Design and Realization of Automatic Video-Based Docking Structure For Home Surveillance Robots By Using Raspberry Pi

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Abstract— Now a days, most of the home security is provided manually by providing the watchman. Therefore it is necessary to design proper electronics home security systems. In this paper presents the electronics home security systems by improvement and classification of examination of robot with regular docking and recharge capability. This proposed home surveillance system has divided in two different sections; the robotics section and docking section. In a robotic section automatic surveillance system is designed with the integration of raspberry pi & web camera having man spotting sensor and docking area for wireless power transfer. The communication between the surveillance robot and PC is through the IEEE 802.15.4. and android mobile phone. The interrupt will give intimation to the camera. The image of the person is captured using web camera and stored in the database as a backup. This image is compared with existing images so that the person authentication can be done. Here the robot model may rotate over different angles due to spontaneous as well as manual power to cover the entire home. The Computer will manage the camera in the rest condition under the lack of person. This robotic system can be operated in normal as well as security mode. In normal mode the robotic system is navigated by the user, but in secure mode the robotic system is navigated automatically. The major idea of this article is to demote the power utilization of robot. The docking system is used for automatic recharging when the battery is too low. This part can be transfer the power from one coil to the other coil via wireless power transmission approach due to home surveillance robot. Ultrasonic signal authenticates the surveillance robot is inside the power transmission area. This process is successfully done by using Python software and Linux operating system which produced accurate results.

Index Terms— Web Cam, Docking System, Robot.

1 Introduction

NOWADAYS movable robots are used in a lot of fields such as house security, industrial surveillance, hospitals and in many other fields. The main reason for this evolution is that the cost of producing and designing the robot is rduced to a great extent. The robots that are designed and prduced reduce the human burden in many ways. Among these the home surveillance robot is widely used. Mobile robots are greatly played in industrial robotization, home robotization as well as in hospitals, space exploration, military, etc[1]. Housebased safety is the typical characteristic applications of home surveillance robots. Monitoring devices can be build up on windows, doors and walls for house safety plan. It is not convenient to install and carry on many appliance and sensors inside the places. Some parts of the rooms cannot be covered by the sensors because of untypical place structure and several corporal limits of sensors. Thus it is essential to have addtional modifiable and additional effective solution for house safety to spread out a mobile robot fit with oversight devices like cameras and piezoelectric infrared sensors. A house safety method which includes an intelligent safety robot and various remote interactions is explained in this paper [4].

House security alarm is one of the conventional applications of home robots. In conventional home safety systems, a device that displays signals on a computer screen are usually assembled on permanent position such as doors, windows and walls. A House security system is depending on an embedded system with different ultrasonic sensor modules has been presented in an article [6]. This can be a structure for semantic anaysis of person behaviour from a monocular observation online video cought by a customer camera. The planned structure coughts a persons motion, classifies its position, infer the semantic incident, and creates the 3D scene renovation. Almost all of the recent house safety systems can work traditionally because it is difficult to organize and continue many more accessories and sensors almost everywhere part of the buildings. The sensors cannot cover the complicated parts of the buldings, to remove this limitations more flexible and extra proficient solution for house safety is to arrange a mobile robot prepared with inspection devices such as pizoelectric infrared cameras and sensors.

Various researchers globally be at the moment are occupied during designing different mobile surveillance robots used for house safety applications. For an example the expansion of a patrol robot method used for house safety by several funtionalities has been offered in reference. Off-the-shelf

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coponents is based on the design as well as performance of an intelligent house safety robot has been offered in reference. Main important aspect for the majority of the house safety applications which takes benefit of the mobile robots repeately have to effort uninterruptedly for numerous days or still numerous weeks with no person interference. Although these systems are robost in their hardware with software design; but it require more sustainable energy. So it is necessary to recharge itself again nad again [4]. A number of investigations are starts to design movable nodes; by using the network of wireless sensors and a few prototypes. This article presents the design of robot with automatic docking and recharging abilities for the house security system. This system is designed in two sections surveillance robot and the docking position. The structure of surveillance robot triangular shaped structure and the size of the robot is 15cm×15cm×9cm (L×W×H). Generally, for the house security usage wheel based mobile robot byUSB using camera is designed. The commucations of robot to the house router is wireless communication and it takes place with the help of WiFi. The docking stations has different network gateway and the robot has different mobile wireless sensors. In this way the communication between the docking station and the mobile robot is takes place. The arc-shaped docking interface with the trapezoidal structure is presents in a docking station. Whn the battery of robot becomes low, hte robot may be return to the docking station.

