Preliminary Study on Movement Controls and Data Streaming in Mobile Robot Surveillance

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***Abstract*—Surveillance is a growing topic that can be applied in multiple fields, such as crowd and social monitoring, wildlife research, and agrarian monitoring. This research is inspired from previous applicable fields in creating a mobile robot to do the surveillance. This paper focuses on the control movement and data streaming system implemented in the robot. The robot will be able to be remotely piloted based on the commands of a user interfacing with a web-based platform. The robot will also be able to operate a camera to capture footage in real-time, encode it, and send it to be stored in a server. In the future, this image capture may be expanded to cover for data processing in object recognition. This paper also presents some designs that can be developed as the basis for future researches.**

Keywords—Surveillance, mobile robot, remote control, image capture

I. INTRODUCTION

Webcam helped many people to monitor social life such as monitoring the school environment, shopping arena, bank arena, and many other indoor areas. Webcam has also able to be evidence in recording crime and unpleasant things that are very helpful to improve our security.

However, what if the environment needed to be monitored is a very large area, difficult area to reach, and a dangerous area, where it is not possible to rely on a webcam camera for monitoring the environment

Surveillance is a growing topic that can be applied in multiple fields, some of which are monitoring the crowd and social movement[1], where research is carried out in very dense environments. In other study [2], conducting research on wildlife research, to examine animal habits, observing the behaviour of these animals, which makes it very easy for researchers to observe these animals without getting dangerous threats and actions. Another study [3] implemented a surveillance system in search operation.

From the above problems, a system is needed to facilitate monitoring an area. Characteristic mobile robot is easy to move, can be control in everywhere, and anytime. With this flexibilty of mobile robot, and with the wide application of surveillance in many fields, this paper focuses on the control movement and data streaming system implemented in the robot, for help the limitations of a webcam that cannot reach certain areas.

In Section II, an overview of mobile robot system development will be explained. Section III is explained about the experimental results of the system. Section IV a design of future work will be explained.

II. MOBILE ROBOT SYSTEM

In this study, The Mobile Robot can perform two main tasks. First, the mobile robot can move forward, move backward, or left, or right and stop remotely based on web-based control. Second, the mobile robot can operate camera to capture footage in real-time. Below will explain the development of the mobile robot that has been developed.

A. Hardware

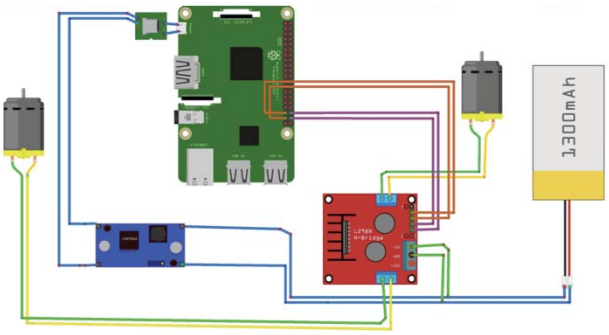

Fig. 1. Electronic Design of Mobile Robot

The mobile robot developed in this research uses Raspberry Pi 3 as its computation core, with two DC motors for motion device. DC motors controlled by a L298 board as the motive core. Power is supplied by a LiPo battery unit that first passes through a L2596 stepdown converter. Another adition, Camera Webcam Logitech C525 is linked to Raspberry Pi 3 using USB connection. For detailed description, electronic design of mobile robot can be shown in Figure 1.

B. Mechanical Design

Mechanical design of mobile robot as shown in Figure 2. Design of mobile robot have round shape, with the two base of body. One for upside robot base and one for downside of robot base. The downside of the robot is used to put all the electronic circuit, including battery. For, the upside of the robot is used to put camera webcam in the center of the part. The main part of the robot are made of acrylic. Acrylic was chosen for its light weight and ease of handling to facilitate the mobility of the robot.

