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DESIGN AND DEVELOPMENT OF SMARTPHONE CONTROLLED MOBILE ROBOT FOR DIFFERENT TYPES OF ENGINEERING APPLICATIONS IN THE MODERN INDUSTRIALIZED WORLD

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Abstract

This paper presents the design and development of smartphone control mobile robot for engineering applications in the modern industrialized world. This project was intended to act as a prototype for an early-stage enterprise that would pave the way for a variety of fresh options in the area of remote-controlled robot interaction. The initial and ongoing plan is to create a virtual environment for controlling the field data and states of actual robots, while also encouraging people to create their own tele operable robots. In this approach, humans can operate robots from anywhere in the globe using wireless networks and the internet to interact with them in the same space. The project's construction of a real robot that can be controlled wirelessly from a computer or a smartphone is a crucial component. As this project is intended to serve as a starting point for the soon-to-be fully operational robots, simplicity was specified as a criterion to concentrate on operability and functionality. One advantage of simplicity is the ability to minimize costs, a task that has been effectively completed. The project's construction of a real robot that can be controlled wirelessly from a computer or a smartphone is a crucial component. As this project is intended to serve as a starting point for the soon-to-be fully operational robots, simplicity was specified as a criterion in order to concentrate on operability and functionality. One advantage of simplicity is the ability to minimize costs, a task that has been effectively completed. Final results include the design and construction of a low-cost, nearly completely printed robot, as well as the development of software for both the robot and the smartphone. A robot controlled by an android has been created. Students across virtually all grade levels are becoming more interested in robotics in this digital age, from preschoolers using toy robot cars to teenagers using high-tech robots like Sphero BOLT, Grill Bot, and many other readily available models. The simulated & experimental results shows the effectiveness of the methodology that is being presented in this paper.

Keywords : Robot, Industry, Mobile, Control, App**.**

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Results

The robot's primary movement commands for forward, backward, right, and left directions have been programmed. To detect harmful gases in the environment, the robot utilizes gas sensors, along with a camera, microphone, and laser light, to capture and transmit video and audio while pinpointing the source. The MQ2 gas sensor is capable of detecting gases such as methane, butane, LPG, and smoke. To control the robot's basic functions, commands can be sent from an Android mobile device to the robot's Raspberry Pi through VNC software, enabling real-time control without significant delays. By connecting both devices via mobile Wi-Fi and matching their IP addresses, the robot's code can be executed. This versatile device can be effectively employed for surveillance purposes in dense forest areas and conflict zones, greatly enhancing military operations and ensuring their safety [1][2].

Application

In this section, the different applications of the project work is presented in a nutshell as follows [3][4]

- Robots that can be operated by a cell phone can be employed at border crossings to show off buried land mines.
- The robot can be utilized for surveillance or reconnaissance.
- The robot can be used wherever there is a connection tower for the service provider if it is mounted on the robot.
- With the help of a military-industrial alliance, it can be effectively applied in national defenses.
- It can be used extensively in resorts and on the edges of renowned structures**.**
- Combat robot installation ensures excellent security at stadiums, holy locations, government, and non-government organizations.

Introduction to the project work

Post-secondary students are increasingly captivated by the fascinating world of mobile robots and their operations. The creation and functioning of these robots have sparked their curiosity, as they seek to delve into the construction and mechanics behind them. With the aim of stimulating young minds and imparting knowledge about robotics, a cost-effective mobile robot with a simple design and implementation has been developed. This robot serves as an excellent gateway for post-secondary students interested in robotics, providing a beginner's guide that is accessible and easy to comprehend. The versatility of mobile robots finds application in various aspects of daily life, including education, scientific research, household tasks, healthcare, space exploration, agriculture, and surveillance of both public and private spaces. Surveillance entails monitoring behavior, actions, or other dynamic information with the purpose of controlling, managing, guiding, or safeguarding individuals, processes, or assets [5][6].