The remaining article is ordered as follows. Section II introduces the Literature review of proposed system. The development of system is presents in Section III. The performance outcome on the locomotion and docking performance of the prototype robot are given in section VI. And finally the section V concludes the paper.

2 Litrature Review

There have been many developments in this field since decades, but the main thing is safety. Now a days, the security guards are presents outside the house for home security. But in every time it is not possible to rely on guards. To overcome this problem; the proposed system is collection of a wireless charging station at high power. The wireless charging station consist of a power supply and two coils for wireless power transfer, one attached to the docking station and one attached to the robot. The better the two coils are aligned, the more power is transferred and the efficiency of the recharging system increases. Hence proper transfer of power is essential for docking part. This section consists of an overview of study papers which are helpful for implementation of the project. This section presents the review of the home surveillance robot and docking system. Some of them are described as follows:

"Automatic docking system for recharging home surveillance robots", Tianhua Meng, Jun Zhang, Hui Wang, and Guangming Song [1]. This article uses the technique to decrease energy consumption of robot. A house surveillance scheme depends on an embedded system by using multiple ultrasonic sensor modules. If some intruder moves during the ultrasonic sensing area, the ultrasonic diffusion will be blocked by the person being body existence. house safety is the useful applications of house robots. In this project through wireless power transmission system the robotic part can be charged.

"Home Automation as a Means of Independent Living", E. Prassler, Y. Tsumaki, P. Fiorini, D. D. Finlay and C. D. Nugent [5], This article presents home automation can potentially turn into a secure place whether individual can relate effortlessly. In addition to this, numerous forms of automation can allow people to get contact, to work together with the external globe. This system contact to services which previously have been past the reach of the home environment. Museums, libraries, shops and hospitals are the some examples presents in this article for the supply services. The actuators and sensors are used in this article for the communication betwen the robot and the docking station.

"A Hybrid Sensor Network System for Home Monitoring Applications", Aiguo Song, Weijuan Zhang, Zhigang Wei, and Guangming Song, Member, IEEE[2]. In this article hybrid sensor networks are used to design house monitoring structure. The robot presents in this having the tracking capabilities to find the docking station by using the nodes. also the stability of this system is well checked. To controlled mobility to wireless sensor networks, an enhanced sensor node has been fabricated and planned. The interfacing to the different users are controlled by the mobile node with the simple planer motion. The architecture presents in this uses 3 layer architecture and it is mixed with hybrid node networking with internate access.

"A Surveillance Robot with Hopping Capabilities for Home Security", Xiuzhen Cheng, Yaoxin Zhou, Kaijian Yin and Guangming Song [4]. Mainly traditional house robots have always had complications with doorsills and staircase other obstacles so as to people cross simply in muddled inner environments. In this article, the house safety is provided by considering the hopping capabilities of surveillance robot and its characterization and growth. The robot used in this article having 250g in weight and 9cm in height and it can rise above obstacles more than four times its own size. The Wi-Fi protocol is used in this for the wireless communication in between the robot and the docking station.

3 Development of System

This section describes the proposed automatic docking system for home surveillance robots. The theoretical design of a house security system depends on the proposed surveillance robot and the docking station which is shown is figure 1. The surveillance robot present in this paper operated in 3 different modes. All these modes are depends upon the task properties and user requests. The 3 modes are remote control mode, first responder mode and patrolling mode.

The surveillance robot automatically moves inside the building with the help of predefined routes in patrolling mode. If there is any obstacle is presents in front of robot, then the robot sends the security related information to the home server for the further analysis.

