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Portable Laparoscopy 3D Measurement System by using Raspberry Pi

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***Abstract*---**Minimally invasive techniques have become the standard for a variety of surgeries in all surgeries. Specially ‹there has been a recent move to integrate low-cost and more efficient technology into standard laparoscopy and endoscopy. Surgery to design portable laparoscopy device and improve visual field stability using, a low cost laparoscopic camera, the portable device differ from conventional in equipment (number, size, Wight, ..). The scope of the control room of the inserted laparoscopic platform system receives increasing attention from researchers, surgeons, and also patients. Although many prototype by using Raspberry pi embedded system laparoscopes have been introduced with a built-in platform smart touch screen system, few of them eliminate the blocked cable. It is suggested to Hardware architecture for integrated system Endoscopic camera design fully modern dynamic platform, facilitating installation without fully connected cables laparoscopic surgical robotic camera with adequate in-vivo motility. Modular design and preliminary test on board.

***Keywords*---**portable laparoscopy, dynamic platform, Raspberry Pi.

Introduction

Laparoscopic surgery, also known as minimally invasive surgery (MIS) or keyhole surgery, uses tiny incisions, usually less than 1 cm, to perform abdominal or intrathoracic procedures compared to the larger incisions required with a laparotomy. This approach offers less blood loss and postoperative pain as well as less bleeding and a shorter recovery time and more efficient cauterization. Laparoscopic surgery refers to the broader field of endoscopy, which is the use of a viewing system to visualize the surgical field.[1]

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The advent of laparoscopy was a milestone in the evolution of surgery as superior patient outcomes led to a dramatic shift towards laparoscopy over open techniques.[2]

Laparoscopy requires learning to design a 3D surgical field from a 2D video image. Additionally, compared to open surgery, laparoscopy is associated with reduced tactile feedback, paradoxical instrument movements, and a restricted range of motion. Therefore, many researchers point to a higher complication rate in the early laparoscopic experience of surgeons.[3]

Operating payloads have demonstrated the viability of a wireless system. Wireless laparoscopic surgical camera based on standard electronic and industrial wireless standards that operate in the 2.4 GHz ISM frequency bands. Possible improvements for Laparoscopic surgery has benefited from this hardware architecture. includes smoother in-vivo camera Gastrointestinal endoscopy has evolved from angled fiber optic mirrors, a video chip, endoscopy, wireless endoscopy. But the devices themselves remained largely passive[4]. Endoscopes respond to manual manipulation. Imagine what the endoscope is aiming for. Take pictures when motivated. They are generally promoted when pushed. Once in place, they serve as performed for biopsies and therapeutic procedures. The endoscopic reigns as the only director where the instrument goes and the only interpreter of the image that appears. If a problem occurs, the oscilloscope remains silent. Atechnician It is necessary to determine the source of a leak or the reason for a defective image. In this Research and implementation of new and comfortable design plans according to endoscopic surgical physiology.[5]

Laparoscopy allows the doctor to look inside the body in real time without open surgery. The laparoscopic zoom camera contains fluid lenses based on biological materials that can change curvature and focal length similar to the lenses in the human eye. the operating field is provided with a video camera, which is the surgeon's eye. It goes without saying that having the right video equipment is of paramount importance. Laparoscopy, also called peritoneoscopy, is a surgical procedure used to examine organs in the abdomen (stomach) and pelvic area.[6]

Method

Project Development

The design is consists of two parts:

1) The hardware part, we used Raspberry Pi 3 Model B, is a credit card sized microcomputer chip used to implement code and run the system. The choice of this device is due to its low cost and high ability to program and work with various hardware and software applications, powered by power bank power supply, as well as its simplicity. It works and can be connected like any other computer with a mouse, a keyboard, a screen that performs arithmetic functions, which connects to the HD screen through the HDMI connector. Laparoscopy camera is the most important part in the design and its connected to the board via USB connector. that represented by figure(1)