Governments utilise surveillance for intelligence gathering, crime prevention, the safety of people, things, or processes, or the investigation of crimes. Robots can now be used to remotely monitor important regions instead of people thanks to technological advances over the years. Robots, both physical and space-based, may detect small features that are not obvious to people, in addition to the obvious benefit of not losing any labour force. Robots are robots that work autonomously and are employed to replace human labour, even if they may not carry out tasks precisely or resemble humans physically. By extension, robotics is a branch of engineering that deals with the creation, upkeep, and use of robots. A robot that operates on software and can move around in its environment with the aid of sensors is simply referred to as a mobile robot [7][8].

Literature Reviews / Surveys

A number of authors, researchers have worked on the proposed project. A few of them has been presented here in this context. In reference [1], titled, "Force feedback assistance in remote ultrasound scan procedures", Energies, vol. 13, no. 13, p. 3376, 2020; M. Bucolo, A. Buscarino, L. Fortuna, and S. Gagliano, the following discussions were made. The usage of KUKA robots for remote control ultrasonic scan applications was suggested by Bucolo et al. Based on ultrasonic sensors, they created a medical investigation system that was affordable and integrated force reactive behaviour using strong control feedback on a synthetic body. With the help of the suggested method, remote-controlled ultrasound scanning can provide medical professionals with a reasonable amount of information.

In the reference [2], R. Sparrow and M. Howard, "Robots in agriculture: prospects, impacts, ethics, and policy", in Precision Agriculture, vol. 22, no. 3, 2021, pp. 818–833, the following discussions were made. A survey on the prospects for and potential effects of agricultural robotics was done by Sparrow and Howard. They also looked at the ethical and political issues, as well as the economic and environmental effects, of using robots in agriculture. The study emphasised how crucial it is to address partisan, general, cultural, and security aspects that have gotten little consideration in the agricultural robotics literature to date.

In the reference [3], "Automation of the Leonardo da Vinci machines," Machines, vol. 8, no. 3, p. 53, 2020; M. Bucolo, A. Buscarino, C. Famoso, L. Fortuna, and S. Gagliano, the following discussions were made. A project by Bucolo and colleagues sought to create a general theory for the design of all Leonardo machines operated by contemporary control methods and apparatus. By emphasizing the function of conventional mechanics in engineering projects, the study sought to close the gap between traditional and future engineering. The project also popularized the idea of "woodtronics," which entails building mechanical devices out of wood and operating them with reusable electronic parts, motors, and inexpensive microcontrollers.

In the reference [4],"IoT Servomotor Enhanced Pick and Place Robo Arm", G. Ramakrishna Prabu and E. Elangovan, ISSN (Online): 2278-8875, vol. 5, issue 6, June 2016, the following discussions were made. Elangovan and Ramakrishnaprabu talked about how technology is progressing, especially in the area of education and how remote laboratories might benefit from it. They concentrated on how communication protocols changed from HTTP to web sockets and how this technology enables two-way communication between clients and servers. The paper described the creation of a mobile robot that can be controlled by a smartphone for engineering purposes, using web sockets to facilitate communication. The authors highlighted the critical function of IoT hardware like Arduino and Raspberry Pi in achieving this task.

In the reference [5], "The colour of the light: A remote laboratory that uses a smart device to connect teachers and students", Global Engineering Education Conference (EDUCON), 2014 IEEE, vol., no., pp. 854-860, 3-5 April 2014. G. Carro, M. Castro, E. Sancristobal, G. Diaz, F. Mur, M. Latorre, M. haparro, A. Lopez-Rey, C. Salzmann, and D. Gillet, the following discussions were made. The Techno Museum and Go Lab projects, which facilitate the use of technology in educational contexts for a larger audience, were detailed by Carro et al. They demonstrated a working prototype of a smart device powered by Arduino that UNED had created to include distant laboratories into educational scenarios. The Arduino smart gadget was initially created for robotics labs and later expanded to others.

