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Swumanoid:An Autonomous Manoeuvre Sailing Robot For Oceanographic Research

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ABSTRACT: Ocean Exploration and Navigational Research is leading efforts by supporting expeditions with computer vision techniques have shown potential for Sailboat robots developed in order to make measurements at the surface. The marine environment presents an almost ideal test-bed for the evaluation and development of robotic technologies. Robot sailing is a challenging task in both building and controlling the boat therefore it brings together many different disciplines. The sailing robot explores in interpretation of video footage, the identification of sailing features, human-robot interaction, vehicle control, position estimation and mechanical design. Key applications for this vessel are the assessment of marine habitats and complex manoeuvres. An idea presented has been with a Robotic vehicle which activates automatically and manually control the moving object in the water the robot will capture and sends the information to the pc (personal computer) which uses advanced image processing technology and compares relevant images by identifying underwater features which will follow the object present in the surface of ocean. Here ARM7 processor is in built with interfacing a wireless camera which uses RF based communication. The DC motors are used to rotate the arms of the robot to catch habitats.

KEYWORDS: Sailing robot; Footage; Manoeuvres; Habitats;

I. INTRODUCTION

The development and deployment of Autonomous boat sailing is possible by the effective combination of appropriate new and novel techniques that will allow for a number of applications has been successfully completed. Autonomous robots have been successfully demonstrated in a number of applications, including planetary and underwater exploration. While the use of unmanned buoys for ocean observation is well established, the use of unmanned systems capable of long term purposeful navigation is still in its infancy. A sailing vessel will only require minimal electrical power to adjust its control surfaces and power on board computers. Sail propelled vessels thus prove an attractive prospect for investigation. A range of model sailing dinghies and very small cruising vehicles were examined, but a number of difficulties arise with each. Sailing dinghies will also require drastic modification to make them self-righting as well as requiring a modified rig to allow reliable automatic control. Sailing robots and were able to demonstrate basic working control systems. This paper presents the autonomous sail propelled robot for ocean observation will measures the sea shores, depth of oceans, rescue and also give the direction.

II. RELATED WORK

The overall block diagram of the robotic system consists of Transmitter and Receiver sections. The Transmitter section consists of PC with commands, RF Module and the Receiver section consists of RF module, ARM processor (LPC2148), H- Bridge and DC Motor.

A. Transmitter:

The Transmitter section having the four switches placed around the neck and RF Module. Initially the switches are at logic1. When the switch is pressed the concerned switch level goes to logic0.The switches are the inputs to RF transmitter through the RF encoder is shown in fig.1

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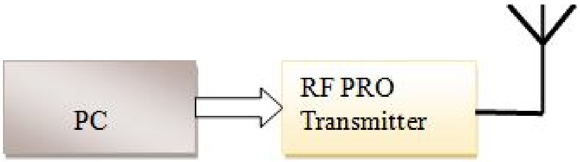

Fig. 1. Transmitter Section

B. Receiver

The received signal from the transmitter is fed to the RF decoder (Serial input and parallel output) .The output of the decoder is given to H-Bridge through the ARM processer shown in fig2.The output of H-Bridge drives the DC motors.