The programming of the surveillance robot is done in the first responder mode. This programming is done with the help of fixed monitoring devices. Figure 1 shows the circuit show-

ing the model of surveillance Robot. This Robot is designed in such a manner that it can be reprogrammed and it is designed to shift tools, materials, parts or specific devices motions for the presentation of different assignment.

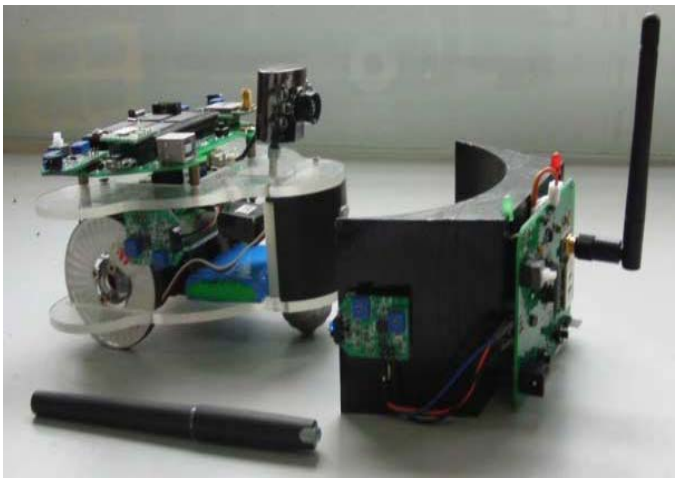

Fig. 1. Circuit showing the model of surveillance Robot.

3.1 The Supervision Robot

The block diagram of surveillance robot consists of different module such as raspberry pi, web camera, LCD display, Ultrasonic sensors, RF transceiver, two DC motors and DC motor driver circuit includes IC L293D etc. The figure 2 shows the basic block diagram of the proposed Surveillance Robot Unit. Raspberry pi controls the angle of rotation of two Servo Motors. The DC motor is used for the movement of the robot in left, right, forward, backward direction with the help of android cell phone. Digital section includes the Raspberry pi Controller along with required interfaces like Display Keypad and communication drivers. The Power section include the power supply that is required for various parts of machine like controller, motors etc.

Fig.2. Block Diagram of Surveillance Robot Unit.

The Firmware part is used to write the software which requires to control various operation, also it helps to program various parameters and setting of machine. Also it covers the communication with PC. The voltage detection module is also presents in this system to detect the real time battery status of the robot. If the voltage falls below the preset level of valtage, the circuit gives instruction to the robot to return the docking station. The two ultrasonic sensors presents in this are used to find obstacles.

3.2 Docking system

At any time the battery voltage is small and if the surveillance robot wish to go on its own then it should goes reverse to the docking region and join through the docking station repeatedly. Various key methods contain local and universal lane planning, self-localization, charging and docking status recognition, and fault-tolerant proceeding.

The figure 3 shows the block diagram of docking system. It consists of a current detection module and two charging coils. The comparater is presents in the current detection module which is used to detect the charging condition of a battery of robot. If the charging of battery is less the wireless communiation with the help of WiFi is done in between the docking station and the robot. The ultrasonic sensors ar eused to find the obstacles in between the path of robot. In this way the robot can find the path automacally.

When the docking starts in between the robot and station, the Ultrasonic Sensors on the robot will momentarily stop working to avoid interfering with the Ultrasonic Sensors on the docking station. Detailed docking method will be introduced in the following section. In docking system the timer 555 and driver circuit are used for wireless image transmission to robot at docking. In docking system the coil are used for electromagnetic induction to set position of robot at docking.

