg (=auto)           Sets the Denoise operating mode: auto, off, cdn_off, cdn_fast, cdn_hq
--viewfinder-width arg (=0)     Width of viewfinder frames from the camera (distinct from the preview window
                                size
--viewfinder-height arg (=0)    Height of viewfinder frames from the camera (distinct from the preview window
                                size)
--tuning-file arg (=-)          Name of camera tuning file to use, omit this option for libcamera default
                                behaviour
--lores-width arg (=0)          Width of low resolution frames (use 0 to omit low resolution stream)
--lores-height arg (=0)         Height of low resolution frames (use 0 to omit low resolution stream)
--lores-par [=arg(=1)] (=0)     Preserve the pixel aspect ratio of the low res image (where possible) by
                                applying a different crop on the stream.
```

libcamera-still의 다양한 옵션 (4/5)

```
--mode arg                          Camera mode as W:H:bit-depth:packing, where packing is P (packed) or U
                                    (unpacked)
--viewfinder-mode arg               Camera mode for preview as W:H:bit-depth:packing, where packing is P (packed)
                                    or U (unpacked)
--buffer-count arg (=0)             Number of in-flight requests (and buffers) configured for video, raw, and
                                    still.
--viewfinder-buffer-count arg (=0)  Number of in-flight requests (and buffers) configured for preview window.
--no-raw [=arg(=1)] (=0)            Disable requesting of a RAW stream. Will override any manual mode reqest the
                                    mode choice when setting framerate.
--autofocus-mode arg (=default)     Control to set the mode of the AF (autofocus) algorithm.(manual, auto,
                                    continuous)
--autofocus-range arg (=normal)     Set the range of focus distances that is scanned.(normal, macro, full)
--autofocus-speed arg (=normal)     Control that determines whether the AF algorithm is to move the lens as quickly
                                    as possible or more steadily.(normal, fast)
--autofocus-window arg (=0,0,0,0)   Sets AfMetering to  AfMeteringWindows an set region used, e.g.
                                    0.25,0.25,0.5,0.5
--lens-position arg                 Set the lens to a particular focus position, expressed as a reciprocal distance
                                    (0 moves the lens to infinity), or "default" for the hyperfocal distance
--hdr [=arg(=auto)] (=off)          Enable High Dynamic Range, where supported. Available values are "off", "auto",
                                    "sensor" for sensor HDR (e.g. for Camera Module 3), "single-exp" for PiSP based
                                    single exposure multiframe HDR
--metadata arg                      Save captured image metadata to a file or "-" for stdout
--metadata-format arg (=json)       Format to save the metadata in, either txt or json (requires --metadata)
--flicker-period arg (=0s)          Manual flicker correction period
                                    Set to 10000us to cancel 50Hz flicker.
                                    Set to 8333us to cancel 60Hz flicker.
```

libcamera-still의 다양한 옵션 (5/5)

- 사진 촬영 전용 옵션

```
-q [ --quality ] arg (=93)            Set the JPEG quality parameter
-x [ --exif ] arg                     Add these extra EXIF tags to the output file
--timelapse arg (=0ms)                Time interval between timelapse captures. If no units are provided default to
                                      ms.
--framestart arg (=0)                 Initial frame counter value for timelapse captures
--datetime [=arg(=1)] (=0)            Use date format for output file names
--timestamp [=arg(=1)] (=0)           Use system timestamps for output file names
--restart arg (=0)                    Set JPEG restart interval
-k [ --keypress ] [=arg(=1)] (=0)     Perform capture when ENTER pressed
-s [ --signal ] [=arg(=1)] (=0)       Perform capture when signal received
--thumb arg (=320:240:70)             Set thumbnail parameters as width:height:quality, or none
-e [ --encoding ] arg (=jpg)          Set the desired output encoding, either jpg, png, rgb/rgb24, rgb48, bmp or
                                      yuv420
-r [ --raw ] [=arg(=1)] (=0)          Also save raw file in DNG format
--latest arg                          Create a symbolic link with this name to most recent saved file
--immediate [=arg(=1)] (=0)           Perform first capture immediately, with no preview phase
--autofocus-on-capture [=arg(=1)] (=0)
                                      Switch to AfModeAuto and trigger a scan just before capturing a still
--zsl [=arg(=1)] (=0)                 Switch to AfModeAuto and trigger a scan just before capturing a still
```

명령어 실습 1

- 2초 후에 사진을 촬영하고, 현재 작업 디렉터리안에 image01.jpg라는 이름으로 사진 파일을 저장하라.

