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Autonomous Mobile Robot Navigation System

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***Abstract*— This project presents a metal detecting robot using RF communication with wireless audio and video transmission and it is designed and implemented with Atmel 89C51 MCU in embedded system domain. The robot is moved in particular direction using switches and the images are captured along with the audio and images are watched on the television .Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. The proposed method is verified to be highly beneficial for the security purpose and industrial purpose.**

The mine sensor worked at a constant speed without any problem despite its extension, meeting the specification required for the mine detection sensor. It contributed to the improvement of detection rate, while enhancing the operability as evidenced by completion of all the detection work as scheduled. The tests demonstrated that the robot would not pose any performance problem for installation of the mine detection sensor. On the other hand, however, the tests also clearly indicated areas where improvement, modification, specification change and additional features to the robot are required to serve better for the intended purpose. Valuable data and hints were obtained in connection with such issues as control method with the mine detection robot tilted, merits and drawbacks of mounting the sensor, cost, handling the cable between the robot and support vehicle, maintainability, serviceability and easiness of adjustments. These issues became identified as a result of our engineers conducting both the domestic tests and the overseas tests by themselves, and in this respect the findings were all the more practical.

Index Terms—RF Communication, Navigation System, Detection sensor

I. INTRODUCTION

This paper proposes a novel methodology for autonomous mobile robot navigation utilizing the concept of tracking control. Vision-based path planning and subsequent tracking are performed by utilizing proposed stable adaptive state feedback fuzzy tracking controllers designed using the Lyapunov theory and particle-swarm-optimization (PSO)-based hybrid approaches. The objective is to design two self-adaptive fuzzy controllers, for x-direction and y-direction movements, optimizing both its structures and free parameters, such that the designed controllers can guarantee desired stability and, simultaneously, can provide satisfactory tracking performance for the vision-based navigation of mobile robot. The design methodology for the controllers simultaneously utilizes the global search capability of PSO and Lyapunov- theory-based local search method, thus providing a high degree of automation. Two different variants of hybrid approaches have been employed in this work. The proposed schemes have been implemented in both simulation and experimentations with a real robot, and the results demonstrate the usefulness of the proposed concept.

Every circuit need a source to give an energy to that circuit. The ource will a particular voltage and load current ratings. The following is a circuit digram of a power supply. We need a constant low voltage regulated power supply of +5V, providing input voltages to the microcontroller RS232, LM311 and LCD display which requires 5 volts supply.

The transformer works on the principle of faradays law of electromagnetic inductions. Transformer in its simplest form. The core is built up of thin laminations insulated from each other in order to reduce eddy current loss in the more. The winding are unguarded from each other and also from the care. The winding connected to the load is called the secondary winding for samplings they are shown on the opposite side of core but in practice they are distributed owner broth sides of the cores. The high voltage winding encloses the low voltage.

Let us say that transformer has N1 turns in its primary winding and N2 turns in its secondary winding. The primary winding is connected to a sinusoidal voltage of magnitude V1 at a frequency FH2. A working flux is set up in magnetic core. The working flux is alternating and sinusoidal as the applied voltage is alternating and sinusoidal. When these flux link the primary and the secondary winding emf are induced in them. The emf induced in this is called the self-induced emf and that induced in the secondary is the mutually induced emf. These voltages will have sinusoidal waveform and the same frequency as that of the applied voltage. The currents, which flow in the close primary and secondary circuits, are respectively I1 and I2.

Radio frequency is a frequency or rate of oscillation within the range of about 3Hz to 300 GHz. 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 the most mechanical systems can respond to, RF usually refers to oscillations in electrical circuits. RF is widely used because it does not require any line of sight, less distortions and no interference. Examples include, Cordless and cellular telephone, radio and television broadcast stations, satellite communications

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systems, and two-way radio services all operate in the RF spectrum. The portable small-sized camera has the ball-point pen appearance, photographing a particular location in secret is possible without exposure to others. The camera circuit part is connected to a wireless transmission device for outputting a signal by a cable. A wireless receiving device at a remote location from the wireless transmission device receives a signal of the wireless transmission device for outputting or recording.

