Border Patrolling Operations Using Intelligent Robot

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Abstract- *The ordinary border patrol system suffers from intensive human involvement. Border security robot utilizes an ARM microcontroller kit, an IR sensor for obstacle detection, temperature sensor to detect the presence of explosives and surrounding temperature. The proposed system uses machine intelligence to provide immediate response from sensors. The robot system is equipped with sensors those can alert the user when some anomaly appears within the range while robot is working. The main feature of this robot differentiating it from others is execution of versatile tasks in night and rough areas.*

Keywords- ARM, Microcontroller, sensors, robot.

I. INTRODUCTION

Border patrol systems have recently achieved interest to address the concerns about national security. The major problem in protecting long stretches of borders is the need for large human involvement in patrolling the premises. In our border patrol system consists of security checkpoints and border troops. All vehicle traffic is need to stop in security check points which are set up on the international roads to detect and apprehend illegal aliens, drugs, and other illegal activity. The border troop watches and maintain control in a specific section of the border. The troops patrol the border according to predetermined route and time interval [1]. Under the conventional border patrol system, even modest-sized areas require large human resources if manual patrolling is considered alone. To monitor the border in real-time with accuracy and minimize the need for human support, multiple surveillance technologies, which complement each other are required. To address the challenges still facing by the existing surveillance techniques, we introduce Border security robot, a new border patrol system framework based on sensors, which can accurately detect the border intrusion with minimum human involvements. Border security robot utilizes an IR sensor for obstacle detection and a temperature sensor for explosive detection. While the potential benefits of Border security are significant, several research challenges need to be addressed before a practical realization. In this project, a framework to deploy and operate Border Sense for border patrol is described.

Webster defines a robot as "An autonomous device that performs functions normally ascribed to humans or a machine in the form human." Generally, it is machine that functions in spite of a living person. Robots are used for special applications like handling hazardous situations and tasks that need high accuracy and speed. A danger event is normally happened by the negligence of humans. To implement real time inspection and surveillance of the border security, intelligent remote monitoring system is developed. Wireless sensor network is used to monitor physical or environment conditions such as temperature, gases, humans, metals etc. Our system consists of sensory network, embedded system and intelligent program on the robot vehicle.

II. PROPOSED SYSTEM

The module consists of an Embedded System device which includes an ARM Microcontroller with an IR sensor, metal detector and a piezo buzzer. H-bridge driver IC is used to drive the two motors. Driver ensure the proper working voltage for DC motor and also protect the microcontroller from being harmed due to the back EMF generated in the motor. DC motors are for robotic control. The motors can be driven in forward and backward direction.

In this proposed system, Obstacle detection sensor and temperature sensor are used. Obstacles can be detected using IR sensor. IR sensor detects the obstacles upto certain range. The IR motion sensors provides additional information e.g. in case where the intruder is behind an obstacle that can be detected.

III. HARDWARE REQUIREMENTS

3.1 ARM Cortex M3

Microcontroller is a general purpose device having large number of the components of a microprocessor system on a single chip. Variety of microcontrollers are available in a market we can use any of them. Here, we are using microcontroller ARM Cortex-M3.

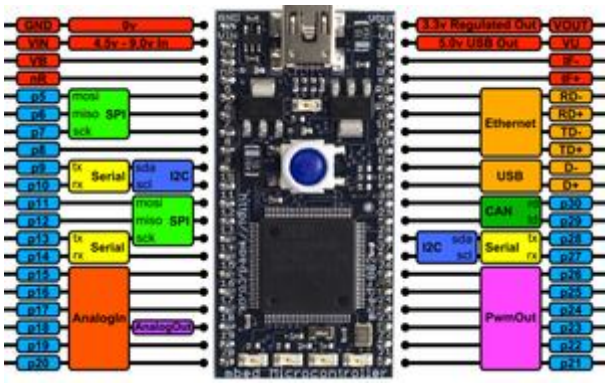

Fig.3.1: ARM Cortex-M3 board

The mbed NXP LPC1768 Microcontroller in particular is designed for prototyping all sorts of devices, especially those including Ethernet, USB, and the flexibility of lots of peripheral interfaces and FLASH memory. It is packaged as a small DIP form-factor for prototyping with through-hole PCBs, strip board and breadboard, and includes a built-in USB FLASH programmer. It is based on the NXP LPC1768, with a 32-bit ARM Cortex-M3 core running at 96MHz. It includes 512KB FLASH, 32KB RAM and lots of interfaces including built-in Ethernet, USB Host and Device, CAN, SPI, I2C, ADC, DAC, PWM and other I/O interfaces.

3.2 Temperature Sensor

The TMP102 is an I2C digital temperature sensor in a small SOT563 package, with a 0.0625C resolution and 0.5C accuracy. The TMP102 is an easy-to-use digital temperature sensor from Texas Instruments. The TMP102 breakout allows you to easily incorporate the digital temperature sensor into your project.

