Mobile Node for Wireless Sensor Network to Detect Landmines

P.Vijaya Kumar[1], M.Saravana Guru[2], D.Saravanan[3], R.Saparnaa[4]

[1]ECE AP (SR.G), SRM University, Chennai- 603203, India

[2] ECE, SRM University, Chennai- 603203, India

[3] ECE, SRM University, Chennai- 603203, India

[4] ECE, SRM University, Chennai- 603203, India

Abstract- Individual sensor nodes are low power devices which integrate computing, wireless communication and sensing capabilities to detect land mine. Such multiple nodes collectively form wireless sensor network. To detect landmine in ground surface, sensor node that able to sense the mine and to process the information locally are mounted on a mobile robot to scan the ground surface in the organized pattern resulting in detection of all the mines present in the proposed area which is synchronized by Infrared pills; the node can communicate to the data collection point (Sink) typically through wireless communication. The aggregation of such multitude of mobile nodes and a mobile sink forms a versatile mine detection unit. When the mine is detected the node routes it information to the hand held device (Base) through sink and stays in it position to help the demining crew to identify the position where the mine is present. When the demining crew presses a button the node continues in its pattern.

Keywords- Wireless sensor Network, Base, Sink, Node, Path pattern, IR-pills, Multi node.

1. INTRODUCTION

More than 100 million landmines lie buried around the world. Although intended for warfare, these mines remain active after warfare ends. Each day these mines are triggered accidentally by civilian activities, ravaging the land and killing or maiming innocent people. To help stop this destruction of the environment and humanity, the scientific community has explored numerous approaches to detect land mines. The demining work mainly depends on hazardous manual removal by humans; it involves serious safety and efficiency issues. For increased safety and efficiency, some large-sized machines have been developed although many machines with various techniques have been developed Salient problems are the demining rate, limitation of demining area and prohibitive weight. Recently, various demining robots have been developed [1] such as quadruped walking robot, some snake-type robots, mechanical master-slave hands to remove landmines those machines are operated manually or by remote control and scans the area in an unorganized pattern also expert operators are required for each machine. Our study proposes a WSN-type mine detection robot which scans in an organized path pattern for farmland aiming at "complete removal" and "automation". It involves integration of both multi node advantage for fast detection which helps in military demining and organized path pattern for humanitarian demining which requires scanning the whole area without leaving any mine undetected .

2. WIRELESS SENSOR NETWORK

The wireless sensor network (WSN) proposed in our project consists of spatially distributed autonomous mobile sensor node containing inductive proximity sensor (For demonstration) to detect land mine and to cooperatively route their data through the network using RF modules to a base to indicate the presence of mine to the demining crew. This system supports power efficient multi node utilization for fast scanning.

3. SYSTEM MODEL

The system proposed consists of two mobile nodes which move in the path pattern as shown in the fig.2; that able to sense the mine and to process the information locally and to route the data to the Base through the Sink .The Node and Sink communicate to the hand held device Base typically through RF Module.

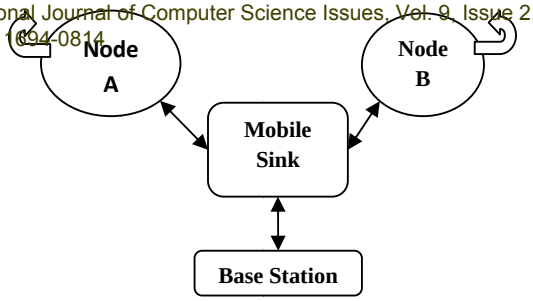


Fig.1 System Organization

3.1. Node

The node consists of a microcontroller to process the sensor data and to route it to the sink with the low power short range RF module. The controller controls the motor drive which is synchronized to the programmed path pattern.

