www.ijecs.in
International Journal Of Engineering And Computer Science ISSN: 2319-7242
Volume 4 Issue 10 Oct 2015, Page No. 14856-14860

Implementation of Surveillance robot with the feature of semi automatic recharging capability

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Abstract:-This paper presents the design and implementation of a surveillance system with semi automatic battery recharging capability for the prolonged activities of robots. A battery recharge station is proposed to implement battery off - line recharging when it's drained. The surveillance robot is a wheeled robot with an onboard camera and a rechargeable battery case in the front. It communicates with the user wirelessly through Wi-Fi network. As the system powered up the surveillance robot will move across the area avoid obstacles using infra red sensor and by exporting the battery voltage values over web for user reference, when on board battery is low then the threshold value, the robot will stop then the user can route the robot to the docking station using web based controls. After the battery is completely charged the robot will be unlocked from docking station and continuous its surveillance. The experimental results show that the system is working with 95% accuracy. The proposed system is proved to be efficient in security applications that need the robots to work continuously over a long period.

Keywords-Arm9, Surveillance, Docking station, USB camera, Wi-Fi module.

I.INTRODUCTION

With the rapid development of home automation on a global scale in recent years, mobile robots are increasingly used in home environments [1]. Surveillance robots are widely used in home automation services such as cleaning, security, rehabilitation training, and homecare. Owing to advances in Microelectromechanical System (MEMS) technology, the size and cost of home robots have been reduced significantly. More and more people want to use surveillance robots to make their lives more intelligent, easier and more enjoyable [2] - [4].Taking into account the needs of users, surveillance robots must exhibit some self - sustaining property. In addition to being robust in their hardware and software design surveillance robots must have autonomous capabilities for long duration missions. Renewable energy sources are therefore of great concern [5]. Solar cells or rechargeable batteries are the most commonly used energy sources for mobile robots. But this is not suitable for surveillance robots which work in indoor environments, so using rechargeable batteries is a feasible method to increase long - term autonomy. However, most current surveillance robots have to have their batteries replaced by human operators or to carry manually to the recharge point. People prefer robots to be able to do this job automatically. Several methods have been proposed for the automatic recharging station of home robots. Luo *et al.* [7] present a concept of recharging station for home robots. The station consists of an automatic recharging device and a robot docking mechanism. Song *et al.*[8] present a surveillance robot with automatic docking and recharging capabilities for home security and implement the design of a simple semi - circular recharging station. Home robots must be designed to dock themselves into the station to recharge their battery.

Most current surveillance robots lack autonomy capability in long duration missions. They either have to have their Batteries replaced by human operators or carry manually to recharge station. In order to solve this problem and semi automatic battery charging system for the prolonged activities of home robots is presented in this paper. It provides the functions of surveillance and guidance to charging docking station from remote location.

II SYSTEM ARCHITECTURE

The conceptual architecture of the proposed semi automatic battery recharge system is shown in Figure1 and 2. It is specifically designed to continually provide battery voltage and current status while doing surveillance that has to work long hours. Before the robot runs out of energy, it immediately stops and indicates its status, so that from remote location the user can guide the

robot to the charging station. A prototype of the robot for security applications is implemented on a ARM 9 architecture based Samsung Processor.

It is a single board computer which is a open source Linux based operation system, the device is communicated through the TCP/IP based Wi-Fi protocol with use. A voltage cum current sensor is used in order to find out the voltage present in the battery time to time, the values will be displayed on the LCD as well be posted to the web for remote view.