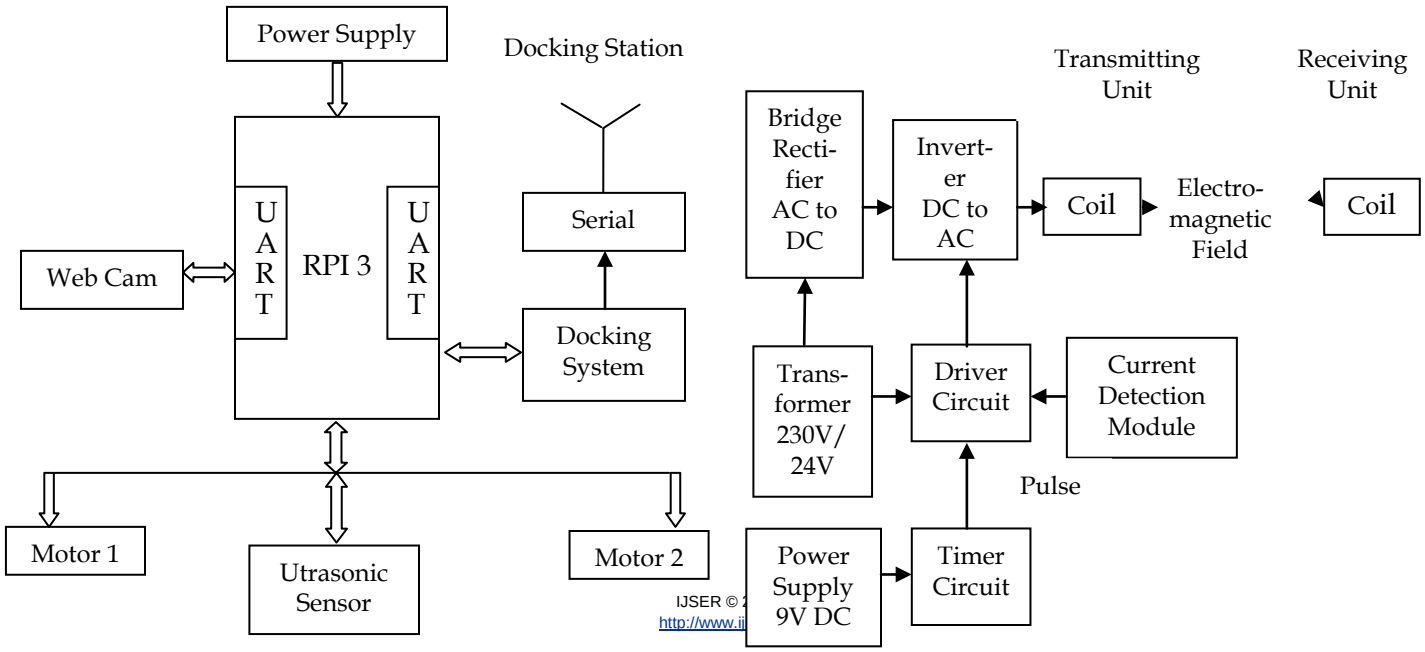

Figure 3. Block Diagram of Docking System.

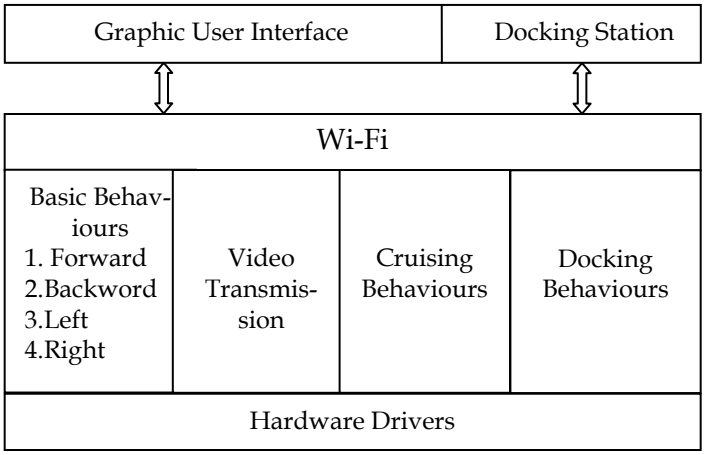

Fig. 4. Surveillance Robot Software Architecture.