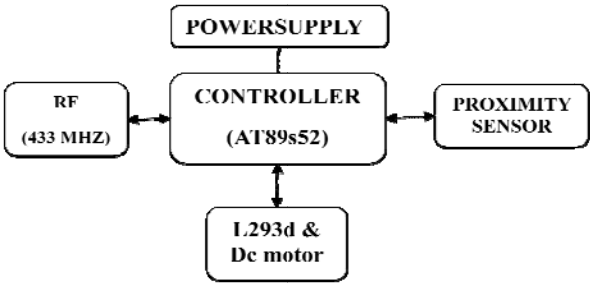


Fig.2 Node Implementation

3.2. Sink

The sink is similar to the node except that the sensor data received from the nodes is routed to the base through the sink if more than one sink is used by high power RF modules supporting long distance data transfer.

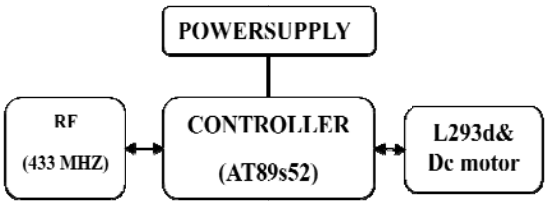


Fig.3 Sink Implementation

3.3. Base

The base is the hand held device which receives the sensor data and process using the controller utilizes the LCD screen along with the buffer to indicate the presence of mine to the crew.

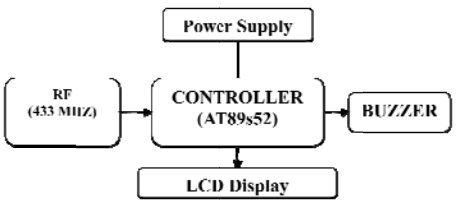


Fig.4 Base Implementation

4. PATH PATTERN

The path pattern followed by the nodes and the sink is as shown in the fig.2 and the Path guidance is given by IR pills which will provide synchronization of the path [2, 3]. The mobile node when set in initial position begins the scanning loop based on the programmed path. When it reaches the pill the turning sequence is executed similarly when two mobile devices meets the whole scanning loop is repeated. If a mine is detected by any one of the node that node pause the scanning loop till the demining crew press the continue button in it simultaneously the respective encoded value is transmitted to the sink where it is routed to base. This path pattern provides scanning of whole area without leaving any mine undetected.

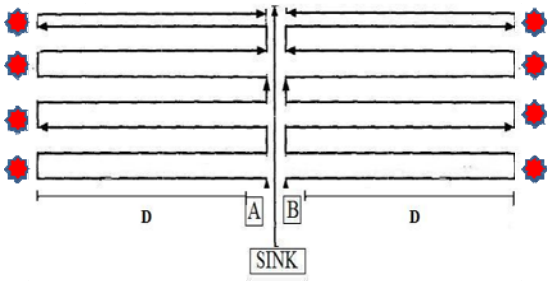


Fig.5 Path Pattern

5. MULTI NODE SUPPORT

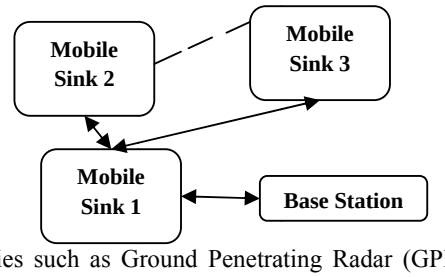
Our project involves efficient multi node utilization that results in fast scanning for military demining purpose [4]. In the proposed system there are two mobile nodes and a mobile sink together referred as versatile unit which scans the specific area for detection of mine in certain time. To speed up the scanning process similar versatile unit is added in which the data routed to an sink is transferred to the base through other sink if the base is not in range similarly addition of multi units and the concept of routing supports fast scanning along with the efficient power maintenance in the nodes since Node

Fig.6 Multi Unit Routing

Scans the whole area draining power for motor drive where as in sink the power is utilized only for transmission and a little on motor than nodes hence by limiting the power required for transmission in node large area is scanned quickly and efficiently.