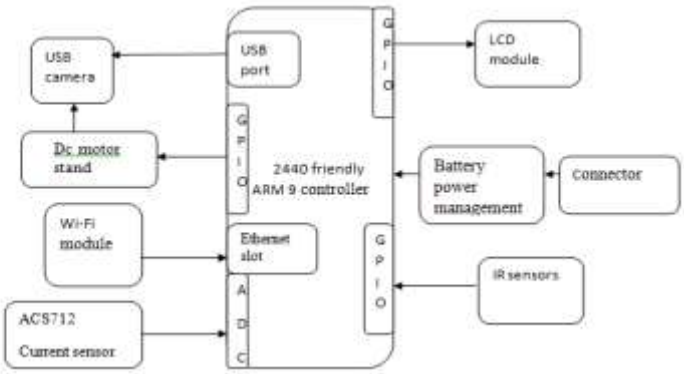

Fig 1: Robot Section

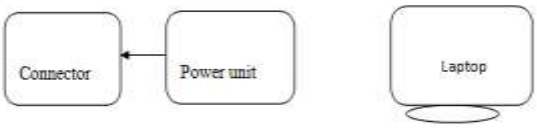

Fig 2: Charging Station

The Robot section is equipped with different sensors to monitor and obstacle avoidance while doing surveillance. Charging section will have a power unit so that whenever the user

III. HARDWARE

A. FRIENDLY ARM MINI 2440

The mini2440 is a practical low cost ARM9 Single Board Computer (SBC) with a very high performance/cost ratio. With the Samsung S3C2440 microprocessor and the use of professional layout and quality peripheral chips, it is very robust. The Mini2440 uses a four layer board design with gold immersion processing, and has high quality equal length bus routing in timing critical areas. The production environment and quality control are the same as those of modern high speed motherboards. The S3C2440A (450 MHz) offers outstanding features with its CPU core, a 16/32-bit ARM920T RISC processor designed by Advanced RISC machine ltd. The ARM920T implements MMU, AMBA BUS, and Harvard cache architecture with separate 16KB instruction and 16KB data caches, each with an 8 –word line length. The S3C2440A minimizes overall system costs and eliminates the need to configure additional components.

Fig 3: Arm 9 Board

B. ROBOT

DC motors are used to rotate the wheels of the robot. Using an L293d Motor Driver. It is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

C.ROUTER

Router is interfaced with RJ45 Jack controller. A router is a networking device that forwards the data packets between computer networks. Routers perform the "traffic directing" functions on the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the inter-network until it reaches its destination node.

D. Wi-Fi MODULE

A computer's wireless adapter translates data into a radio signal and transmits it using an antenna. A wireless router receives the signal and decodes it. The router sends the information to the Internet or Intranet using a physical, wired Ethernet connection. The process also works in reverse, with the router receiving information from the Intranet, translating it into a radio signal and sending it to the computer's wireless adapter. The radios used for Wi-Fi communication are very similar to the radios used for walkie-talkies, cell phones and other devices. They can transmit and receive radio waves, and they can convert 1s

and 0s into radio waves and convert the radio waves back into 1s and 0s.

E.USB CAMERA

USB camera is interfaced to the microcontroller to transfer the images to PC. Camera plays a vital role in automation purpose. The camera is used for monitoring of a room from a remote place. The camera used is a USB camera. Whenever the user clicks on to video button on loaded webpage, the corresponding room video will be streamed on to webpage .For this purpose we use a MJPG streamer. MJPG- streamer is used to capture the video frames and transmit them to the output plug-in. The MJPG-streamer is designed by C language.

F. IR SENSOR

In this project infrared emitters and detectors are used for detecting obstacles in front of the robot. An IR transmitter is designed through an IR led with a series resistance. The IR receiver section contains a photodiode which receives the IR rays and on the basis of IR intensity provides variation in voltage. The analog voltage obtained is in between its maximum and minimum operating range. This analog variation of voltage is fed to the microcontroller. Emitter in one knob and detector in another knob, when these two knobs are connected properly (i.e., detector detects the IR light) then the robot will stop and move in the other direction.