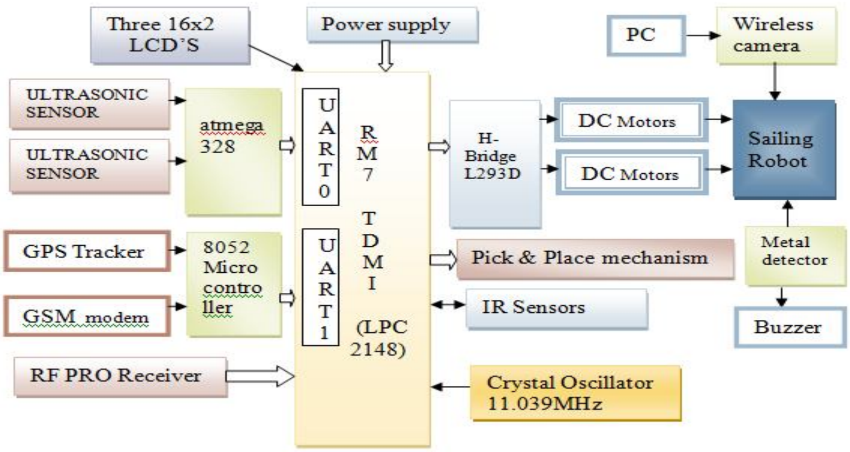

Fig. 2. Receiver Section

III. DESIGN STUDY

Radio frequency [RF] has a frequency range about 3Hz to 300GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves. Since most of this range is beyond the vibration rate that most mechanical systems can respond to RF usually refers to oscillations in electrical circuits or electromagnetic radiation. When an RF current is supplied to an antenna, it gives rise to an electromagnetic field that propagates through space. Electrical currents that oscillate at RF have special properties not shared by direct current signals. One such property is the ease with which it can ionize air creates a conductive path through air. Another property is the ability to appear to flow through paths that contain insulating material, like the dielectric insulator of a capacitor. The degree of effect of this property depends on the frequency of the signals. RF is a radio frequency technology which uses frequencies in the range of 3MHZ to 300 MHZ in general. Here in this RF system, we are using the frequency of 433MHZ which is in the Frequency range. The distance of this radio frequency range is up to 100m in general. In this project, the distance is up to 100m.

The main requirements for the communication in RF:

- RF transmitter.
- RF receiver.
- Encoder and decoder.

A. RF TRANSMITTER:

The STT--433 is ideal for remote control applications as shown in Fig.1 where low cost and longer range is required. The transmitter operates from a 1.5-12v supply, making it ideal for battery powered applications. The transmitter employs a SAW-stabilized oscillator, ensuring accurate frequency control for best range performance. The manufacturing friendly SIP style package and low– cost make the STT-433 suitable for high volume applications.

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Features: 433.92Hz Frequency, Low cost, 1.5-12V operation, small size.
PIN OUT:
GND: Transmitter ground. Connect to ground plane.
DATE: Digital date input. This input is CMOS compatible and should be driven with CMOS level inputs.
VCC: Operating voltage for the transmitter VCC should be bypassed with a .01uF ceramic capacitor and filtered with a 4.7uF tantalum capacitor . Noise on the power supply will degrade transmitter noise performance.
ANT: 50ohm antenna output. The antenna port impedance affects output power and harmonic emissions. Antenna can be single core wire of approximately 17cm length or PCB trace antenna.

B. RF RECEIVER:

The data is received by the RF receiver from the antenna pin and this data is available on the data pins. Two data pins are provided in the receiver module. Thus data can be used for further application.

This output is capable of driving one TTL or CMOS load .It is a CMOS compatible output. The data transmitted in to the air is received by the receiver. The received data is taken from the data line of the receiver and is fed to the decoder.

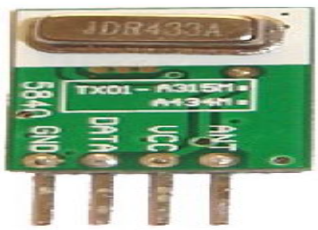

Fig. 3. RF Transmitter STT-433MHZ

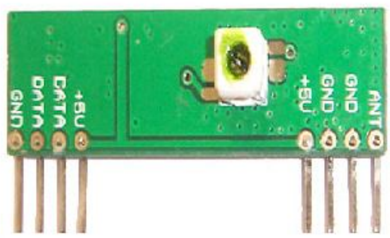

Fig. 4. RF Receiver STT-433MHZ.

Features:
* Low current (max.100ma)
* Low voltage (max.65v).

