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Research Article

SMART ELECTRIC FENCE (*For Agriculture*)

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ABSTRACT

Conflicts of human-elephant has been on the peak in the farmlands with herds of wild pachyderms straying into human habitation. The surveillance and tracking of elephant herds are difficult due to their size and nature of movement. In this article, we present an analytical procedure to recognize the behavior of pachyderms, especially elephants along agricultural fields by sending SMS (Short Message Service) to the farmer using controller and GSM (Global System for Mobile Communication) modem. A Smart Electric Fence is a simple user friendly idea to provide more security to the farmlands and the farmers by detecting the unwanted activities around their farms, in particular by wildlife and also from theft. It consists of a microcontroller based system for detecting the activities around the fenced area with GSM modem for acknowledging those activities around the farmland. The GSM modem sends text message to the farmer indicating the location on which the impact has been occurred. Also detects the kind of wildlife which is giving an impact on the fence by detecting the height of the animal.

INTRODUCTION

The massive raise in human population in Asian countries like India propelled by industrial growth has led to the conversion of forest lands into human settlements. Due to this, the wild elephant and other animal populations face acute shortage of resources like food, water and shelter. This made them to move into human habitats. Hence there has been severe man–elephant conflict. The conflict has been on the rise in the forest border areas with herds of wild pachyderm's straying into human habitation. The surveillance and tracking of these herds are difficult due to their size and nature of movement. The time to prevent from the danger is negligible; hence the loss due to destruction in the farms is more. Therefore, there is a need for intelligent elephant surveillance and tracking system. The magnitude of impact of human– elephant conflict can be viewed from the fact that globally around 5 lakh families are affected by human–elephant conflict per year. It is important to reduce human-elephant conflict in order to save the lives of both human as well as elephants. There is no one particular reason for this conflicts and some factors that contribute to such conflicts include population density of humans, elephant habitat structure, weather, time of year and animal life. Human population growth and land occupation for settlement may increase the conflict with elephants. However, it is generally the borders of forests that are the focal points for conflicts. Traditional methods to drive away the wildlife entering the farmlands by local communities include noise (shouting, beating drums, burning bamboo, bursting fire crackers), light (fire at entry points to fields, powerful spotlights) and missiles (stones, spears).

Electric fences are designed to create an electrical circuit when touched by a person or animal. A component called a power energizer converts power into a brief high voltage pulse. One terminal of the power energizer releases an electrical pulse along a connected bare wire about once per second. Another terminal is connected to a metal rod implanted in the earth, called a ground or earth rod. A person or animal touching both the wire and the earth during a pulse will complete an electrical circuit and will conduct the pulse, causing an electric shock. The effects of the shock depend upon the voltage, the energy of the pulse, the degree of contact between the recipient and the fence and ground and the route of the current through the body; it can range from barely noticeable to uncomfortable, painful or even lethal.

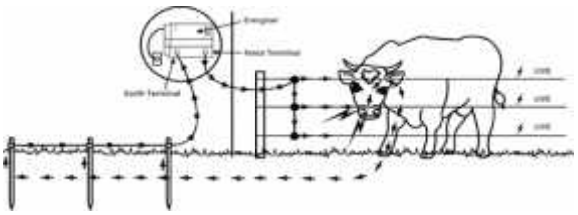

Fig. 1 Existing Electric Fence

Fig. 1 shows the principle of an existing Electric Fence used in farmlands. In addition a Buzzer and LED lights are used in

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recent times. When the animal touches the fence wire, electric circuit conducts and allows current pulses to pass through the circuit. This makes the buzzer to buzz and LED to glow. In case of theft, when a person tries to cut the fence wires, the buzzer buzzes thus providing more security from theft.

The method in [1] is used to detect the height of the wildlife entering the farmland with the help of laser beam. Although this system is more secured when compared to conventional electric fence, implementation cost is more. Since existing fence has to removed and new fence has to be constructed with the provision of laser points.