G.CURRENT SENSOR

In this project current sensor is used to measure the current and voltage of the battery. Current sensor gives precise current measurement for both AC and DC signals. These are good sensors for metering and measuring overall power consumption of systems. The ACS712 Low Current Sensor Breakout outputs an analog voltage that varies linearly with sensed current. For ACS712 5V should be supply to Vcc of ACS712 breakout board and the GND should be the negative of 0V of supply. Once it is powered, the Vout should produce output voltage which represent current going through the sensing pads. If there is no current, it should produce VCC/2 = 5V/2 = 2.5V at Vout. That indicates the current going through the sensor is 0 amps. ACS712 is able to measure current in two direction. Output voltage more than 2.5V (VCC/2) indicates current in one direction (e.g. from A to B) and voltage less than 2.5V indicates current in another direction (e.g. B to A).

IV SOFTWARE

A) QT (Qtopia)

Qt is a cross-platform application framework that is widely used for developing application software that can be run on various software and hardware platforms with little or no change in the underlying codebase, while having the power and speed of native applications. Qt is currently being developed both by the Qt Company, a subsidiary of Digia, and the Qt Project under open-source governance. Qt is used mainly for developing application software with graphical user interfaces (GUIs); however, programs without a GUI can be developed, such as command-line tools and consoles for servers. Qt uses standard C++ with extensions including signals and slots that simplify handling of events, and this helps in development of both GUI and server applications which receive their own set of event information and should process them accordingly. Qt supports many compilers, including the GCC C++ compiler and the Visual Studio suite. Qt can be used in several other programming languages via language bindings. It runs on the major desktop platforms and some of the mobile platforms. It has extensive internationalization support. Non-GUI features include SQL database access, XML parsing, JSON parsing, thread management and network support.

B) QT CREATOR

Qt Creator is a cross-platform C++, JavaScript and QML integrated development environment which is part of the SDK for the Qt GUI Application development framework. It includes a visual debugger and an integrated GUI layout and forms designer. The editor's features include syntax highlighting and auto completion, but purposely not tabs (although plug-ins are available). Qt Creator uses the C++compiler from the GNU Compiler Collection on Linux and FreeBSD. On Windows it can use MinGW or MSVC with the default install and can also use cdb when compiled from source code. Clang is also supported.

C) MJPG Streamer

"MJPG-streamer", is a command line application that copied JPG-frame from a single input plugin to multiple output plugins. It can be used to stream JPEG files over an IP-based network from the webcam to a viewer like Firefox, Cambozola, Videolanclient or even to a Windows Mobile device running the TCPMP-Player. It is written for embedded devices with very limited resources in terms of RAM and CPU. Its origin, the "uvc_streamer" was written, because Linux-UVC compatible cameras directly produce JPEG-data, allowing fast and perfomant.M-JPEG streams even from an embedded device running OpenWRT. The input module "input_uvc.so" captures such JPG frames from a connected webcam. It does support upto 1080p 30fps, but the bandwidth produced would be more than the usb bus (and therefore ethernet port / wifi dongle) can provide. 720p 15fps is a good compromise. MJPG-streamer takes JPGs from Linux-UVC compatible webcams, filesystem

DOI: 10.18535/ijecs/v4i10.40

or other input plugins and streams them as M-JPEG via HTTP to web browsers, VLC and other software.