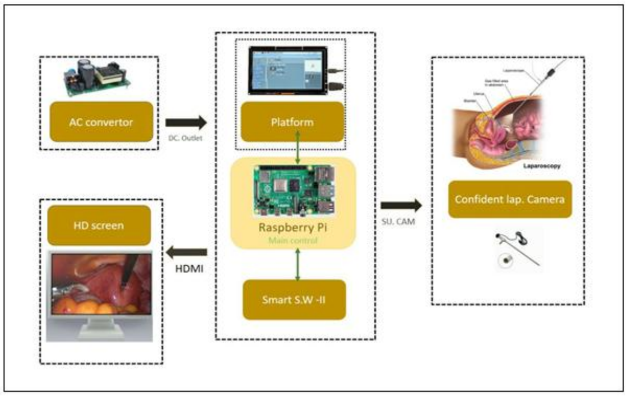

Figure 1. System component

2) The software part, represented by Windows-compatible software. There are different programs in this device, one for the Raspberry Pi board and another for the Raspberry Pi camera, both free and open source. The Raspberry Pi configuration has many Linux-based operating systems that shown in figure (2). will be used to control the states of certain pins of the Raspberry Pi and to get the data from camera that are connected to the Raspberry Pi. The goal is to display this data on HD monitor. Guvcview (GTK+ UVC Viewer) is the Raspberry Pi camera software that used, its simple interface for viewing and capturing video from V4L2 devices, with a special focus on the Linux UVC driver. All controls are done with GTK, which offers a more user-friendly graphical user interface. In addition, this webcam application ,i.e. the UVC stream processing software for the Linux desktop Guvcview, in normal use a dual-window interface.[7] One window displays the image captured by the camera, while the other displays settings and controls. The process of gathering information using a camera inserted into the abdominal cavity. Consistent and continuous video display on a high-resolution monitor screen. Real time Readings of this device would automatically be forwarded to HD display monitor and an automatic Database records update within the system will takes place.

Figure 2. Configuration of raspberry pi

System process operation

After installing the Raspbian OS on the SD card, install the card in the Raspberry Pi board, and update the system, turn on the camera and install all the necessary software, reboot the system and run complete the following steps:
Firstly, initialize and connect your Raspberry Pi. it onto your screen, mouse and keyboard. Second: Connect your Raspberry Pi to the network. Third: connect HD screen. Fourth, connect the power supply. Fifth, plug the compact scope into the box trainer and start capturing as soon as the code runs. The video is displayed on the HD screen, showing the process of sending the image, the size and the time counting down from the moment it is captured.

Systems work

In the system shown in Figure (3), the camera is built into the laparoscope. During a laparoscopic operation, a laparoscope was inserted into the abdominal cavity. The image processing algorithm and reading of the collected data was controlled by a set of data acquisition microcontrollers that received a full resolution image from a camera with optimized parameters,[8] cropped it and calculated the average values for the RGB pixel data. The image viewed with the Sw-Raspberry Pi camera was obtained by processing the image through direct manipulation of the numeric matrix. All images were captured at maximum resolution and then saved to a micro SD card for further processing during analysis. The video data from the boards was transferred to a computer running the stitching program. The stitching program combined live video to show a large field of view. The operator viewed the stitched video in real time on the operational monitor.

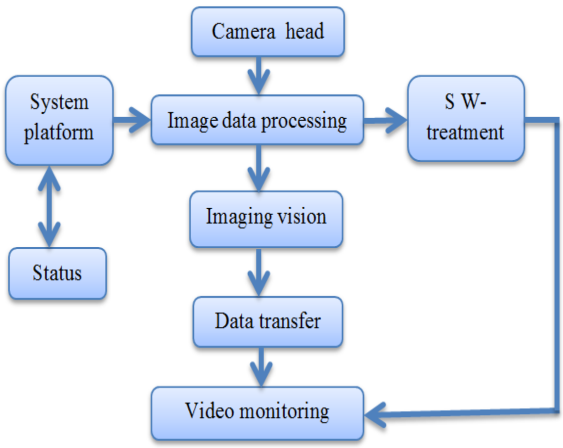

Figure 3. System work schematically

With the new system design, surgeons now have a cost-effective, minimally sized, portable laparoscopic device that can be conveniently transported and used in an operating room or ambulatory setting to perform laparoscopic procedures in a variety of surgical areas and other specialties.