In [2] sensors where used. However the sensors have to be replaced whenever it fails to work. In the system, sensors are replaced by two phase and neutral wires in Smart Electric Fence. This reduces the cost during installation, thereby making the system simple and cost effective.

Proposed Smart Electric Fence for Agricilutural Farmlands

Block Diagram

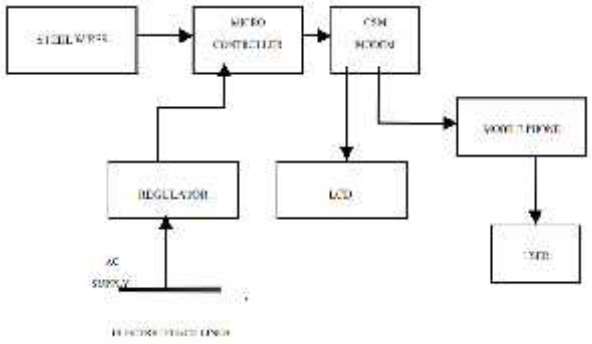

Fig. 2 Block Diagram *(Smart Electric fence)*

Fig. 2 represents the block diagram of Smart Electric Fence. The system Smart Electric Fence is based on PIC 16F877 as a central core. This includes transformer, rectifier, IC voltage regulators (IC7805), liquid crystal display (LCD), SIM 300 (GSM module) and wireless communication.

Fence Wires

Smooth steel wire is the material most often used for electric fences as shown in Fig. 3, ranging from a fine thin wire used as a single line to thicker, high-tensile (HT) wire. Less often, woven wire or barbed wire fences can be electrified, though such practices create a more hazardous fence, particularly if a person or animal becomes caught by the fencing material. Synthetic webbing and rope-like fencing materials woven with fine conducting wires (usually of stainless steel) have become available over the last 15 to 20 years, and are particularly useful for areas requiring additional visibility or as temporary fencing. The electrified fence itself must be kept insulated from the earth and from any materials that will conduct electricity and ignite or short out the fence. Fencing must therefore avoid vegetation, and cannot be attached directly to wood or metal posts. Typically, wooden or metal posts are driven into the ground and plastic or porcelain insulators are attached to them, or plastic posts are used. The conducting material is then attached to the posts.

Fig. 3 Fence Lines

Power Supply

Fig. 4 shows the block diagram of Power Supply. The ac voltage, typically 220V rms, is connected to a transformer, which steps the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also maintains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

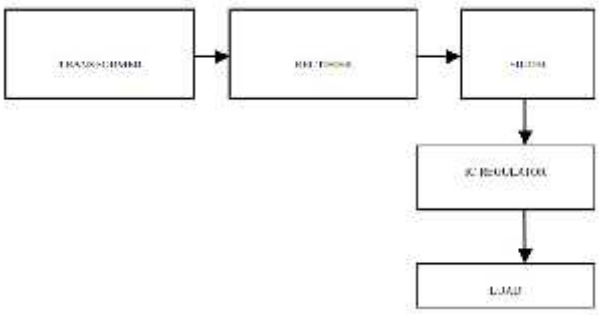

Fig. 4 Block Diagram *(Power Supply)*

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer is connected to the precision rectifier, which is constructed with the help of op–amp. The advantage of using precision rectifier rest of the circuits will give only RMS output that the output produced is peak value of DC.

When four diodes are connected as shown in Fig. 5, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential at point A and a negative potential at point B. The positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow the current flow to pass through them, whereas D4 and D2 are reverse biased and will block the current flow. The path for current flow is from point B through D1, RL, D3 and

through the secondary of the transformer back to point B. Later the polarity across the secondary of the transformer reverses, forward biasing D2 & D4 and reverse biasing D1 & D3. Current flow will now be from point A through D4, RL, D2 and through the secondary of the transformer back to point A. The current flow through load is always in the same direction. Since current flows through the load during both the half cycles of applied voltage, this bridge rectifier is a full-wave rectifier. One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

