Web-Based Open Loop Remote Control Robot

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Abstract

A web-based open loop remote control robot in this paper is designed for surveillance application. The robot is a prototype of remote control toy car but it is controlled via web and not via radio wave as what we found nowadays. The robot is utilized with a camera where the surveyor can observe surrounding area via web and navigates the robot to reach the desired destination. There are several parameters that were measured to understand the robot’s performance such as accuracy, pricing and robustness. Data were taken in surrounding area both with and without obstacles. Nevertheless, the experiment result showed that the error rate was 20% which is quite severe in area with obstacle and error can be reduced if the robot is designed with closed loop system.

Keywords: web-based, open loop, remote control, robot, surveillance

1. Introduction

Mobile robot is used in order to replace human’s tasks especially when these works need high accuracy, consistency, stability, and moreover for high risk task where accident sometimes happened. The number of work accident in Indonesia is never lesser from year to year [1] and some difficult task are performed in manufacturing industry [2]. To avoid accidents during the heavy task, some robots are applied and play important roles in radioactive area such as in Nuclear Power Plant [3,4], or for surveillance application in tracking the earthquake’s victim [5]. This paper will discuss a simple prototype of mobile robot based on remote control toy car that is combined with small camera and remotely
controlled via website. The mobile robot is designed as an open loop system and the parameter that are measured are its responsiveness, accuracy, robustness, movement repeatability, energy consumption, and pricing comparison with present mobile robot that is available in the market.

Market Info Group[6] states that advances in sensors and payloads, integration, data fusion, autonomy software and data link transmission hold the promise of increasing the responsiveness of mobile robotics to the needs of every user community. They develop an Unmanned Group Vehicles (UGV) which is used both in military and non-military purposes, where this UGV is equipped with imaging sensor. Yamanobe N. et al.[7] showed some MATLAB simulation results on responsiveness for positioning of close loop mobile robot with deviation from ±0.4mm to ±0.5mm and the vertex deviation up to ±1 degree. In the mean time, Newman W.S. et al.[8] addressed force-responsive automated assembly include contact stability, the degree of force responsiveness required for success, the speed of a successful implementation, and the means to program a force-responsive system to perform a given assembly task. Elatta A.Y. et al.[9] did calibration to enhance robots positioning accuracy with error rate between 8% and 10% due to the flexibility of joints and links.

Based on several results that mentioned in previous works by others, we tried to develop a simple open loop prototype remote control robot that guided via website. Hopefully this simple inexpensive mobile robot can be one of alternate solution for any surveillance work such as locating earthquake victim as well as for bomb identification.

2. Experimental Setup

Figure 1 show the block diagram of web-based open loop remote control robot where it used an embedded system based on PM-LX-800 that controlled webcam, wireless communication, and motor driver. The DC motors were used to control the movement of the wheels both forward-backward and right-left while the stepper motor was used to control the movement of the web camera up and down.

![Block Diagram of Web-Based Open Loop Remote Control Robot](image)

The camera will show the surrounding of the mobile robot via internet and from the website window, the user click the button to the direction that surveyor wants. The data was processed in embedded system and sent to motor driver where this driver controls both DC Motor and Stepper Motor. The mobile robot will move to the position that is determined while the camera keeps on recording the surrounding area.
While moving around, the mobile robot also detects communication that is available in order to receive the next instructions.

The robot had some built in applications such as Web Server, DHCP Server, and MJPG Server for real time data streaming. All of the applications were integrated with Linux Slackware and were connected to wireless LAN via USB Wireless LAN (TN-WN322G)[10,11]. For data streaming, a USB Webcam (Webcam Y7) was attached on the stepper motor and sent the data via Wireless LAN to the website where the surveyor could observe the surrounding area. Not only a real time video can be captured during its operation, but it could capture frame per frame picture if necessary. Energy consumption for this robot was supplied by three AA 1.5V batteries and one 6V dry battery of 2CR5W while the motor driver was designed with H-Bridge configuration by using L298 components. C language was used to develop the software system for this robot, which was compiled in GCC format. For the total design we found that the economic value of this robot is around US$ 190.

