Design and Development of Virtual Fence System for Agriculture Field using Laser and GSM Technology

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Abstract: *Agriculture field is a valuable resource for rural farmer's survival and development. So for the safekeeping of agriculture field, fencing is essential as it protects land and necessary equipment [10]. Fencing aims to keep cattle or intruder away from the fields, thus avoiding trespassing. This proposed research work is based on the combination of technologies that afford high level of detection, vigilance and barrier system via cost effective methods and equipment. The main positive feature of this research work is that it does not require personal attention after installation as well as it reduces the chances of robbery of power equipment's. It also overcome the problems of various existing systems and does not have any destructive consequence on intruder*

Keywords: Virtual Fence, Laser, Detection and Alert System, GSM, Agricultural Field Surveillance.

1. Introduction

There is technical innovation in each field of existence but the topic associated to protection of agriculture field against intruders (intruder management), security of power equipment and electric power lines is still unattended. This area seems to pursue the traditional methods, which are not so efficient in controlling the illegal entry. Moreover they require additional maintenance, more labour work and time, etc. So we need an innovative superior method which requires low maintenance, ease of installation and require ideally no manpower to monitor, thus making it more effective and efficient. This paper proposed a virtual fence system that enables any individual to secure and surveillance his agriculture field in real time. The designed system is capable of detecting passages and providing early warning regarding intrusion. Laser Virtual fence is a boundary without a physical barrier on the landscape via laser pointer. Laser beam is highly directional, monochromatic and low powered operating device that makes the system more secure and accurate. Intrusion Detection is the process of recognizing illegal entry in the field. Unauthorized entry on farm leads to problems like deterioration of field, robbery of power equipment and electric power lines, etc. so Intruder Management in the field of agriculture is vital as damage caused by trespassers have extreme effect on farmers.

2. System Architecture

The block diagram of virtual fence system is demonstrated in the fig 1. The system is supplied with +5v and +9v power supply. Three laser pointers are used to generate invisible beams which act like virtual fence. Phototransistor receives laser beam and provides input signal to microcontroller. The AT89C51 microcontroller takes input from all three laser receivers and performs the necessary control operations; like display message on LCD, operate lights and speaker and send the SMS to the mobile phone via the GSM communication module. The system is divided into two sections – (a) laser virtual fence and (b) boundary monitor block.
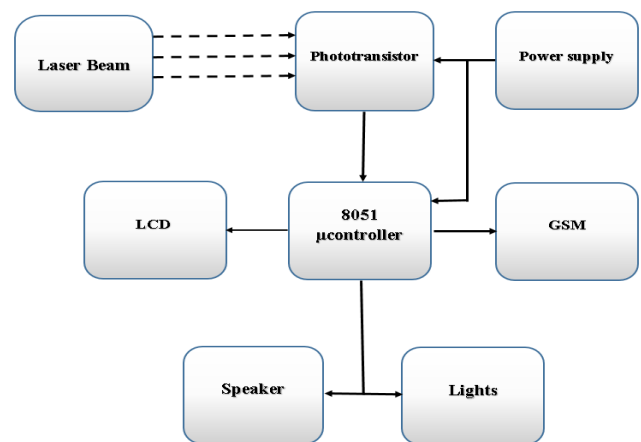

Figure 1: Block Diagram of Virtual Fence System

2.1 Laser Virtual Fence

Laser virtual fence module is used to detect the presence of intruder. Laser pointers are fixed on the vertical pillar with their receiver phototransistor at certain angle are shown in fig 2. These pointers continuously transmit invisible beams which are received by phototransistor on the receiver side. High level signal at receiver output is to signify the presence of intruder, wherever low level signal shows no occlusion of laser beam. Therefore it is easier to detect the intruder and alert the on duty operator according to change in signal level of phototransistor receiver.