The TMP102 is capable of reading temperatures to a resolution of 0.0625°C, and is accurate up to 0.5°C. The breakout has built-in 4.7kΩ pull-up resistors for I^2C communications and runs from 1.4V to 3.6V. I^2C communication uses an open drain signaling, so there is no need to use level shifting. It is used for fire detection in an area where robot is moving. It detects the temperature of the environment.

The TMP102 is ideal for extended temperature measurement in a variety of communication, computer, consumer, environmental, industrial, and instrumentation applications. The device is specified for operation over a temperature range of –40°C to +125°C.

3.3 IR sensor

An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

The principle of this sensor is that Infrared light is send through IR LEDs which is reflected by any object in front of the sensor. In this sensor, instead of constant beam, a pulse of IR light at 1 KHz frequency is transmitted and receiver will detect IR pulses of exact same frequency, rejecting all higher and lower frequencies. Operation range of this sensor varies according to the color of the object; light color object has more range. Range of this sensor is 10cms for white object.

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000µm. The wavelength region which ranges from 0.75 to 3µm is known as the near infrared regions. The region between 3 and 6µm is known as the mid-infrared and infrared radiation which has a wavelength greater higher than 6µm is known as far infrared.

3.3 H-Bridge Drive

The TB6612 motor driver used on the carrier board has a peak current rating of 3 A per channel. The peak ratings are for quick transients (e.g. when a motor is first turned on), and the continuous rating of 1 A is dependent on various conditions, such as the ambient temperature. The actual current you can deliver will depend on how well you can keep the motor driver cool. The carrier's printed circuit board is designed to draw heat out of the motor driver chip, but performance can be improved by adding a heat sink.

3.4 DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

3.5 Piezo Buzzer

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source,

driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

IV. SOFTWARE REQUIREMENTS

4.1 Online Complier

The mbed Compiler is an online application used to create your own programs for the mbed microcontroller. It translates *program source code* that you write in to a *program binary* that the Microcontroller can execute.

The mbed compiler is completely online. This allows for easy use without the need to download anything. However, you must have internet access to develop the mbed. Once you have compiled your code simply drag and drop it into the mbed device which will appear on the file explorer as an external memory device. Press reset and the mbed will then run the latest program uploaded to it.

A compiler is a tool that allows you to write your software, find any mistakes from it and subsequently turns your software into a format that the machine (in this case the mbed microcontroller) can understand.

When you arrive at the mbed compiler you will be greeted with something which look like this:

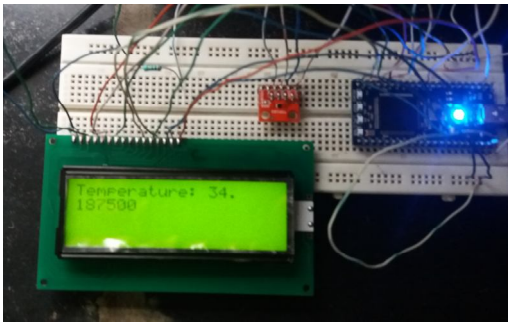

Fig.4.1 Experimental Setup

4.2 mbed Programming

mbed is a platform and operating system for internet-connected devices based on 32-bit ARM Cortex-M microcontrollers. Such devices are also known as Internet of Things devices. The project is collaboratively developed by ARM.

4.2.1 Applications

Applications for the mbed platform can be developed using the mbed online IDE, a free online code editor and compiler. Only a web browser needs to be installed on the local PC, since a project is compiled on the cloud, i.e. on a remote server, using the ARMCC C/C++ compiler. The mbed IDE provides private workspaces with ability to import, export, and share code with distributed Mercurial version control, and it can be used also for code documentation generation. Applications can be developed also with other development environments such as Keil µVision, IAR Embedded Workbench, and Eclipse with GCC ARM Embedded tools

V. FEATURES

1) IR sensor is used to detect the obstacle upto certain range.

2) Temperature sensor is used to detect the explosions and the surrounding temperature of the environment.

3) H-Bridge driver is used to drive the dc motors in forward and backward direction.

4) Piezo Buzzer is used to give the beep sound when obstacle is detected.

VI. RESULTS

In this we are showing some figures and snapshots of our project. Fig(3.1) shows the representation of pin diagram of ARM cortex M3 LPC1768. Fig(4.1) shows the online compiler process, where program can be written and it can be compiled online and errors can be checked after debugging. Some snapshots of the project are shown which are taken during the working of the project where we have taken the reading of room temperature using temperature sensor which is displayed on the 16*2 LCD display and obstacle detection is done using the IR sensor.

VII. CONCLUSION

A prototype robot which can be detect any kind of explosions and intrusions is built. This robot can be used for the purpose of unmanned border patrolling operations.

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