II. PROPOSED SYSTEM

In the transmitter section (remote), we have the following components:

- Four switches
- RF encoder (HT640L)
- RF transmitter (STT-433MHz)

There are four switches for the movement of the robot in various directions like forward, backward, left and right. These four switches are connected to the RF encoder . The RF encoder is then connected to RF transmitter, which is thereby connected to the antenna for the transmission of the radio waves.

Depending on the switch that is been pressed (left, right, forward, and backward), the digital data from the switches is transferred to the RF encoder, which encodes this digital data into RF signals and transmits to the RF transmitter. This transmitter transmits the RF waves to the receiver (robot) through the antenna.

The receiver section consists of the following components:

- RF receiver (STR-433MHz)
- RF decoder (HT648L)
- Microcontroller (AT89C51)
- H-Bridge
- Geared motors of 60RPM
- Metal detecting circuit
- Wireless camera

In this receiver section, the RF receiver is connected to the RF decoder. This decoder is connected to the microcontroller, which is, in turn, connected to the H-Bridge. This H-Bridge is connected to the geared motors of the robot. Metal detecting circuit is also other separate sub-section on the receiver part. The wireless camera is placed separately on the receiver section to view the surroundings.

When the radio waves are transmitted from the transmitter (remote) to the receiver (robot), these waves are received by the RF receiver through the receiver antenna. From the RF receiver the signals are sent to RF decoder, which decodes these signals into digital data. This digital data is sent to the microcontroller, which, depending on the code written in it, enables either the upper H-Bridge or lower H-Bridge. This H-Bridge correspondingly activates the specified geared motors (Geared Motors-I or Geared motors-II). Power set –reset button is used for activating the receiver section. Metal detecting circuit is other sub-section on the receiver part.

As the robot moves in any specified direction and if a metal is been placed on the path of the robot., the inducting coil present at the lower side of the receiver section, which acts as a metal detecting coil, will detect the metal and activates the buzzer sound on the receiver section. The metal detection processes goes on by induction of eddy currents in the metal due to the variation in the magnetic fields of the two components-coils and metal.

The wireless camera is placed to view the images surrounding the robot to locate the position of the metal being detected. The images can be viewed on a television at the user location. When the robot moves the camera also moves as per the adjustment of the camera on the receiver section. This provides the view of the location of the robot. Whenever the metal is detected, which we can be aware by the sound of the buzzer on the receiver section.

III. SYSTEM DESIGN

PIC microcontrollers Includes:

- EEPROM.
- Timers.
- Analogue comparators.
- UART.

In fact the 8 pin (DIL) version of the 12F675 has an amazing number of internal peripherals. These are:

- Two timers.
- One 10bit ADC with 4 selectable inputs.
- An internal oscillator (or you can use an external crystal).
- An analogue comparator.
- 1024 words of program memory.
- 64 Bytes of RAM.
- 128 Bytes of EEPROM memory.
- External interrupt (as well as interrupts from internal peripherals).
- External crystal can go up to 20MHz.
- ICSP : PIC standard programming interface.

In the mid-range devices the memory space ranges from 1k to 8k (18F parts have more) - this does not sound like a lot but the processor has an efficient instruction set and you can make useful projects even with 1k e.g. LM35 temperature sensing project that reports data to the serial port easily fits within 1k.

In fact a PIC microcontroller is an amazingly powerful fully featured processor with internal RAM, EEROM FLASH memory and peripherals. One of the smallest ones occupies the space of a 555 timer but has a 10bit ADC, 1k of memory, 2 timers, high current I/O ports a comparator a watch dog timer.