Figure 2: Laser Virtual Fence

2.2 Boundary Monitor Block

Boundary monitor block is located near the virtual fence. It sends alert signal and drives the peripherals attached to microcontroller. It consists of Microcontroller AT89C51, 16x2 LCD Display, GSM SIM 900 module, lights and speaker. The flow chart of the system is given in fig. 3. In order to reduce false alarms boundary monitor terminal take following measures:

- When two or more laser beams are interrupted only then it can derive alert system. Therefore it resolves the false indication problem; when birds and small animals like dogs, cats, etc. are interrupted the laser beam.
- The receiver generate alert signal with the help of microcontroller after receiving low or high level output signal from photo transistor. It makes the system to diminish unnecessary indication and interference. Choose AT89C51 as microcontroller to reduce the cost and power consumption of the system.
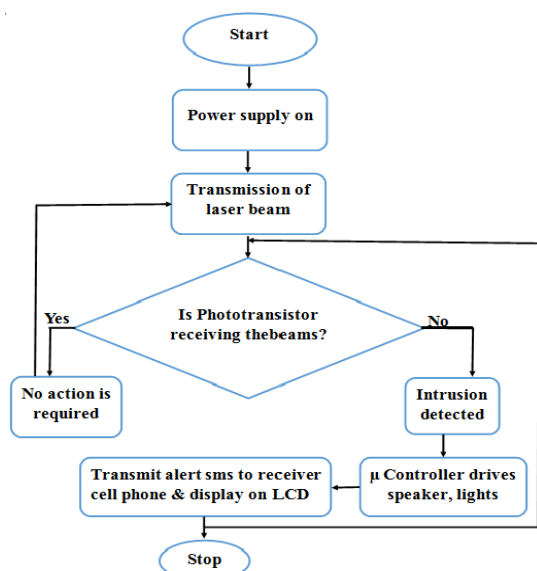
Figure 3: Flow chart of proposed system

3. Hardware Design

The hardware contains laser pointer, phototransistor, AT89C51 Microcontroller and GSM as the main parts of the system.

3.1 AT89C51

The AT89C51 microcontroller is an 8-bit microcontroller with flash program memory (4Kbytes) and additional. Microcontroller consist of in-built reprogrammable flash memory which is divided into three program memory lock levels that are Timer/ Counters and Interrupt Sources, Programmable I/O Lines and Internal RAM. Due to the small size it consumes less power and it is a low density device. It is a Flash with adaptable 8-bit CPU on a single chip, powerful microcomputer, which provides cost-effective solution to many embedded control applications and is highly flexible.

Figure 4: AT89C51 Microcontroller

3.2 Laser Pointer

Laser pointer is a small handheld, low cost and portable device used to highlight something important with a small bright spot of light as shown in figure 5. The word LASER stands for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. It is a low power device having small width of laser beam that makes the beam invisible in clean atmosphere. It produces monochromatic and coherent radiation [14]. Laser beam can be seen as a small dot of light only when it strikes a dense surface. High power laser pointer beam is visible due to scattering of light with dust and water droplets along the path.
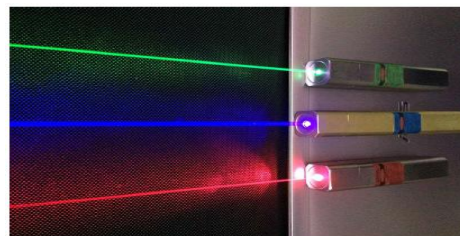
Figure 5: Laser Pointer

3.3 Phototransistor

Phototransistor is a semiconductor device used to sense sensitivity of light. It works as an ordinary transistor except, current flow can be controlled by light instead of base current. When light photons strike at the junction, base current is generated due to transfer of energy form light to base electrons. The unit for transfer of received power into collector current is ampere per watt. The collector current of phototransistor depends on the received power density, sensitivity, spectral response factor, and angle response so, accurate shielding of phototransistor is very important.

