

Evaluation system of open platform cameras for bio-imaging

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DRESDEN

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INTRODUCTION

Gel Document System

- An immediate device for taking images of the gel after electrophoresis for analysis.
- Used in DNA fingerprinting used in research methods and forensics, and for analyzing base sequences

Bio imaging Sensors

- Commercial equipment using expensive CCD sensors and photographing equipment such as DSLRs
- A large price burden and a large focal length.



Open platform Camera Sensors

- Development of mobile devices such as smartphones, it has become easy to obtain ultra-high-quality, low-cost open platform-based cameras.
- Not only small in size, but also has a short focal length, which makes it possible to implement a small system at a low cost.

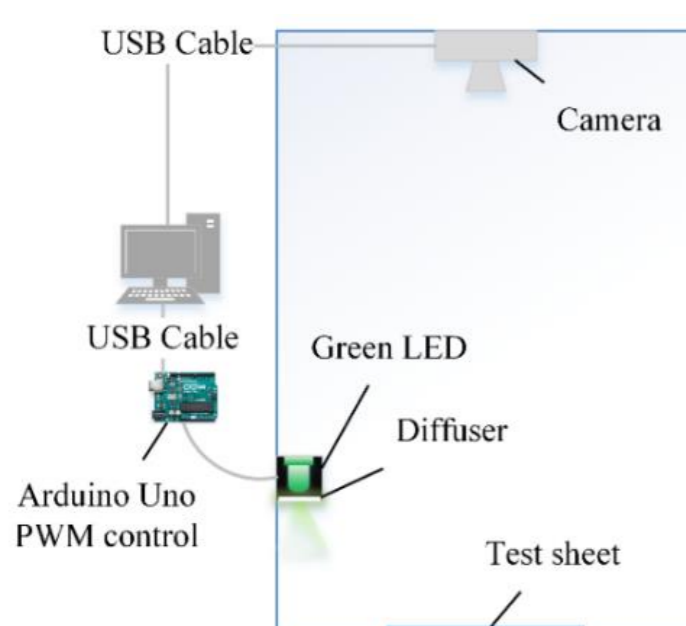


Low-Cost Gel Document System

- An emulation test comparing the linearity of slope according to the brightness of the other three open platform cameras.
- Compared the band volume of the agarose gel image after gel electrophoresis taken with Canon 1100D (DSLR), Sony IMX179, and AR0130.

Materials & Method

Gel Document Emulation System Configuration



Bio-imaging Sensors

DSLR Camera



Canon EOS 1100D

1. Cost : KRW 479,500 ~
2. Lens : EF-S 18-55mm f/3.5-5.6 IS STM
3. Size : 130 * 100(mm)

IMX179



HBVCAM-8M1822 V11

1. Cost : \$36 ~
2. Lens : Lens included
3. Size : 38 * 38(mm)

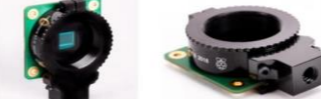
AR0130



KYT-U130-CS2812

1. Cost : \$35 ~
2. Lens : CS mount varifocal, 2.8~12mm lens
3. Size : 38 * 38(mm)

Pi Camera



Raspberry Pi High Quality Camera

1. Cost : ;
2. Lens : 8-50 Zoom lens
3. Size : 38*38(mm)

EXPERIMENT

Gel-Doc Emulation System

- The first to the sixth-order equation was used to find the minimum order at which the fitted error no longer decreases.
- The function obtained by fitting the calculated minimum order to the image taken in the brightest illumination for each camera .
- While dimming the illumination, the function to be fitted was assumed to be the result of multiplying the function value by a constant less than 1.



Gel Photographing

- To verify the proposed emulation system, a UV trans-illuminator was attached to the bottom and renovated to a gel-document system.
- Photographed by attaching an emission filter to the DSLR used in the commercial system, and the IMX179, and the newly selected AR0130.
- Added the nuclease-free water to the amplicon obtained by amplifying CT (Chlamydia Trachomatis) DNA, dilute it to a concentration of 1, 1/2, 1/5, 1/10, 1/20, and insert it into agarose gel(0.5x TBE).