One of the most useful features of a PIC microcontroller is that you can re-program them as they use flash memory (if you choose a part with an F in the part number e.g. 12F675 not 12C509). You can also use the ICSP serial interface built into each PIC Microcontroller for programming and even do programming while it's still plugged into the circuit.You can

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either program a PIC microcontroller using assembler or a high level language and I recommend using a high level language such as C as it is much easier to use (after an initial learning curve). Once you have learned the high level language you are not forced to use the same processor e.g. you could go to an AVR or Dallas microcontroller and still use the same high level language.

With the larger devices it's possible to drive LCDs or seven segment displays with very few control lines as all the work is done inside the PIC Micro.
Comparing a frequency counter to discrete web designs you'll find two or three chips for the microcontroller design and ten or more for a discrete design. So using them saves prototype design effort as you can use built in peripherals to take care of lots of the circuit operation. Many now have a built in ADC so you can read analogue signal levels so you don't need to add an external devices e.g. you can read an LM35 temperature sensor directly with no interface logic.

The PIC microcontroller has many built in peripherals and this can make using them quite daunting at first which is why I have made this introductory page with a summary of each major peripheral block. The best way to start is to learn about the main features of a chip and then begin to use each peripheral in a project. I think learning by doing is the best way.

Devices used in projects on this site can be re-programmed up to **100,000** times (probably more) as they use Flash memory - these have the letter F in the part name. You can get cheaper (OTP) devices but these are One-Time-Programmable; once programmed you can't program it again.

LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have individual electrical contacts for each segment. An external dedicated circuit supplies an electric charge to control each segment. This display structure is unwieldy for more than a few display elements.Small monochrome displays such as those found in personal organizers, or older laptop screens have a passive-matrix structure employing super-twisted pneumatic (STN) or double-layer STN (DSTN) technology—the latter of which addresses a color-shifting problem with the former—and color-STN (CSTN)—wherein color is added by using an internal filter. Each row or column of the display has a single electrical circuit. The pixels are addressed one at a time by row and column addresses. This type of display is called passive-matrix addressed because the pixel must retain its state between refreshes without the benefit of a steady electrical charge. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible. Very slow response times and poor contrast are typical of passive-matrix addressed LCDs.
High-resolution color displays such as modern LCD computer monitors and televisions use an active matrix structure. A matrix of thin-film transistors (TFTs) is added to the polarizing and color filters. Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is activated, all of the column lines are connected to a row of pixels and the correct voltage is driven onto all of the column lines.

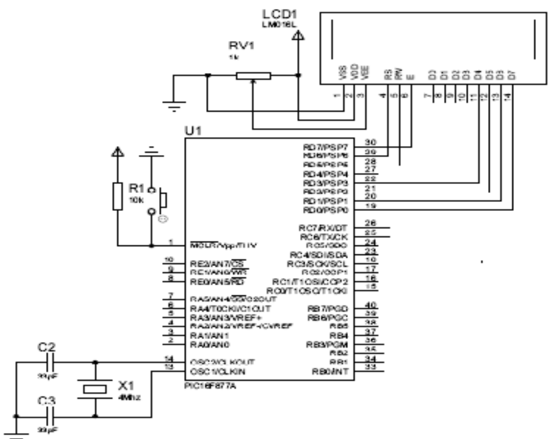

Fig.1. Interfacing LCD with the Microcontroller

The LCD we have used in this project is HD1234. This is an alphanumeric type of LCD with 16 pins. Of which Pins 7 to 14 are used as data pins, through which an 8-bit data can be input to the LCD. These Pins are connected to the Port 0 of Micro controller. There are 3 control pins RS (Pin-4), RW (Pin-5) and EN (Pin-6). The RS pin is connected to the 28th Pin of micro controller. The RW pin is usually grounded. The Enable pin is connected to 27th Pin. The LCD has two Rows and 16 Columns. The LCD is powered up with 5V supply connected to Pins 1(Gnd) and 2(Vcc). The Pin 3 is connected to Vcc through a Potentiometer. The potentiometer is used to adjust the contrast level.

The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies.