Dynamic response speed signal

After configuration the system and setting up the graphics card, you can get an excellent result. This is particularly important when considering clinical applications that require 3D information to guide the surgeon or enhance instrument capabilities. The work here is the first step towards achieving this goal as it provides real-time tool path extraction. The next step in the development of this work will be the development of assessment criteria that work in real time and have such a property that they give instant feedback to the learner when use plastic organ (liver)in box trainer an display in HD monitor in real time as shown in figure (4).

Figure 4. Laparoscopic camera in box trainer and display

Discussion
1-Over all system result

The overall design plan is to select a reliable, flexible, and cost-effective component to develop a portable laparoscopic system[9]. The flexible instrument fundamentally ensures its ability to perform surgical procedures, while the drive unit design provides motion control and reduces the weight of the system. As shown in figures (5,6)The images produced were obtained from two sources, the first from a handheld device(kali) and the second from a conventional laparoscopic camera (a Gimmi video system connected to a Gimmi Alphascope II camera), also the colors that were compared between the two devices were red, orange, yellow, green, blue and purple.

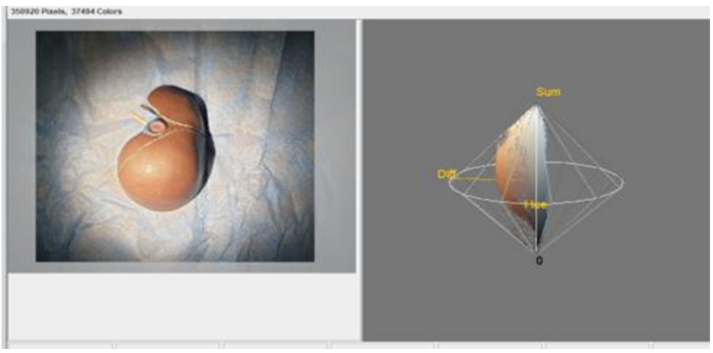

Figure 5. Image spectrum when use Gimmi device

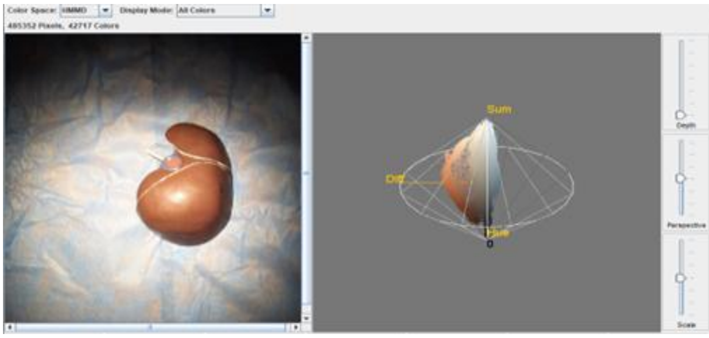

Figure 6. Image spectrum when use kali device

The images were captured on both devices with the same movements and changes in orientation. Illumination in the case of a conventional laparoscopic tower was provided by a tower-contained [10]source (300 W xenon lamp). In order to create two final and identical videos of 20 seconds each, in which the elements intended for evaluation are clearly visible, it is important to clarify that there were no manipulations on the image or any filters or additional effects, the developed system worked successfully and this was confirmed by the hospital doctors after testing on the box trainer when use plastic organ.