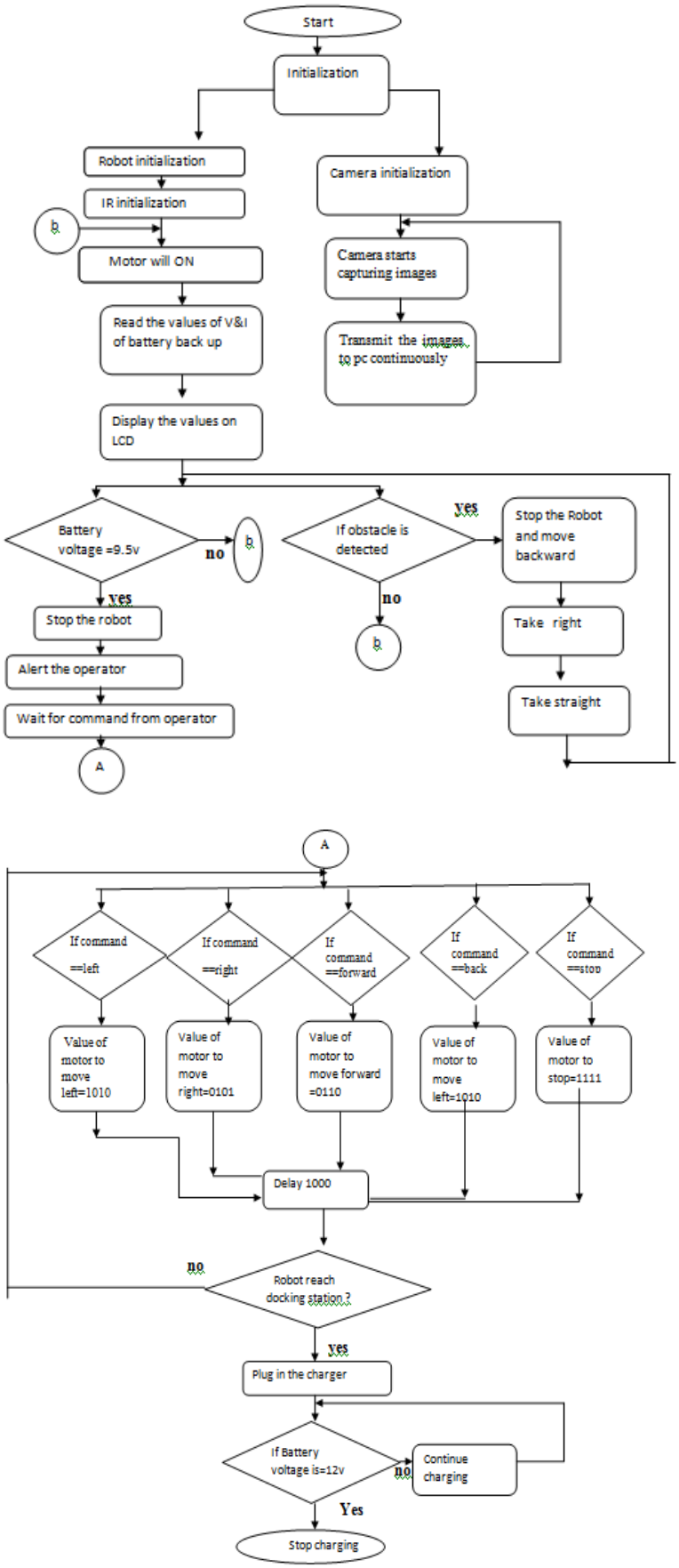

Fig 4: System Flow Chart

V. RESULTS

The Surveillance Robot setup is designed as shown in fig 5, the system will monitor continuously

Fig 5.System Hardware Setup

through the place and a USB Camera is used for live video streaming of the location by l continuously transmitting the images over the web which can viewed used mobile or laptop. On moving, on- board battery power will be gradually decreased, as it touch the threshold values of less then 9V the robot will be stop on its own. Based on the voltage values monitored on web, the user using Wi-Fi network will move the robot to docking station with control keys from user interface as show in fig 7 .Charging status of the battery will also be displayed on LCD of the ARM 9 board.

Fig 6.Web Interface Control Page

Captured images will be transferred to pc using the Wi-Fi. Whenever the user clicks on to video button on loaded webpage, the corresponding video will be streamed on to webpage .For this purpose we use a MJPG streamer. MJPG- streamer is used to capture the video frames and transmit to the output plug-in.

Fig 7.Live Video Streaming over PC

VI.CONCLUSION & FUTURESCOPE

From this paper, I want to conclude that the proposed system is composed of a surveillance robot and a docking station. In this the robot docking station with battery charging was introduced. The robot can move back to the docking station when the battery is too low.

Future work will focus on improving the current prototype robot to enable more functions. We plan to address several technical challenges such as visual navigation, adding more docking stations, and the automatic battery replacement mechanism.

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