It is often necessary to be able to detect a certain voltage and switch a circuit according to the voltage that has been detected. For example a temperature sensing circuit will produce a given voltage and it may be necessary to switch heating on when the temperature falls below a given point. For these and many other uses, a circuit known as a comparator can be used.As the name comparator implies these circuits are used to compare two voltages. When one is higher than the other the comparator circuit output is in one state, and when the input conditions are reversed, then the comparator output switches to the other state. Here we use

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LM324 as comparator. This consists of 4 op-amps inbuilt on to it. We can connect sensors with inverting inputs and potentio meters connected on the Non-inverting inputs. The output pins are interfaced to the Micro controller. The LM124 series are op amps which operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 VDC. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 2.3 VDC.

The pinouts of the package have been designed to simplify PC board layouts. Inverting inputs are adjacent to outputs for all of the amplifiers and the outputs have also been placed at the corners of the package (pins 1, 7, 8, and 14). Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 VDC (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

IV. RESULTS AND DISCUSSION

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/15-0-15v is used to perform the step down operation where a 230V AC appears as 15V AC across the secondary winding. In the power supply unit, rectification is normally achieved using a solid-state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow.A commonly used circuit for supplying large amounts of DC power is the bridge rectifier. A bridge rectifier of four diodes (4*IN4007) is used to achieve full wave rectification. Two diodes will conduct during the negative cycle and the other two will conduct during the positive half cycle.

The DC voltage appearing across the output terminals of the bridge rectifier will be somewhat less than 90% of the applied RMS value. Filter circuits, which is usually capacitor acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to ‘short’ the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output. The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output. IC7812 and 7805 are used in this project for providing +12v and +5v DC
supply.

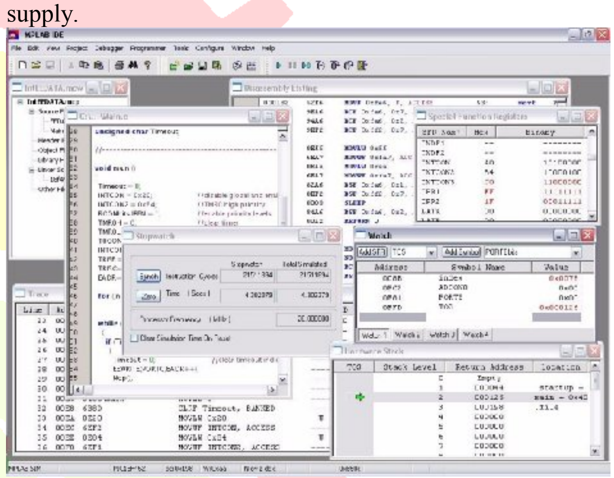

Fig.2.MATLAB IDE
Functionality

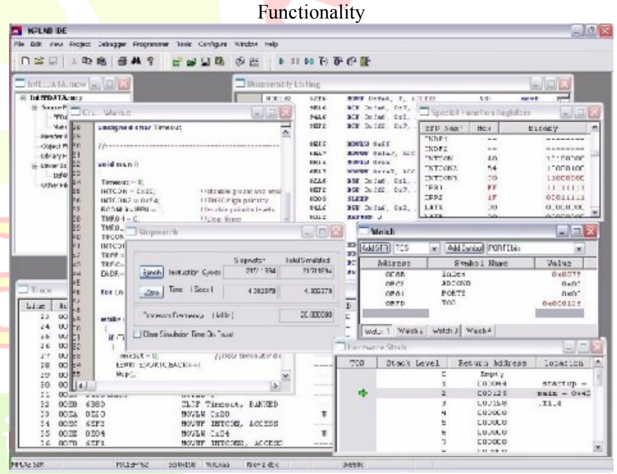

Fig.3. Project Simulation

V. CONCLUSION

This project presents a metal detecting robot using RF communication with wireless audio and video transmission and it is designed and implemented with Atmel 89C51 MCU in embedded system domain. The robot is moved in particular direction using switches and the images are captured along with the audio and images are watched on the television .Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. The proposed method

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