IV. SAILING MECHANISM

The boat model is made of thin Aluminium Sheet Two brush-less DC motors are fixed to the boat model. Pedals made of MS (Mild Steel) are fixed to the shafts of the DC motors. To move the boat forward, both the motors are operated in clockwise direction by the microcontroller. To move the boat reverse, both the motors are operated in counter-clockwise direction by the microcontroller. To turn left / right, one motor is rotated in clockwise and the other is rotated in counter-clockwise directions. The DC motor direction is controlled by H-Bridge (L293D IC). Pick and place operation is done by robotic arm.
The other key factor which must be considered in designing such a vessel is that of the sail type. Traditional fabric sails are typically controlled through a series of ropes known as sheets and halliards, these frequently break or jam (particularly when swollen by salt water) and require regular attention from the crew. Performing such tasks autonomously would incur significant overheads resulting in excessive power usage, weight and financial cost. A potential alternative is that of a rigid wing shaped sail attached directly to the mast. The sail is manipulated through the rotation of the entire mast via an electric motor. This design eliminates common points of failure found in traditional sails and is therefore ideal for use in an autonomous sailing vessel.

V. SAILING ROBOT HARDWARE TOOLS

Robotic colonizer main board is the brain of mechanical robot which receives the commands from PC through ZigBee wireless connection and processes these commands to perform pattern motion control. The main part in the robot main board is ATmega168 microcontroller which generates two PWM signals for each wheel of DC motor. The two active wheels of the robot are actuated by two independent servo motors modified for continuous rotation. In particular, the robot is powered by 12 V battery. The hardware tools of the robotic system are: ZigBee, ATmega 168

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Microcontroller, L293D Driver Circuit, DC Motors, PH Meter, Metal Detector, GPS The hardware components of the robotic system is as shown in Fig. 4.

A) ARM Processor

ARM7TDMI is a core processor module embedded in many ARM 7 microprocessors including LPC2148. The ARM7TDMI core is a 32-bit embedded RISC processor. Its simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.
Founded in November 1990, it is spun out of a corn computers, it designs the ARM range of RISC processor cores. Licenses ARM core designs to semiconductor partners who fabricate and sell to their customers. ARM dose not fabricate and sell to their customers it also develop technologies to assist with the design in of the ARM architecture. Software tools, boards, debug hardware application software, bus architectures, peripherals etc. The ARM processor core originates within a British computer company called acorn. Instruction set. Essentially, the ARM 7TDMI-S processor has two instruction sets:
*The standard 32 –bit ARM set.
*A16-bit thumb set.

ARM stands for advanced RISC machines. It is a 32 bit processor core used for high end applications. The LPC 2148 micro controller are based on a 16– bit/32-bit ARM7 TDMI-S CPU with real time emulation and embedded trace support that combined the micro controller with embedded high speed flash memory running from 32 KB to 512 KB.
ARM (Advance RISC machine)
T- The thumb 16 bit instruction set.
D-ON chip debug support.
M- Embedded multiplier.
I- Embedded ICE hard ware.
S-Synthesizable.

The ARM has seven basic operating modes

User: unprivileged mode under which most tasks run
FIQ: entered when a high priority (fast) interrupt is raised.
IRQ: entered when a low priority (normal) interrupt is raised.
Supervisor: entered on reset and when a software interrupt instruction is executed.
Abort: used to handle memory access violations.
Undef: used to handle undefined instructions.
System: privileged mode using the same registers as user mode.

The ARM architecture provides a total of 37 register , all of which are 32 –bits long . however these are arranged in to several banks, with the accessible bank being governed by the current processor mode. In each mode, the core can access; A particular set of 13 general purpose registers (r0 –r12),A particular r13 -which is typically used as a stack pointer, r14 is used as a link register for branching.

B) LPC2148 Controller:

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM 7TDMI-CPU With real–time emulation and embedded trace support, that combine microcontroller and embedded high speed flash memory ranging from 32KB to 512KB. Serial communications interfaces ranging from a USB 2.0 full–speed device, Multiple UART's, SPI,SSP to 12C- Bus and on-chip SRAM of 8KB up to 40KB, make these devices very well suited for communication gate ways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point of sale.