Image measurement

Images are rotate at some positions on X axis ,Y axis and Z axis in order to take 3D measurement .where x and y ,z show coordinate of image.The images were taken in the training box of the stereoscopic(liver organ) used for image analysis by using the designed system(karl laparoscopic) and the existing system that is currently used in Al-Diwaniyah Hospital Gimmi laparoscopic .In order to standardize the resolution of the image, the United States Air Force resolution test card (Edmund Industrial Optics, Barrington, NJ) was used to group vertical and horizontal lines in different measurements and the resolution was calculated as the smallest group of elements than can be clearly visualized (lines/ mm) as shown in figure (7,8).

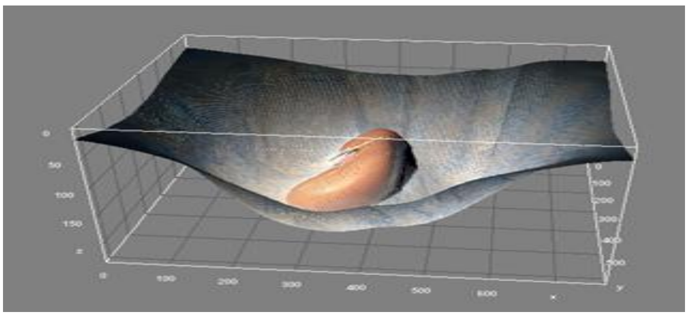

Figure7. XYZ image orientation and horizontal view

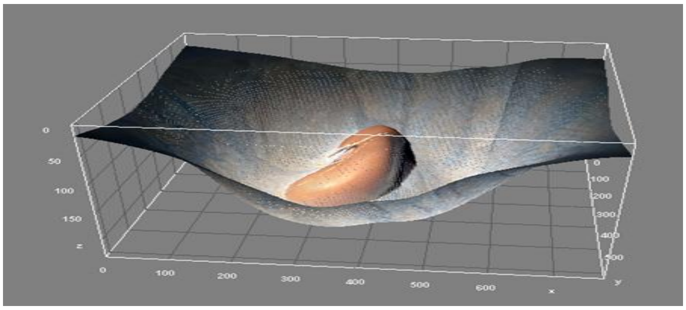

Figure 8. XYZ image orientation and vertical view

Systems evaluation and practical data transfer and processing

The system is evaluation to compensate with traditional system that use in therapeutic or diagnostic the organ inside the abdominal cavity, the organ measurement, an evaluation tool that use.After completing the entire assembly process of the system with the necessary accessories to test the system evaluation of the Raspberry Pi, the steps were taken as follows:

- Experiment with the system assembled by us on the educational experimental box of the laparoscopic operations room in Al-Diwaniyah Teaching Hospital and under the supervision of the hospital's medical staff , the experimental device(kali device) image in HD screen shown in figure (9) , where the pictures or preliminary results were shown, according to the attached:

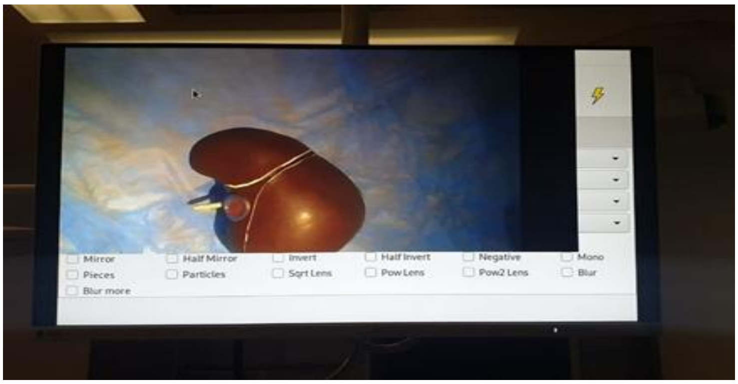

Figure 9. Experimental setup for evaluation of the developed

- Re-experimenting the basic hospital tummy tuck for laparoscopic surgery and a Gimmi type showing the possibility of using the system in work and the success of its experimental application in a scientific and practical way with the support of the medical staff for that. Image of conventional laparoscopic system shown in figure (10).

