DE GRUYTER
OPEN

DOI: 10.1515/SBEEF-2017-0031

RASPBERRY PI BASED MICROSCOPE CAMERA WITH WIRELESS FUNCTIONALITY

A. C. GHEORGHE
Department of Electronics, Telecommunications and Energy Engineering, Valahia University of Targoviste
E-mail: gheorghe_andrei89@yahoo.com

Abstract. ***The paper proposes the development of a wireless video camera that is used to capture images from any microscope, and is universally compatible with the standard C-Mount. The purpose behind developing this camera is to offer an economical alternative to the current high-priced microscopy camera without compromising performance. In addition this camera has the technology to work wirelessly.***

Keywords: wireless. video camera, performance, economical

1. INTRODUCTION

The paper proposes the development of a wireless video camera that is used to capture images from any microscope and it is universally compatible with the standard C-Mount. The purpose behind developing this camera is to offer an economical alternative to the current high-priced microscopy camera without compromising performance. In addition this camera has the technology to work wirelessly. The camera is made out of four major components [1], [2]:
- Raspberry Pi Zero W that is used to save all the data captured form the sensor, either to save or to send the data over IP (Internet Protocol) or to a web interface. The Pi Zero is very small in size and can be fitted in a small enclosure.
- Raspicam v2 is used as the actual camera because it has an IMX219 Sony sensor that has a good quality price and offers good performance.
- For the optics we used and optic adapter with a fixed focal length, the adapter is a FMA037 that we can find on the market at a cheap price and it has a 0.37X magnification, is fit to support a 1/4"-1/3" sensor and has the eye tube standard c-mount to Dia. 23.2 mm.
- A LiPo battery that offers the power that we need to use the camera for a few hours, the battery gives 5v and has the capacity of 5500 mAh.

1.2 Raspberry Pi Zero W

The Raspberry Pi Zero W development board is very unique in size as can be seen in Figure 1 and gives us a way to connect with the Raspicam v.2 trough the CSI (Camera Serial Interface) port. The Raspberry Pi Zero W (Figure 2) has a single-core CPU at 1 GHz with 512 MB of RAM, 802.11 b/g/n wireless LAN and the CSI port. The operating system on the raspberry is a modified Linux distribution specially made for the Pi named Raspbian. The Raspberry Pi acts like a server that send over IP the images obtained from the Sony sensor or saves them on the internal storage that is about 16 GB of space, this method is used for later downloading from the internal storage [3].

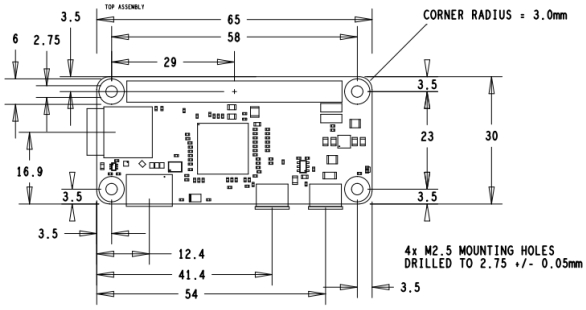

Figure 1. Mechanical schematic

Figure 2. Raspberry Pi Zero W development board

1.3 Raspcam v.2

The camera sensor used (Sony IMX219) has a good quality price and is specially design to be used with the Raspberry Pi trough the CSI port. The optic sensor has a diagonal size of 4.60 mm, type 1/4.0" with a 8 MPX (Mega Pixels) that offers video modes of 1080p (1920x1080) at 30 FPS (Frames Per Second), 720p (1024x720) at 60 FPS and 480p (640x480) at 60/90 FPS. The Linux software integration is made trough the V4L2 driver, the pixel size is 1.12 µm x 1.12 µm and the supported resolution for pictures is 3280 × 2464 pixels. In Figure 3 we can see the sensor already installed in the camera enclosure [4], [5].

Figure 3. Optical sensor installed in the optical enclosure

In Figure 4 we can see the block diagram of the Sony IMX219 sensor.