Enhancements

In the field of force feedback assistance during remote ultrasound scan procedures, the research conducted by Bucolo *et.al.* [1] presents valuable insights. Their study, published in the journal Energies, explores the potential enhancements in this area. Additionally, the work by Sparrow and Howard [2] in the domain of robotics in agriculture offers a comprehensive analysis of prospects, impacts, ethics, and policy considerations. Their research published in Precision Agriculture provides valuable information that can contribute to the enhancement of robotic systems in the agricultural sector. Furthermore, the research by Bucolo *et.al.* [3] on the automation of Leonardo da Vinci machines, published in the journal Machines, provides further insights into the advancements in automation technologies. By drawing upon these studies, the proposed enhancements in this IEEE paper can benefit from the knowledge and findings presented in these related research works [9][10].

Block Diagram and Working

The project's goal is to create a robot that can be operated wirelessly by an Android phone. Through preset keys specified in the Android application, the robot may be manoeuvred in all four directions (forward, back, left, and right). This study outlines a novel, cost-effective approach to robot control systems. Numerous advanced robotic applications can make use of the provided robot arm control system. A Raspberry pi serves as the project's controlling tool for the robotics. The Wi-Fi module attached to the Raspberry Pi will receive the data supplied from the Android mobile phone over Wi-Fi. The project aims at designing a robot which is controlled through Android phone over Wi-Fi technology [11][12].