6. INDUCTIVE PROXIMITY SENSORS

The Proposed System Supports all the sensor



technologies such as Ground Penetrating Radar (GPR), Induction coil sensor imaging, Infrared imaging, Millimetre wave emission detection, [5] for demonstration purpose we have used Inductive proximity sensor. It operates under the electrical principle of inductance. The oscillator generates a fluctuating

magnetic field. The shape of the sensing area and the winding of the coil that locates in the device's sensing face. When a metal object moves into the inductive proximity sensor's field of detection, Eddy circuits build up in the metallic object, magnetically push back, and finally reduce the Inductive sensor's own oscillation field. The sensor's detection circuit monitors the oscillator's strength and triggers an output from the output circuitry when the oscillator becomes reduced to a sufficient level.

7. HARDWARE

The project involves implementation and demonstration of the working of the versatile unit which is capable of detecting the presence of metal in the path curtained. The torque and the RPM of the motor are rationalized considering the operating errors due to the repeat distance of the sensor. The dc motor is operated at maximum power providing 1000 rpm since the repeat time provided by the sensor for a metal of diameter 2cm (demonstration model) is 10 sec. Therefore the maximum speed of the node should be 12 cm per minute.

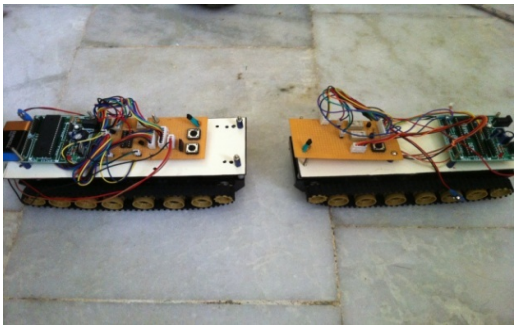


Fig.7 Nodes

Circumference of the wheel =2*3.14*

radius of the wheel = 2*3.14*0.6= 3.8cm

Distance made for 1000 rotation =1000*3.8/360

I.e. Distance moved by the node per min=10.8 cm.

Table 1: Parameters of At89s52

Parameter	value
Flash (Kbytes)	8 Kbytes
Max. Operating Frequency:	24 MHz
CPU:	8051-12C
Max I/O Pins:	32
UART:	1
Operating Voltage (Vcc):	4.0 to 5.5
Timers:	3

7.1. RF Modules 433 MHz ASK

The module is low cost module and is capable of sending and receiving serial data wirelessly between microcontrollers for the required range. The low power consumption makes this module ideal for use in battery power. TX-ASK are designed by the saw resonator, with an effective low cost, small size and simple to use for designing. The transmitter ranges about 100mt which is sufficient for the prototype proposed.

Table 2: Specifications of RF Module

Parameter	value
Range in open space	100 Meters
TX Frequency Range	TX 433.92 MHz
Supply Voltage	3V ~ 6V
TX Out Put Power	4 ~ 12 Dbm
RX Receiver Frequency	433 MHz
RX Typical Sensitivity	105 Dbm
RX Supply Current	3.5 mA
RX IF Frequency	1MHz

7.2. Power Source:

There are a wide variety of batteries to choose from. Rechargeable batteries are more economical than other batteries in the long run. The two most common rechargeable batteries is Nickel-cadmium (NiCad).

7.3. LCD and Buzzer:

A buzzer or beeper is an audio signaling device that is used to indicate the presence of mine by producing beep sounds. The buffer is interfaced with the controller and programmed to be triggered when the base receives command from the node through the sink by the wireless RF module.

The display used is a standard LM016L which displays 2 lines of 16 characters which displays the name of the node that detected the mine. The display is used for visual indication for the status of the node.

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is utilized in battery-powered electronic devices as it uses very small amounts of electric power. 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. Connection or linking of an external device (that is not inbuilt in the micro-controller) to the micro-controller based on some rules for that particular device. The LCD interface is a parallel bus, allowing simple and fast reading/writing of data to and from the LCD.

Table 3: Pin Description of the LCD Module

PIN NO	NAME	DESCRIPTION
1	GND	Ground
2	Vcc	Supply Voltage +5V
3	V_{EE}	Contrast adjustment
4	RS	Register select :0->Control input, 1-> Data input
5	R/W	Read/ Write
6	E	Enable
7 to 14	D0 to D7	I/O Data pins
15	VB1	Backlight +5V
16	VB0	Backlight ground

7.4. Dc Motor:

The motors will be used to physically navigate our robot around. This was due to the fact that the robot will be carrying all of its power on board in the form of batteries. Therefore, it would be illogical to choose a motor that does not use DC, if consist of permanent magnets and field coil. In general, DC motors are characterized by possessing high torque from stand still and are easily controlled by varying the applied voltage. DC motor with a permanent magnet gets adequate enough torque for our robot. Also, implementing design with DC motors is safe due to the low power consumption.