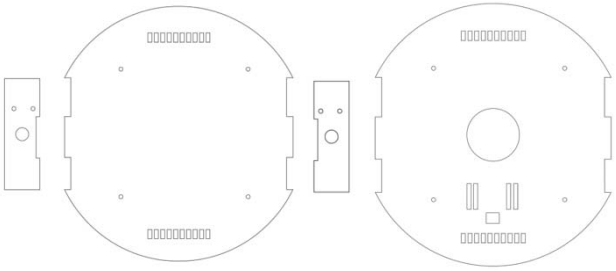

Fig. 2. Mechanical Design of Mobile Robot

C. Architecture Design

Architecture design of mobile robot was developed in two different task. First, the robot will be able to remotely

piloted based on instruction was given on webpage control. Communication between robot and webpage is using socket.

Another, robot will also be able to operate a camera to capture footage in real time. Every capture camera from the mobil robot will be store to server. The scheme of architecture design of mobile robot can be shown in Figure 3.

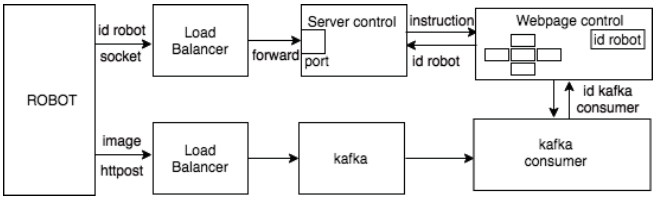

Fig. 3. Architecture Design of Mobile Robot

D. Movement Controls

Every single movement of mobile robot based on instruction was given on web-based control. Communication between robot and webpage via is serial port. In the web-based control contain several button, button forward for move forward, button backward for move backward, button left for move left, button right for move right, and button stop for stop. For each button is pressed on the webpage, the robot will move according to the command on the button.

For example, when the forward button is pressed, the robot moves the two DC motors to move forward. Likewise if when the backward button is pressed, the robot will move backward, and when the left button is pressed, the robot also move to the left, and when the right button is pressed, the robot will move to the right, and if the button stop is pressed, the robot will stop to move. The scheme of the movement control mobile robot can be shown in Figure 4.

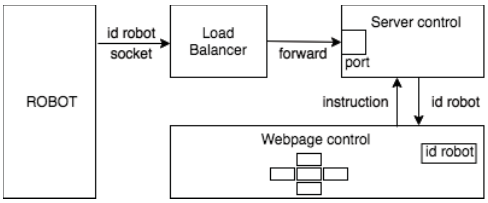

Fig. 4. Movement Controls of Mobile Robot

E. Camera Stream

Beside ability to move remotely, the robot will also be able to operate a camera to capture footage in real time. Scheme of stream camera of mobile robot starting from robot capture camera first, then every capture camera will be encode, and then robot continue to sending the encode result to server. And the last, server will received the encode result of the camera capture of mobile robot. As shown in Figure 5, the scheme of stream camera of mobile robot described.

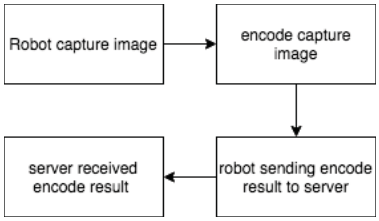

Fig. 5. Stream Camera of Mobile Robot

III. Result and Experiment

There were two kinds of experiments. The first was the perfomance testing of movement controls of mobile robot and the second was testing the perfomance of success of mobile robot in camera stream.

A. Movement Control Experiment

Before applying on web-based control. Movement control of mobile robots was first applied through PC Keyboard first. The mobile robot system developed at this time can be control through a PC Keyboard or Web-based control.

As shown in Table 1, the movement control experiment of mobile robot can be applied in real time, the robot can move right, left, forward and backward, according to the instructions of the PC Keyboard and also commands from the web-base control.

However, the developments of mobile robot on movement control are not yet ideal. For that, in the future, it will be an evaluation of the development of the movement control of mobile robots.

TABLE I. Movement Control Experiment

Direction	PC Keyboard	Web-based control
Forward	Success	Success
Backward	Success	Success
Left	Success	Success
Right	Success	Success
Stop	Success	Success

B. Stream Camera Experiment

As shown in Table II, Camera stream experiment of mobile robots shows that Raspberry Pi as a core can be able to operate the camera to capture footage in real-time. Example in row one, shown at 14:44:44 Raspberry Pi shows message success in the process of sending camera capture results to the server. Likewise with the response provided by the server, which shows that the image received is 640x480 in size.