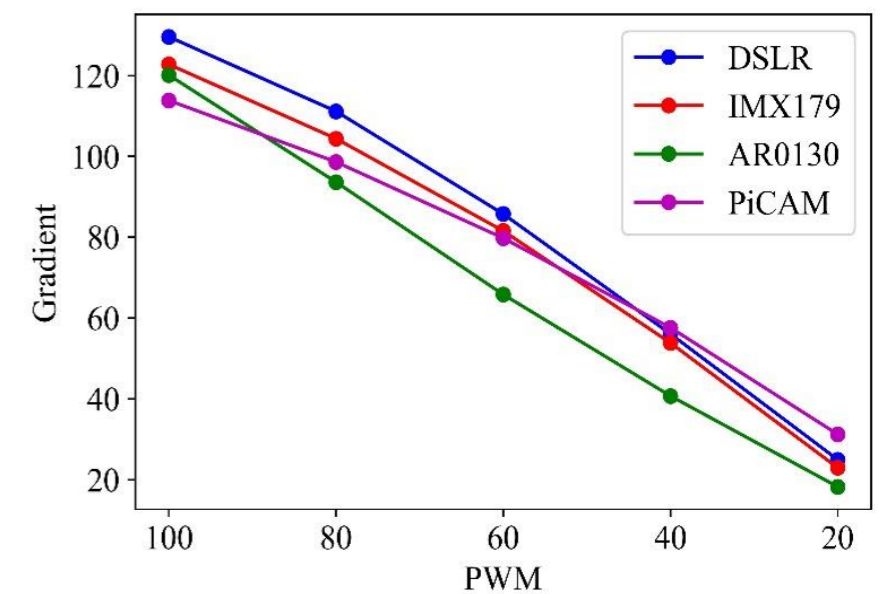


Gel Analysis

- The gel images were matched equally using the OpenCV function, and the band images to be used for analysis were output.
- Since the brightness of the gel may decrease depending on the UV exposure time, two gels were used in the two camera experiments to alternately take pictures and compare.

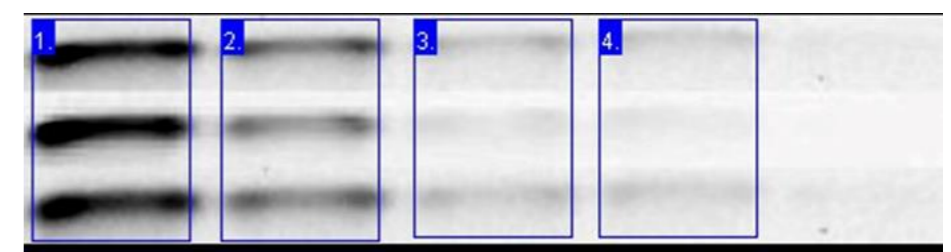
RESULTS

Gradient by the first PWM for each camera

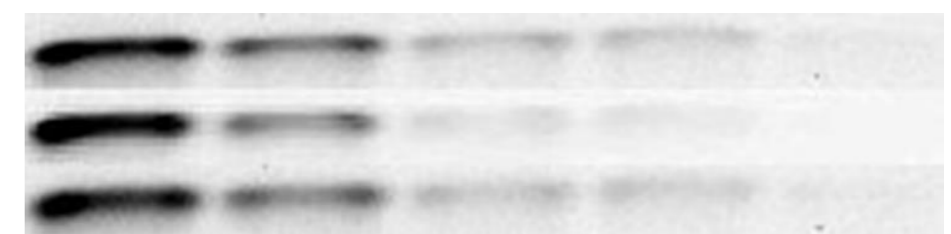


- The change in gradient was proportional to the brightness of all cameras, and the slope of AR0130 was the most linear.
- The relationship between the PWM of each camera and the error of each order was analyzed
- In the analysis results of all cameras, there was almost no difference in error in the third-order or higher

Gel image analysis



(a) Band Image



(b) Exp #1 Band Image

The result of comparing the band volume of each camera in 4 types of experiments

Exp #1	EOS 1100D 1 st shot	AR0130 2 nd shot	EOS 1100D 3 rd shot
R ²	0.9962	0.9866	0.9947
Rank	1	3	2
Exp #2	AR0310 1 st shot	EOS 1100D 2 nd shot	AR0130 3 rd shot
R ²	0.9884	0.9995	0.9793
Rank	2	1	3
Exp #3	AR0130 1 st shot	IMX179 2 nd shot	AR0130 3 rd shot
R ²	0.9884	0.9995	0.9793
Rank	1	2	3
Exp #4	IMX179 1 st shot	AR0130 2 nd shot	IMX179 3 rd shot
R ²	0.9561	0.9952	0.9942
Rank	3	1	2

- DSLR was superior to the results of the ranking test of Experiment 1 and Experiment 2 concerning the R2 value.
- In Experiments 3 and 4, AR0130 was confirmed to have better performance than IMX179.

CONCLUSIONS

1. The emulator that can evaluate whether an open platform-based smart phone camera is suitable for bio-imaging.
2. The results of comparing the performance of open platform cameras emulation system
 - lighting and test sheets are changed not only in the gel-document system but also in other bio-imaging devices.