The robot was tested in indoor environment without any obstacle in the pathways and several parameters that were tested are robot movement, robustness when the robot was tested in outdoor environment and ride along asphalt pathways, camera movement, controlling robot via web, wireless interconnection, and pricing comparison.

3. Results and Discussion

When robot was operated to reach the desired destination in indoor environment, several results are observed as seen on figure 2(a) and 2(b) for both forward and backward movement, respectively. It is shown that the error rate is around ±2cm which is higher than what is achieved by Yamanobe N. et al.[7] This error is expected to be lower if a sensor is applied in the robot. However, this error can be neglected for this application since the precise destination is controlled by the view of the surveyor via web. We also found out that the repeatability of the total movement is 100% but the accuracy is about 90%.

Another experiment was also performing for outdoor environment where the robot was guided to find destination along asphalt pathways. Due to this obstacle, we found that the error is severe compared to indoor experiment. Figure 3(a) and 3(b) showed the deviation recorded for both forward and backward movement, respectively. The error rate increased up to 20% with repeatability of the total movement is only 90%. This experiment also showed that the robustness for this mobile robot is poor.

Open loop system[12-15] is not favorable for outdoor environment especially when the obstacles applied. We also tried several experiment by using stepper motor instead of DC motor where we found out that stepper motor is quite ideal for open loop system compared to DC motor. In order to improve the performance of this robot, both sensors and motor selection become important parts that should be considered.

A web camera was attached in motor stepper and controlled by L293D driver. We tried to test the up and down movement of the camera but when we put looping instruction to the motor we found that the motor could not respond properly. We found that this is due to the complexity on executing stop address of the ID process in web interface which is needed during looping instruction in operating system background. Besides we also figured out that DC motor and custom gearbox will be a good choice for controlling web camera up and down movement.

The application to monitor the robot via website could be found in http://robospy.com where we can find a visual box and some button selections to navigate the robot continuously. Figure 4 showed the print screen of the website, but all the buttons are written in BAHASA language. We also provide a website to control the movement step by step for 90cm and 180cm movement as shown in figure 5.
The test results in figure 5 showed that communication via web to the robot system, the live streaming, as well as snapshot could be performed both on continuous movement and step by step movement. However, we need to define the specific distance for step to step movement and this can be improved by providing input selection in the website. We also try to access the website more than 1 person at a time, the result shows that each person can see the view of the surrounding but can not control the robot at the same time. If this is done, there will be error in the program. Nevertheless, this finding gives us idea for improvement in the second model assembling which is now under construction.

Wireless connection is well performed as far as 80 meter and the robot also needs additional lighting system so that it can be operated in low light environment during live streaming. The total power consumed by the robot for one time operation (3 hours continuous moving) is around 14.65Watt and the total pricing is US$190 as seen on figure 6. WowWee Rovio mobile web camera [16] offered a WiFi client mobile webcam includes speaker as high as $279.99, the mobile webcam itself can be navigated on TrueTrack System and consumes 18Watt.
Fig 4. Print screen of website to navigate the robot movement continuously.

Fig 5. Print screen of website to navigate the robot movement step by step.
Fig 6. Web-based open loop remote control robot that is designed.

4. Conclusion

Web-based open loop remote control robot is designed with the ability of a WiFi mobile webcam but with lower price and with flexibility to be developed more. Even though the robustness is lower than it is expected due to the disadvantage of open loop system, this robot can function normally according to its application as surveillance mobile webcam. In the future, the closed loop system will be designed to improve this model. No innovative technique is presented here but its flexibility to be customized according to the user’s need is one of the strength that is offered. The second model is under construction based on current model; hopefully the second model will be more powerful with better accuracy but spend almost the same price.

References


