

Development of Teleoperative System for Ultrasonography Collaborative Robots

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Abstract—Ultrasonography is a widely used imaging method for internal organ diagnoses that generally require training, qualification, and experiences from the practitioners. Because of this, Thailand currently lacks licensed physicians for this particular purpose, particularly in the rural hospitals. Since many collaborative robots have been invented and commercialized to assist various medical applications due to their high levels of safety and precision, the use of a teleoperative system has the potential to solve this problem as it can deliver the same outcome as that from an expert. Therefore, the goal of this study is to develop a teleoperative system for ultrasonography through the utilization of collaborative robots.

Index Terms—Ultrasonography, Teleoperation, Collaborative Robot, Medical Diagnosis

I. INTRODUCTION

Nowadays, Ultrasonography is one type of non-invasive procedure which used high-frequency sound waves to produce images of internal organs or tissues through bouncing of wave with structures and reflect back then converts the waves into electrical signals and converts the pattern of electrical signals into an image. This procedure is one of the most popular diagnosis technique because of it does not involve equipment penetrate skin and break through human body which mean that it has high safety and also can reduce human tissues injury during the procedures. The ultrasonography is considered as a gold standard measurement for abnormal pregnancy diagnosis [2, 3]. However, it still need the trained physician to acquire the high quality of abnormal pregnancy diagnosis. Thailand is facing with the shortage of the qualified physician in rural stages cause by the urban concentration of doctor [1]. Teleoperative system has play a role in solving this problem. This system is a controlling system which can remote control the robot from the capital city to operated the medical task. Which mean that the Ultrasonography experts can use the device

complete the ultrasonography assessment for the provincial patient while stay in the capital city. The collaborative robot (Cobot) is a developed robot aim to work, interact and assist human in shared space with high safety proven. Cobot also considered use in healthcare working which mean that cobot is a suitable choice for used as teleoperative system. At present the teleoperation for ultrasonography had been developed initially and still has a gap of the study. The aim of this study is to develop the ultrasonography teleoperative system by using cobot to resolve that problem which Thailand is facing.

II. MATERIAL AND METHOD

A. Collaborative Robots

Collaborative robot (cobot) is the robot that can safely operate with human or its operator in a close range. Cobots are designed based on operator safety as the first priority, for example, it was constructed using lightweight materials with no sharp edge structure, its movement speed is limited, and also implemented the collision detection to increase the operator safety. Essentially, this study selected ABB YuMi to perform teleoperated ultrasonography due to its high safety during operate the task and collaborate with operator.

B. Teleoperation

Two ABB YuMi cobots are set, master and slave robot. The operator controls the master robot with mock-up ultrasound probe, then master robot will send the information to slave robot making it move in the exact movement. At slave site, the robot holds the real ultrasound probe which is connected to ultrasonography modality. To deliver the information from master to slave robot, local communication via LAN and web-based online communication are utilized. Both approaches send the current angle of each joint from master to slave robot.

Local communication via LAN wiring can rapidly deliver the information with insignificant time delay, but it is unpractical if long distance teleoperation is needed to perform. However, web-based online communication can deliver the information with no limitation of operation distance, but its drawback is higher time delay which is varied with internet speed and connection quality.

C. Robotic End Effector

New robot end effector which hold the transducer of ultrasonography devices was created and attached with slave side robot. The new design should be universal design cause by the various shape of the transducer from many brands of the ultrasonography devices in the market. Mocking up transducer was created to attach with master robot for doctor usage (Fig.1).

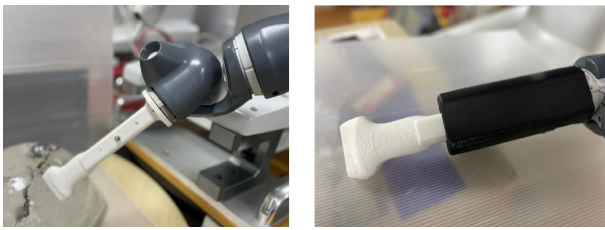


Fig. 1. Design of the master universal slave robot end effector

D. Screen Sharing

The entire screen including acquired images and user interface which appear on screen monitor of ultrasonography imaging modality at slave site was captured using video capture device to display on the computer at the master site by using network socket which a network node and endpoint structure software to sent and receive data via wi-fi communication(fig.2).

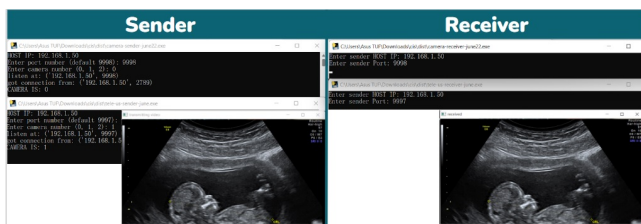


Fig. 2. Quality of ultrasonography images

III. RESULT AND DISCUSSION

A. Usage

Teleoperative system which is developed in this study aims to retain the traditional ultrasonography procedure in order to reduce the learning curve and maintain effective outcomes. However, the reaction forces from each joint of the master robot prevent the operator to control the probe freely. Moreover, every ABB YuMi joints cannot rotate 360 degrees which causes the limited movement for ultrasonography procedure.

As a result, ABB YuMi may not suitable for this task due to its movement limitation and collision resistances.

B. Ultrasonography Image Quality

Since the video capture card is utilized to capture the entire screen of ultrasonography modality, the captured image quality depends on the resolution of the video capturing device and imaging modalities. Nevertheless, the streaming quality depends on the internet speed and connection quality. Therefore, the captured image is delay and have lower frames per second from the imaging modality at slave site.

C. Ultrasonography Function Usage

In traditional ultrasonography, many functions of the machine are needed such as structure measurement, brightness-contrast adjustment, and fluid flow detection. Regardless, the developed system can achieve only preliminary structure measurement through the captured frame. To achieve the complete functions utilization, the developed system must access into the ultrasonography software of commercial modalities which is currently denied.

IV. CONCLUSION

In conclusion, even though the concept of teleoperative ultrasonography using cobots has been proven and the images can effectively be transferred from the slave to the master site, there are still have limitations in term of robot workspace, robot joint movements, time delay, and function accessibility of ultrasonography modality.

ACKNOWLEDGMENT

This study was supervised by department of biomedical engineering, faculty of engineering, Mahidol University, Nakhon Pathom, Thailand and received funding and cooperation from Rajavidhi hospital, Bangkok, Thailand.

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