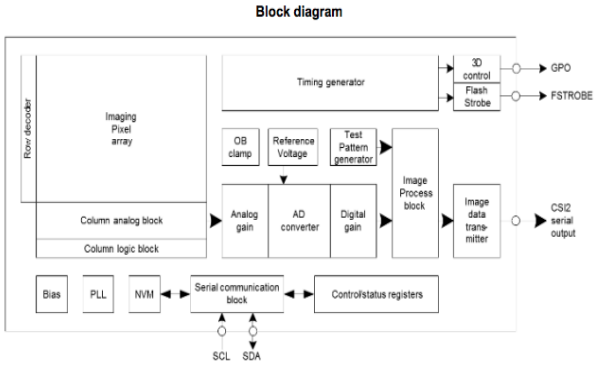

Figure 4. Sony IMX219 block diagram

1.4 Optical adaptor

For the optical adapter we used an FMA037 adaptor Figure 5 that is popular and largely used in the microscopic camera industry, the adapter is made for a 1/4"~1/3" sensor and is perfect for the sensor that we use in this application. The optical adaptor has a fixed focal length, 0.37x magnification and has the standard c-mount to dia.31.75mm eye tube that is largely used in most microscopes.

Figure 5. FMA037 Optical adapter

1.5 LiPo Battery

The camera uses a LiPo battery Figure 6 that provides enough power for about 8 hours of use, it has 5V and 5500 mAh.

Figure 6. LiPo Battery

2. WIRELESS CAMERA

In Figure 7 and Figure 8 we have the commercial concept of the camera, the enclosure is made of aluminium, forming a unitary system that allows to take, wireless, photo/video of the image provided by the microscope (Figure 9). The photo/video is either send over IP/Web Interface or saved on the internal memory of the camera to be downloaded later [6].

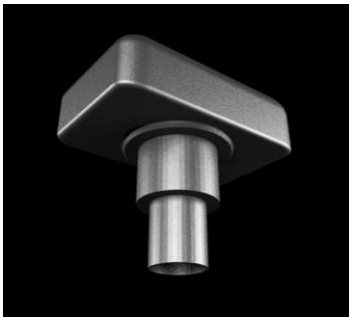

Figure 7. Commercial concept 1

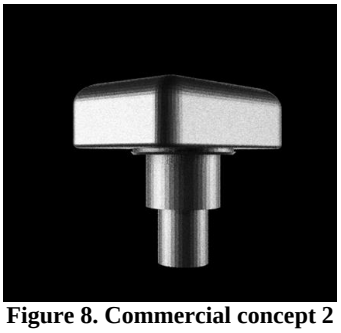

Figure 8. Commercial concept 2

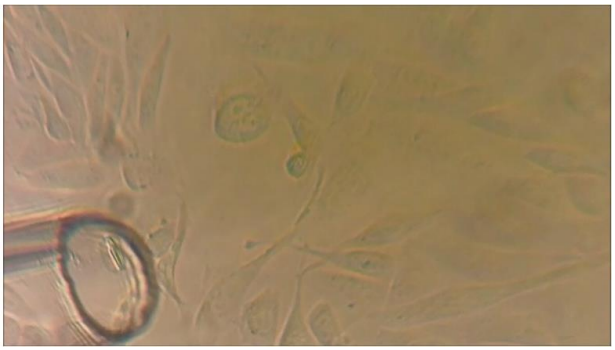

Figure 9. Image taken with the wireless camera

3. CAMERA WEB INTERFACE

The web interface that is used for our application is made in PHP, JS, CSS, Cam APK and works with the Raspberry camera, the interface can be used in different applications like surveillance, recording and time lapse photography. The user can access the camera from every web browser and It is highly configurable [7].

In Figure 10 we have functions like record video, record image, time lapse and motion detection, the user can view the live footage directly from the web browser all around the globe provided that he must have a good internet connection.