The application program may also erase and/or program the flash while the application is running, allowing a great degree of flexibility for data storage field firmware upgrades, etc. The LPC2141/42/44/46/48 flash memory provides a minimum of 100,000 erase/write cycles and 20years of data –retention.

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C) L293D Driver Circuit:

Motor driver is basically a current amplifier which takes a low-current signal from the microcontroller and gives out a proportionally higher current signal which can control and drive a motor. In most cases, a transistor can act as a switch and perform this task which drives the motor in a single direction [4].

D) DC Motors:

DC motors are configured in many types and sizes, including brush less, servo, and gear motor types. A motor consists of a rotor and a permanent magnetic field stator. The magnetic field is maintained using either permanent magnets or electromagnetic windings. DC motors are most commonly used in variable speed and torque. Motion and controls cover a wide range of components that in some way are used to generate and/or control motion.

E) Metal Detector:

A metal detector is a device which responds to metal that may not be readily apparent. The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field[6]. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field

F) GPS & GSM:

This product applies the newest technology in Taiwan and has following advantages: small size, long stand-by life, simple operation, stable functions and convenient installation. It is widely used for household monitoring; children, the elder, and pets' care and the trace for lost cars or other possessions.URL/Listening: After the product is open with a SIM card inside, call its mobile number and after it's through, keep the call for 10 seconds, you can hear things within 10 meters around the product. If you hanging off before connecting successfully or less than 10s after connecting you can also receive a URL telling the device's current location. It's highly suggested to wait longer after opening the device for the first time and then make the call.

Features

1. Use SIM card (Not included)
2. Sound control dialling
3. Environmental surveillance
4. LBS Positioning

VI. EXPERIMENTAL RESULTS

The autonomous manoeuvre sailing robot for oceanographic research is used to explore all the details on the surface of the water. This robot is used for locating the position of the system using GPS & GSM, detects metals present in the ocean, and measures the depth and boundaries, used for surveillance and rescue operation.

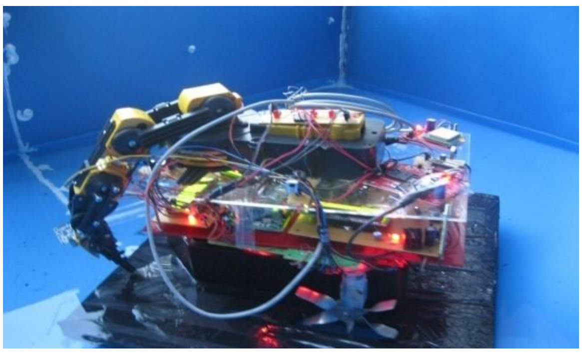

Fig. 4 Robot is at initial state with power ON

Fig. 5. Robot is moving in the forward direction

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Fig 6. Robot is moving in Right side direction

VII. CONCLUSION AND FUTURE WORK

In this paper, we introduce a successful working prototype model of manoeuvre sailing mobile robot is designed for oceanographic research. An autonomous sailing robot offers major advantages compared to submerged operated vehicles. It tracks the movement with the help of wireless cam attached to the robot through RF PRO wireless sensor network. The surface environment of ocean i.e., ocean exploration and navigational research can be studied through wireless cam, GPS & GSM , Metal detector , IR sensors, Ultrasonic sensors interfaced to the robot. Further development is required to demonstrate the feasibility of a sailing robot for long term use in open sea and helpful for oceanographers and scientists.

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BIOGRAPHY

C.Venkatesh received B.Tech Degree from J.N.T.University, Hyderabad and M.Tech degree in Embedded Systems from J.N.T.University, Anantapur. Presently he is with Annamacharya institute of Technology & Sciences, Rajampet, Andhra Pradesh, India, working as an Assistant Professor in Department of ECE. His research interests include Embedded Systems, Signal Processing and Digital Imaging. He presented many research papers in National & International Conferences. He is a member of professional societies like MISTE, IACSIT(Singapore), IAENG(Hong Kong), UACEE(India), ISOC(Switzerland), APCBEES(China) and SIE (Singapore).He acted as reviewer for many International conferences and journals

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