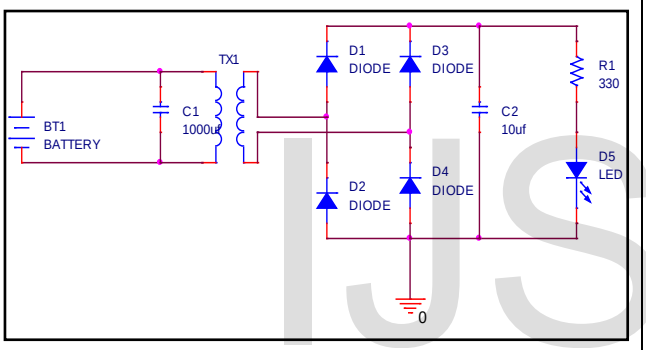

Fig.5. Circuit Diagram of Docking Station.

If the surveillance robot wish to go with its individual and the battery voltage is low then it should navigate back to the docking region and join through the docking station repeatedly. 9V DC supply is used to operate the timer circuit. 230V AC/24V AC supply is used for driver circuit and bridge rectifier of transmitting circuit. Figure 4 shows the surveillance robot software architecture and the figure 5 shows the circuit diagram of docking station.

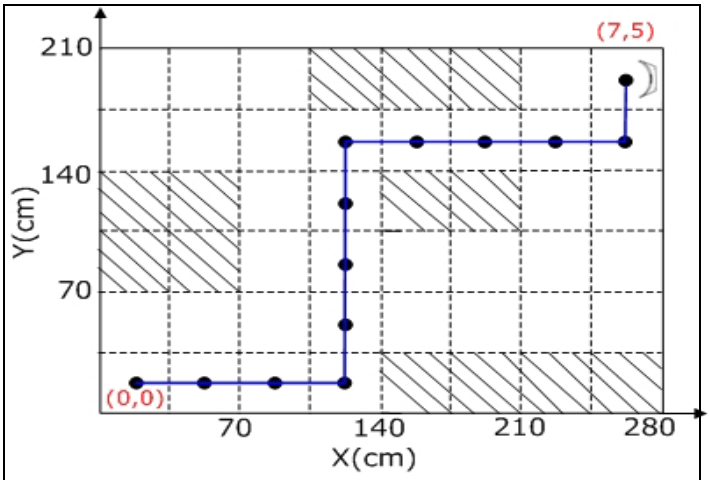

Fig. 6. Grid map of the robot workspace.

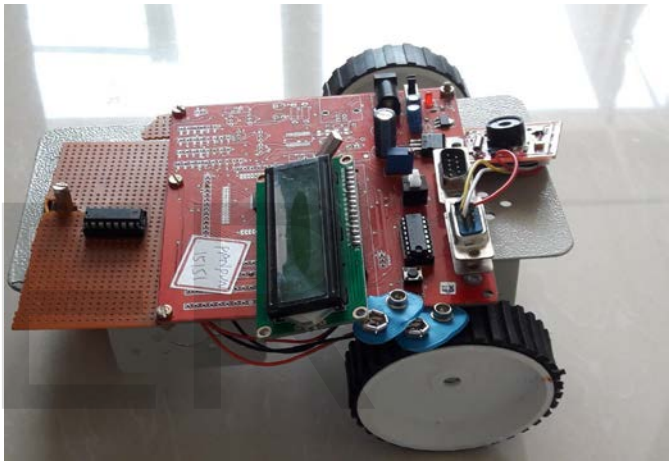

Fig.7. Circuit showing the model of surveillance Robot

4 Result Analysis

This section reports the detail steps of proposed docking system. For the docking system the proposed system uses the shortest path algorithm to find the path. The network routing is used to find the shortest path. It calculates the path from a network device A and B in a network which would have the maximum bandwidth. It can be used by the GPS in a car to calculate the shortest path between two locations. The above figure 6 shows the Grid map of the robot workspace. The proposed design of surveillance robot system is Raspberry Pi based circuitry. Raspberry Pi is used in this circuit because of its enumerable features, which is inbuilt Analog-to-digital Converter (ADC).