TABLE II. Capture Camera Experiment

No	Time	Raspi Result	Result on Server
1	31/May/2018 14:44:44	Success	Image.received.size=640x480
2	31/May/2018 14:44:44	Success	image received.size=640x480
3	31/May/2018 14:44:45	Success	image received.size=640x480
4	31/May/2018 14:44:45	Success	image received.size=640x480
5	31/May/2018 14:44:48	Success	image received.size=640x480
6	31/May/2018 14:44:49	Success	image received.size=640x480
7	31/May/2018 14:44:50	Success	image received.size=640x480
8	31/May/2018 14:44:57	Success	image received.size=640x480
9	31/May/2018 14:44:59	Success	image received.size=640x480
10	31/May/2018 14:45:01	Success	image received.size=640x480
11	31/May/2018 14:45:04	Success	image received.size=640x480
12	31/May/2018 14:45:07	Success	image received.size=640x480
13	31/May/2018 14:45:21	Success	image received.size=640x480
14	31/May/2018 14:46:06	Success	image received.size=640x480
15	31/May/2018 14:46:35	Success	image received.size=640x480

If we look at Table II, and in Figure 6, as shown in Figure 6, value 1 represent of server received encode result of image, and value 0, represent that server not received encode result of image. The time shown (in second) by the mobile robot in completing the camera stream and store to

server process is still not stable. This is caused by the instability of the internet used. In the future, an evaluation will be conducted to improve the perfomance camera stream of mobile robot.

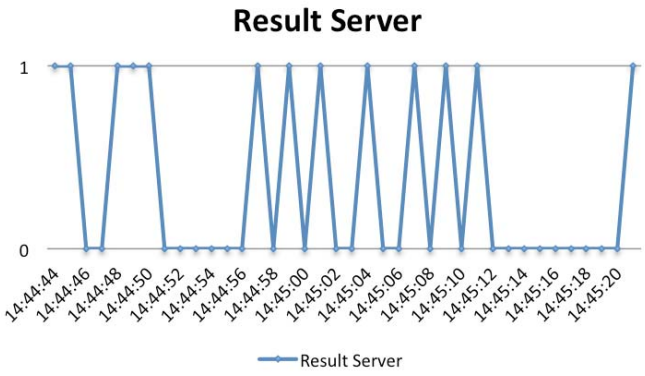

Fig. 6. Perfomance camera stream of mobile robot

IV. Future Work

A. Navigation and Localization

Movement Control of mobile robot that was formed in this study, not at a very ideal stage, drifting on mobile robots, and also robots do not know the their location to the environment.

For this reason, there are a number of things that will be implemented in the future for the development of mobile surveillance robots, applying robot navigation and localization.

The application of navigation and localization of robots will facilitate the robot to find out its location to the surrounding environment, so that the robot can move in accordance with the existing location, without any location error and drifting direction of the robot itself.

B. Distributed Coordination on Multi Agent

Distributed coordination on multi agent systems is now an interesting topic that many researchers talk about [4,5]. This topic has been widely applied, such as on the problems of mobile robotic swarms, sensor networks, and the automated vehicle formation control.

In this surveillance system, if the environment is too large, then it can be ascertained that the monitoring perfomance of one robot will be less than the perfomance of two or more robots. For this reason, it is necessary to implement this mobile robot in a multi agent. Where, needed coordination for the divison of work area, or at least for the movement of same between agents.

With the implementation of distributed coordination of multi agents, the perfomance of mobile robot surveillance can be better, more efficient in working time, and also facilitates the surveillance system.

V. Conclusion

In this research, the development of mobile robot surveillance has succeeded in implementing the movement control, where the robot will be able to remotely based the pilots on the user interface with a web based platform, and also the robot will be able to operate a camera to capture footage in real-time, encode it and send it to be stored in a server.

The next development that will be implemented is to improve the perfomance ssamera stream more stable and improve the movement control of mobile robots by adding ability mobile robots to be able navigate properly and also be able to find out their location. In addition, the next development is to implement a distributed coordination on multi agent concept for better perfomance of mobile robot surveillance.

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