```
cju@raspberrypi:~ $ libcamera-still -t 2000 -o image01.jpg
```

동영상 촬영 명령어

- libcamera-vid 명령어는 카메라 모듈을 이용해 동영상을 촬영하는 명령어임.
- 명령어 사용법

  $ libcamera-vid [option]
    - 다양한 옵션을 붙여 동영상을 촬영할 수 있음.
- 사용 예

  $ libcamera-vid -o test.h264
    - 동영상을 촬영한 후, test.h264라는 이름으로 동영상 파일을 저장함.

libcamera-vid의 다양한 옵션 (1/2)

$ libcamera-vid -h

- 동영상 촬영 전용 옵션

```
-b [ --bitrate ] arg (=0bps)          Set the video bitrate for encoding. If no units are provided, default to
                                      bits/second.
--profile arg                         Set the encoding profile
--level arg                           Set the encoding level
-g [ --intra ] arg (=0)               Set the intra frame period
--inline [=arg(=1)] (=0)              Force PPS/SPS header with every I frame (h264 only)
--codec arg (=h264)                   Set the codec to use, either h264, libav, mjpeg or yuv420
--save-pts arg                        Save a timestamp file with this name
-q [ --quality ] arg (=50)            Set the MJPEG quality parameter (mjpeg only)
-l [ --listen ] [=arg(=1)] (=0)       Listen for an incoming client network connection before sending data to the
                                      client
-k [ --keypress ] [=arg(=1)] (=0)     Pause or resume video recording when ENTER pressed
-s [ --signal ] [=arg(=1)] (=0)       Pause or resume video recording when signal received
-i [ --initial ] arg (=record)        Use 'pause' to pause the recording at startup, otherwise 'record' (the default)
--split [=arg(=1)] (=0)               Create a new output file every time recording is paused and then resumed
--segment arg (=0)                    Break the recording into files of approximately this many milliseconds
--circular [=arg(=4)] (=0)            Write output to a circular buffer of the given size (in MB) which is saved on
                                      exit
--frames arg (=0)                     Run for the exact number of frames specified. This will override any timeout
                                      set.
```

libcamera-vid의 다양한 옵션 (2/2)

```
--libav-video-codec arg (=h264_v4l2m2m)
                                      Sets the libav video codec to use. To list available codecs, run  the "ffmpeg
                                      -codecs" command.
--libav-video-codec-opts arg          Sets the libav video codec options to use. These override the internal defaults
                                      (check 'encoderOptions*()' in 'encoder/libav_encoder.cpp' for the defaults).
                                      Separate key and value with "=" and multiple options with ";". e.g.:
                                      "preset=ultrafast;profile=high;partitions=i8x8,i4x4". To list available options
                                      for a given codec, run the "ffmpeg -h encoder=libx264" command for libx264.
--libav-format arg                    Sets the libav encoder output format to use. Leave blank to try and deduce this
                                      from the filename.
                                      To list available formats, run  the "ffmpeg -formats" command.
--libav-audio [=arg(=1)] (=0)         Records an audio stream together with the video.
--audio-codec arg (=aac)              Sets the libav audio codec to use.
                                      To list available codecs, run  the "ffmpeg -codecs" command.
--audio-source arg (=pulse)           Audio source to record from. Valid options are "pulse" and "alsa"
--audio-device arg (=default)         Audio device to record from.  To list the available devices,
                                      for pulseaudio, use the following command:
                                      "pactl list | grep -A2 'Source #' | grep 'Name: '"
                                      or for alsa, use the following command:
                                      "arecord -L"
--audio-channels arg (=0)             Number of channels to use for recording audio. Set to 0 to use default value.
--audio-bitrate arg (=32kbps)         Set the audio bitrate for encoding. If no units are provided, default to
                                      bits/second.
--audio-samplerate arg (=0)           Set the audio sampling rate in Hz for encoding. Set to 0 to use the input
                                      sample rate.
--av-sync arg (=0us)                  Add a time offset (in microseconds if no units provided) to the audio stream,
                                      relative to the video stream. The offset value can be either positive or
                                      negative.
```

명령어 실습 2

- 10초 동안 동영상을 50 FPS(Frames Per Second)로 촬영하고, video.h264라는 이름으로 동영상 파일을 저장하라.

  $ libcamera-vid -t 10000 --framerate 50 -o video.h264

- 동영상 재생하기.

  $ cvlc -q --play-and-exit video.h264

예제 (1/2)

- 버튼을 눌러 사진 촬영하기

```
#include <wiringPi.h>
#include <stdio.h>
#include <stdlib.h>

int main()
{
    wiringPiSetup();

    const int button=7; // 빨간색 버튼

    pinMode(button, INPUT);

    int prev=HIGH;
    int count=0;
    char command[80]="";
```

예제 (2/2)

```
    while(1){
        const int cur=digitalRead(button);

        if(prev==HIGH && cur==LOW){
            ++count;
            sprintf(command, "libcamera-still --width 320 --height 240 -o picture%d.jpg", count);
            printf("%s\n", command);
            printf("Take a picture!\n");
            system(command);
        }

        prev=cur;
        delay(20);
    }

    return 0;
}
```

질문

Q&A