Figure 6: Phototransistor

### 3.4 GSM Network (Global System for Mobile Communication)

The alert messages to the concerned person are sent via GSM module. In the present work, Subscriber Identification Module (SIM) has been utilized in the modem. Some of the GSM features:

- Used as a plug in modem and compact in size
- It is built with LED showing its status

- Sim900 is simple to use and is low in cost
- Interface directly with computer serial port

4. Implementation and Results

The system is tested and achieved its objective. The Figure 7 shows the prototype of the designed system.
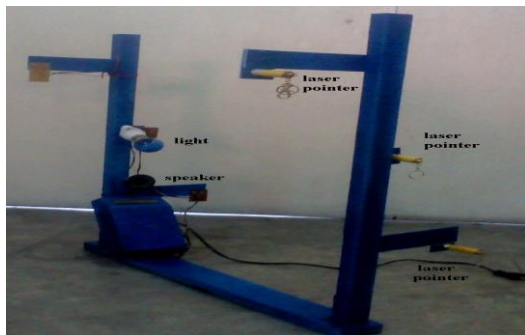
Figure 7: Prototype of designed system

The designed prototype has been tested for its proper working. Laser virtual fence is connected to the Boundary monitor block via connecting wires. Button Cells have been used to drive the laser units. Each unit needs three cells, each cell of 1.5V, to produce laser beams of appropriate intensity. The Boundary monitor block is switched on using power supply of 5V. A volunteer has been asked to work as intruder for the system. The interrupted laser beams have been detected by boundary monitor block. On detection of intruder the warning lights switched on, speaker blew off and warning message was sent to the receiver on his mobile receiver. The sent message is displayed on screen. Results are shown in figure 8 and 9.
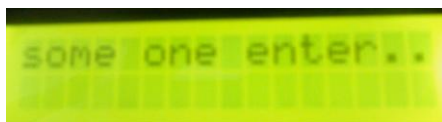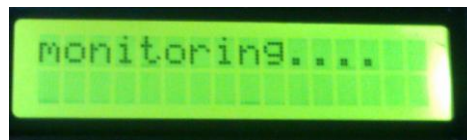

Figure 8: Sms display on LCD

Figure 9: Light is ON

When no occlusion occurs, LCD displays 'monitoring' as shown in figure 10. If intrusion occur in reverse direction then it shows 'someone exit' on LCD displays as shown in figure 11.

Figure 10: Checking for intrusion

Figure 11: Intruder exits the field

Results of testing are shown in table 1.

Table 1: Results

Sr. No	Height of Laser 1	Height of Laser 2	Height of Laser 3	Height of Intruder	Detection of intrusion
1	1 feet	2 feet	3 feet	0.5 feet	No
2	1 feet	2 feet	3 feet	1 feet	No
3	1 feet	2 feet	3 feet	1.5 feet	No
4	1 feet	2 feet	3 feet	2 feet	Yes
5	1 feet	2 feet	3 feet	2.5 feet	yes
6	1 feet	2 feet	3 feet	3 feet	yes
7	1 feet	2 feet	3 feet	3.5 feet	yes
8	1 feet	2 feet	3 feet	4 feet	yes
9	1 feet	2 feet	3 feet	4.5 feet	yes
10	1 feet	2 feet	3 feet	5 feet	yes

5. Conclusion

The developed virtual fence to control intruder management will automatically detect the intruder, send warning message to owner of field by GSM and also to duty personnel by speaker and lights. This will reduce the farmer's problem regarding their field security and improve the life style of guards. The key features of this product is
- Low maintenance
- Less man power
- Low Power consumption
- Easy to use and install
- Ease of modification
- Automated operation
- Portable

It can be used at open wide areas like airports, military base, and residential quarters as alert and detection system. To enhance the effectiveness of this barrier system, a heat generating device can also be added along with speaker system of boundary monitor block. This device will start generating heat as soon as the intrusion is detected. The level of heat generated will rise as the intruder moves towards the boundary and will become unbearable for the intruder.

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