Figure10**.** conventional laparoscopic system setup with elevation at Gimmi type laparoscopy device

Conclusion

Using the Raspberry Pi, a small learning computer, as the main unit of the measurement system is an interesting alternative to PC-based measurement systems. We built a working model to demonstrate the different functions of portable laparoscopy. This results in a layout that can be expanded with even more functions in the future. Measurement of extracorporeal abdominal targets in laparoscopic surgery can more quickly provide accurate, real-time measurements similar to what is currently used.

References

[1] B. Tamadazte *et al.*, "Multi-View Vision System for Laparoscopy Surgery . To cite this version :," 2014.

[2] I. Ghaderi, C. H. Hsu, E. M. Hines, A. Alabagi, and C. C. Galvani, "The Impact of Navigation Grid Overlay on Performance of Camera Assistants during Laparoscopic Abdominal Procedures: A Randomized Controlled Trial," *J. Surg. Educ.*, 2020, doi: 10.1016/j.jsurg.2020.09.015.

[3] B. A. Sharpe, Z. Machaidze, and K. Ogan, "Randomized comparison of standard laparoscopic trainer to novel, at-home, low-cost, camera-less laparoscopic trainer," *Urology*, vol. 66, no. 1, pp. 50–54, 2005, doi: 10.1016/j.urology.2005.01.015.

[4] R. Melo, J. P. Barreto, and G. Falcão, "A new solution for camera calibration and real-time image distortion correction in medical endoscopy-initial technical evaluation (IEEE Transactions on Biomedical Engineering (2012) 59, 3, (634-644))," *IEEE Trans. Biomed. Eng.*, vol. 59, no. 7, p. 2095, 2012, doi: 10.1109/TBME.2012.2203892.

[5] E. J. Bastardo Milano, P. Monsalve, and G. Escalona, "Mobile laparoscopy: use of the smartphone as a tool in the operating room," *Gastroenterol. Hepatol. Open Access*, vol. 10, no. 5, pp. 272–277, 2019, doi: 10.15406/ghoa.2019.10.00395.

[6] S. Jawale, G. Jesudian, and P. Agarwal, "Rigid video laparoscope: a low-cost alternative to traditional diagnostic laparoscopy and laparoscopic surgery," *Mini-invasive Surg.*, vol. 2019, pp. 10–13, 2019, doi: 10.20517/2574-

1225.2019.12.
[7] S. Miura *et al.*, “Optimal monitor positioning and camera rotation angle for mirror image: overcoming reverse alignment during laparoscopic colorectal surgery,” *Sci. Rep.*, vol. 9, no. 1, pp. 1–6, 2019, doi: 10.1038/s41598-019-44939-0.
[8] F. Huettl *et al.*, “Quality-based assessment of camera navigation skills for laparoscopic fundoplication,” *Dis. Esophagus*, vol. 33, no. 11, pp. 1–5, 2020, doi: 10.1093/dote/doaa042.
[9] H. Aoki, H. Yamashita, T. Mori, T. Fukuyo, and T. Chiba, “Ultrahigh sensitivity endoscopic camera using a new CMOS image sensor: Providing with clear images under low illumination in addition to fluorescent images,” *Surg. Endosc.*, vol. 28, no. 11, pp. 3240–3248, 2014, doi: 10.1007/s00464-014-3590-y.
[10] F. Gheza, F. O. Oginni, S. Crivellaro, M. A. Masrur, and A. O. Adisa, “Affordable Laparoscopic Camera System (ALCS) Designed for Low- and Middle-Income Countries: A Feasibility Study,” *World J. Surg.*, vol. 42, no. 11, pp. 3501–3507, 2018, doi: 10.1007/s00268-018-4657-z.