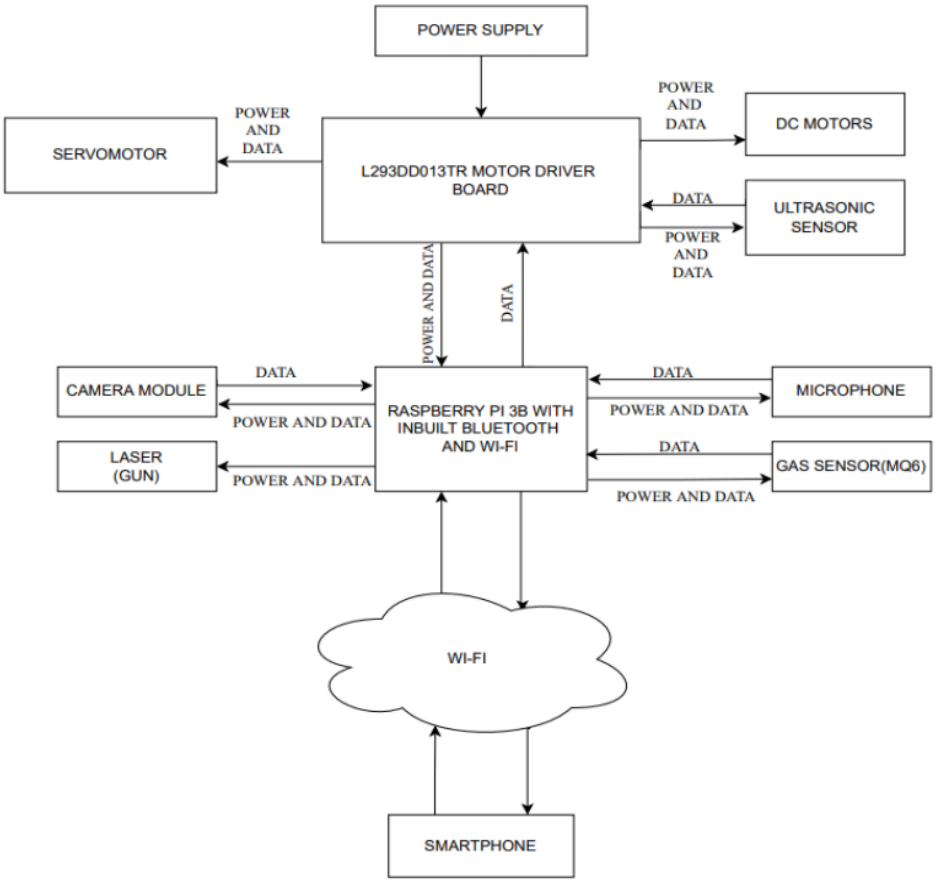

Fig. 1 : Overall block diagram of the proposed project

To operate the different units depicted in the block diagram in Fig. 1, the system requires power. The two 3.7V batteries that make up the power supply unit supply the system with power. This approach was made possible by the fact that two lithium batteries connected in series can successfully power the Raspberry Pi, DC motors, DC driver board, Ultrasonic sensor, Servomotors, Camera module, and USB microphone (each of which operates at voltages between 3V and 6V).The Raspberry Pi and e Motor Driver Board will be able to supply the pan/tilt servomotors with enough current from the 5V digital pin. If the system is run with a battery of much higher voltage, the electronics will be burned, and if it is used with a battery of lower voltage, the motor's RPM will be reduced. being because the Raspberry Pi, DC motors, DC driver board, Ultrasonic sensor, Servomotors, Camera module, and USB microphone (each has working voltages between 3V and 6V) can be successfully powered using two Lithium batteries connected in series that provide approximately 7.4V [13][14].

The e Motor driver board and the Raspberry Pi will be able to provide enough current from the 5V digital pin to power the pan/tilt servomotors. Operating the system with a much higher battery will burn the electronics and operating with a battery of lower voltage will reduce the RPM of the motor, resulting in a reduction in the efficiency of the surveillance robot. the power supply is controlled by a switch. When "on" the current flows through the LED having a10kΩresistor and it turns "on" emitting green coloured light. the power supply is connected to the L293D Motor driver board that drives the DC motors responsible for controlling the four wheels connected to them, which provides forward, backward, left, and right movement of the robot the block diagram of project is shown in Fig. 1 [15][16]

Proposed Methodology

Most of the text in the proposed methodology is devoted to controlling this activity so that we can shift the by sending precise instructions to a robot. DC motors are used in robotics. These motors support the robot's movement in the intended direction. Using a microcontroller, the motors are controlled. Raspberry Pi. A mobile application was used to provide the user interface for controlling the robot. The wi-fi module is given control over the internet. This serves as the receiver and transmits the signal it has received to the microcontroller. We can reach the robotic arm from anywhere since the signal that is transmitted to it is actually sent over the internet. The robot's movements can be captured on camera and stored. Robots are created with the ability to be directed by the human brain in mind. A robot that can effectively maneuver around crowded cities has been created. Speech is the quickest mode of communication with a wide range of applications, according to studies Automobile technology, healthcare, the military, education, and intelligent buildings are just a few examples.

Algorithm

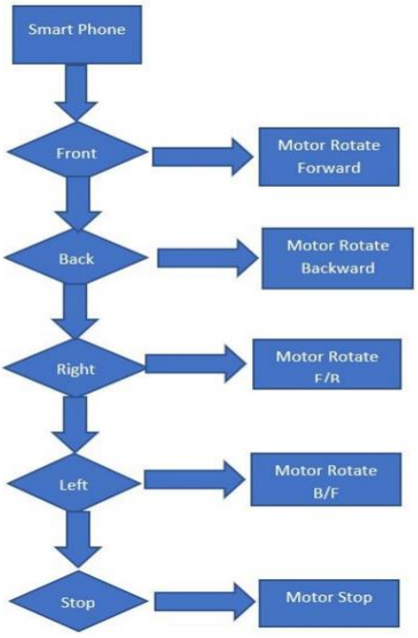

Fig. 2 : Proposed algorithm / data flow diagram / flow-chart

Conclusions

A live audio and video streaming robot has been developed. This robot can be used in remote areas where humans are unable to travel since it can be controlled by a smartphone app from all four directions. With a wi-fi connection, the robot may be controlled up to 100 metres away. Both manual and automatic options are accessible in this instance. An ultrasonic sensor is used to identify obstructions in the path and a microphone is utilised to record the sounds. The methodology used in this study is transferable to a wider range of robot development. Applications are also available for this smartphone-controlled robot.

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