8. SIMULATION

The simulation for the mobile node and base is implemented using the PROTEUS Simulation software.

8.1. Node

The simulation of the node is done to estimate the D.C motor values for the drive to coordinate the Node's run with the response time of the sensors. The buttons in the right side of the design feigns the various sensor inputs to the controller. The Motor drive is designed using the l293d drive which is in the top of the design.

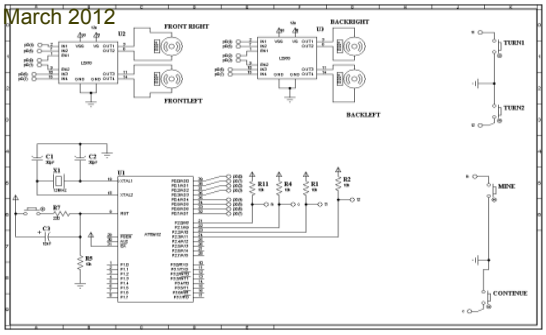


Fig.8 SIMULATION OF A NODE

Table 4: Possible Outcome and Response

IR		MINE	Continue Button	OUTCOME	RESPONSE of THE DRIVE
I	II				
1	0	0	0	The node reached IR pills	Turn left
0	1	0	0	The nodes reached reference point	Turn Right
0	0	0	0	The node is in the forward run	Forward Run
0	0	1	0	Mine detected	Stop
0	0	0	1	The area is marked by Demining crew	Continue the Run

The use of the IR sensor is to guide the node through the path pattern. The Inductive sensor is to define the detection of mine and the continue button is to start the scanning process from after the demining crew marks the area.

The values of rpm, torque and load of the D.C motor are to be coordinated with the sensor response time. The value of the inductive sensor response time is 10 sec hence the switching time of the button in the simulation is set to 10 sec. similarly for turn 1 and turn 2 buttons the switching time is set to 10ms. The rpm of the dc motor is set to1000 with the load of 500.

8.2. Base

The simulation of the Base is done to demonstrate the response of the LCD module to the various input derived to the microcontroller by the RF module. The RF receiver module in the base is feigned by the buttons in this simulation which gives the input based on the possible values received by the RF receiver module.

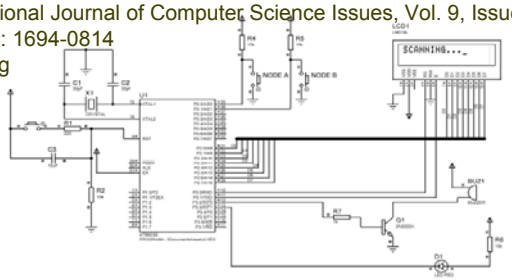


Fig.9 SIMULATION OF A BASE

Table 5: Button Description in Base

Button NAME	Received value indicates
Node A	Node A has detected Mine
Node B	Node B has detected Mine

9. CONCLUSIONS

Here we proposed a simple mobile model to scan the target area efficiently in short time. The proposed technique is integrated with the multi node utilization for fast scanning and wireless sensor network to communicate within the mobile sensor node .This unit requires less skill rather than the other models since the path pattern is automated and can be enhanced by adaptive technique to overcome obstacles in the real-time terrains.

ACKNOWLEDGMENT

We specially thank our project guide Mr.Vijayakumar P., Assistant Professor (Sr.G), Department of Electronics and Communication Engineering, Who has been instructing right from the initial stages of the project till its finishing days. Being our guide and class in charge, he provided us with all knowledge, support & motivation to carry out this project with utmost dedication. We owe him for all the many opportunities catered to us to enlarge our perspective. We gratefully acknowledge his leadership and brilliant ideas throughput the project days.

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