In this planned circuit, PIR and Ultrasonic sensor are used to sense the signal. Liquid Crystal Display (LCD) is used as a 4 bit display.DC motors are used for rotation purpose to the robot. UART is used for serial communication purpose. The proposed design of docking system is as shown figure 8.

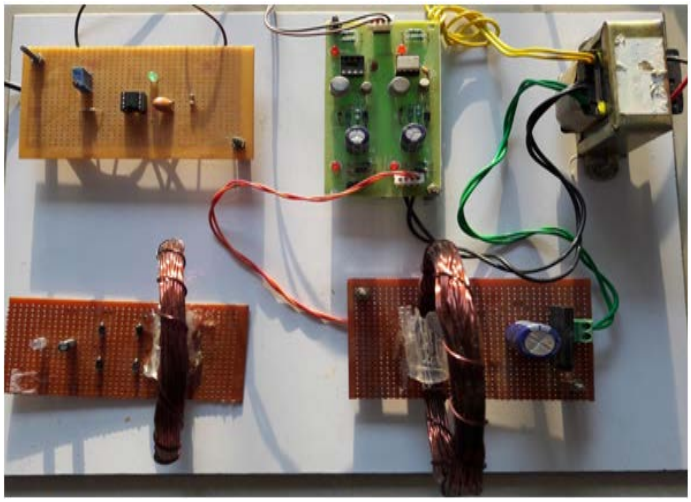

Fig.8. Circuit showing Docking system

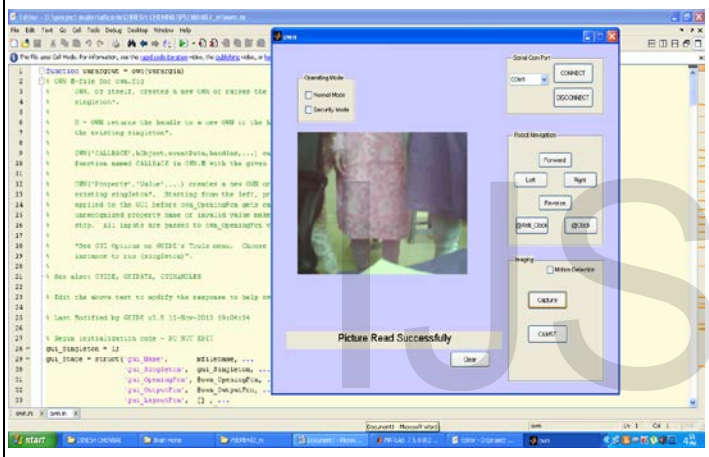

Fig.9. The graphic user interface of automatic docking system.

In this, a step down transformer that is 230v-24V AC. 24V AC supply voltage is given to the transmitting circuit.Transmitting circuit contains the bridge rectifier, capacitor, MOSFET and COIL. Receiving circuit contains the COIL, bridge rectifier, capacitor and LED. The docking system shows how the power is transmitted from transmitting coil to the receiving coil. The receiving coil is placed on the robot part.

Figure 9 shows the graphic user interface of automatic docking system. The above figure 10 shows the experimental setup for the proposed system.

Fig.10. Testbed setup for the automatic docking experiments.

5 Conclusion

The proposed system presents the plan & execution of surveillance robot by way of automatic docking and abilities in favor of house safety. The suggested network has a docking approach on the identity localization of the robot and the wireless power transmission of the docking position. It is observed that the robot can come reverse to the docking station. The receiving coil is placed on the Robot so that the power is transformed from transmitting coil of the docking system to the receiving coil of the robot. The proposed docking part transforms the energy from one coil to the other coil. Future work will focus on improving the current prototype robot to enable more functions. Number of turns in the coil is considered as a major parameter in design of the docking system. More number of turns can be used to transfer more power. We can transfer image through wired communication to the PC instead of that we can change communication of UART through wireless Robot access. The proposed system is successfully done by using Python software and Linux operating system which produced accurate results.

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