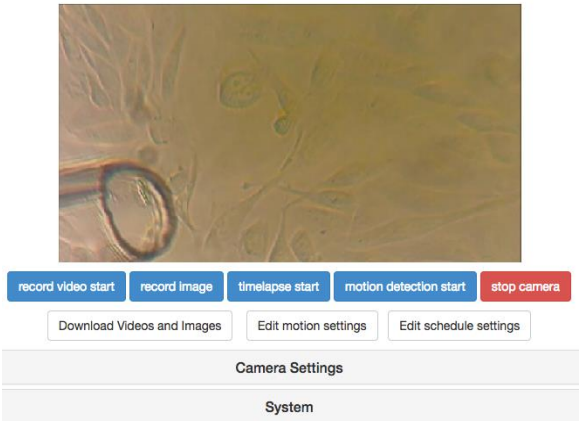

Figure 10. Camera Interface

In Figure 11 we have a few of setting for the camera. The settings are:

- Resolutions (the user can choose custom resolutions, fps for both video and photo);
- Time lapse interval;
- Annotation (to be implemented in the video/photo like a watermark with text and colour settings);
- Sharpness, Contrast and Brightness etc.

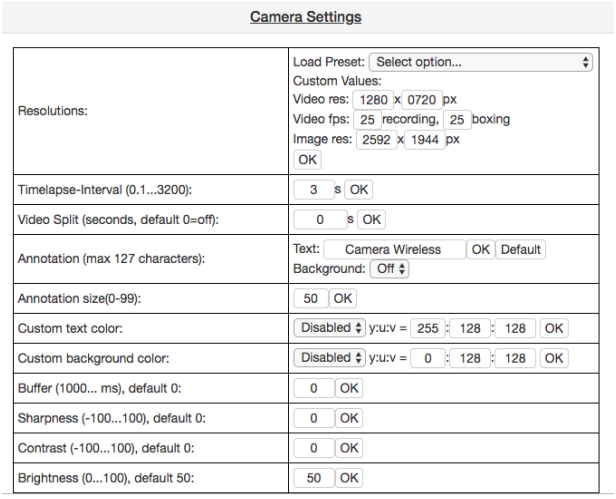

Figure 11. Camera Settings

The user can set the camera very easy from the web browser, the settings are vast in number and can apply for different applications.

In Figure 12 we have the system settings for the camera. The settings include functions like shutdown, reboot and reset. We can load different macros and give different functions for the video/photo/time lapse modes.

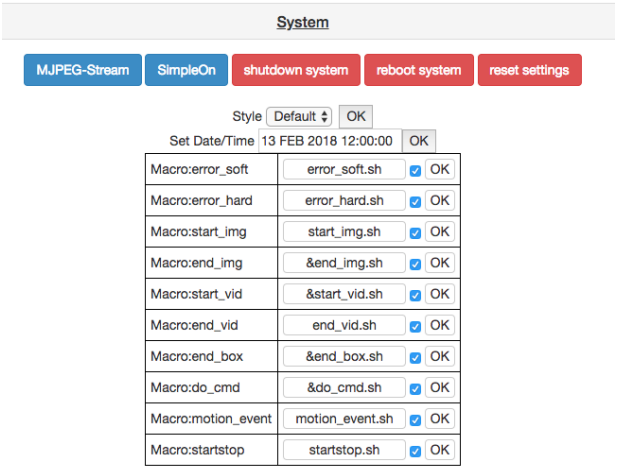

Figure 12. System Settings

4. CONCLUSIONS

The application is very useful and versatile and can be used in other fields for photo/video recording, time lapse and surveillance with minor modifications. It's highly configurable and makes a good economical choice without affecting performance to a microscope camera that we can find on the market but at a higher price. Also the application has wireless functionality.

5. REFERENCES

[1] F. Rost, and R. Oldfield, Photography with a microscope, Cambridge University Press, 2000.
[2] K. Kearney, and W. Freeman, Creative Projects with Raspberry Pi, Raspberry Pi Foundation, 2017.
[3] R. Nixon, Learning PHP, MySQL & JavaScript: with jQuery, CSS & HTML5, O'Reilly Ed., 2014.
[4] D. Singh, Fundamentals of Optics, PHI Learning Pvt. Ltd, 2015.
[5] D. Sklar, and A. Trachtenberg, PHP Cookbook, O'Reilly Ed., 2017.
[6] K, Yank, PPHP & MySQL: Novice to Ninja: The Easy Way to Build Your Own Database Driven Website, SitePoint Pty. Ltd., 2012.
[7] G. R. Fowles, Introduction to modern optics, Dover Publications Inc., 1975.