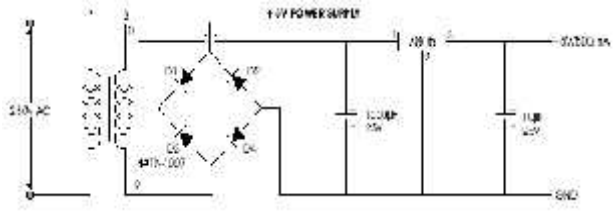

Fig. 5 Circuit Diagram (*power supply to Fence Lines)*

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts. A fixed three-terminal voltage regulator has an unregulated dc input voltage Vi, applied to one input terminal, a regulated dc output voltage Vo, from second terminal, with the third terminal connected to ground. The series 78 regulators provides fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provides fixed negative regulated voltages from 5 to 24 volts.

Microcontroller

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. It consists of a serial I/O port for data transmission, an ADC to allow the microcontroller to accept analogue input data for processing and a timer module to allow the microcontroller to perform tasks for certain time periods. They are smaller in size, consumes less power and costs less. Microcontroller is a stand-alone device which performs functions of its own without any requirement of external hardware. CPU is the central core of a microcontroller.

In this system we have used PIC 16F877 for controller operation. The operating voltage range is between 2.5V to 5.5V. Flash technology is used in PIC 16F877, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877. Flash Program Memory ranges up to 8K x 14 words, data memory up to 368 x 8 bytes and EEPROM data memory up to 256 x 8 bytes. Direct, indirect and relative are the addressing modes of PIC 16F877. Advantages are Power saving SLEEP mode and low power consumption with high speed. PIC microcontrollers are very popular due to their ease of programming, wide availability, easy to interfacing with other peripherals, low cost, large user base and serial programming capability (reprogramming with flash memory), etc.

PIC 16F877 consists of Timer0 (8-bit timer/counter), Timer1 (16-bit timer/counter) and Timer2(8-bit timer/counter). I/O Ports of PIC 16F877 are Port A, B, C, D and E. The register file can be accessed either directly or indirectly through the File Selected Register (FSR). There are some Special Function Registers used by the CPU and peripheral modules for controlling the desired operation of the device. These registers are implemented as static RAM. The Special Function Registers can be classified into two sets: core (CPU) and peripheral.

SIM300 GSM Modem

Fig. 6 is the picture of GSM Modem used for communication. The modem is a plug and play GSM Modem with simple serial interface. This is used to send SMS, make and receive calls and does other GSM operations through simple AT commands from micro controllers and computers. The modem comes with a standard RS232 interface which is used to easily interface the modem to micro controllers and computers. The modem comprises of external circuitry required to start experimenting with the SIM300 module like power regulation, external antenna, SIM Holder, etc. The modem consumes less power of about 0.25 A during normal operations and around 1 A during transmission. The Operating Voltage ranges from 7 – 15V AC or DC. This modem is used for GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP stack.

METHODOLOGY

In this system, fencing around the farmland is same as that of normal electric fencing. In order to determine the height of the animal entering the farmland fence lines are constructed at two levels, one at lower level closer to ground and another at higher level. When huge animals try to enter, fence lines at higher level will be interrupted and accordingly signals will be given to the controller. Input 220V ac supply voltage is given to the primary terminals of a potential transformer. The potential transformer steps down the ac supply voltage to about (0-6) V. Secondary of the potential transformer is connected to a diode rectifier that provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripples or ac voltage variations. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage varies. The fence lines are provided dc supply voltage of about 5V. When the animal body touches the electric fence line, it shorts the steel wire provided in parallel to them. Now the current is allowed to flow through the circuit. This operation is detected by the PIC microcontroller. Accordingly, an alert specifying the location of the farm where the impact is detected along with the height of the animal will be sent to the farmer through SMS by using GSM modem. GSM modem receives AT (ATtention) commands from the controller that activates the message centre to send SMS to user mobile phone.

Fig. 7 describes the sequence of operation that takes place in this system under normal condition as well as during the interruption of wildlife.

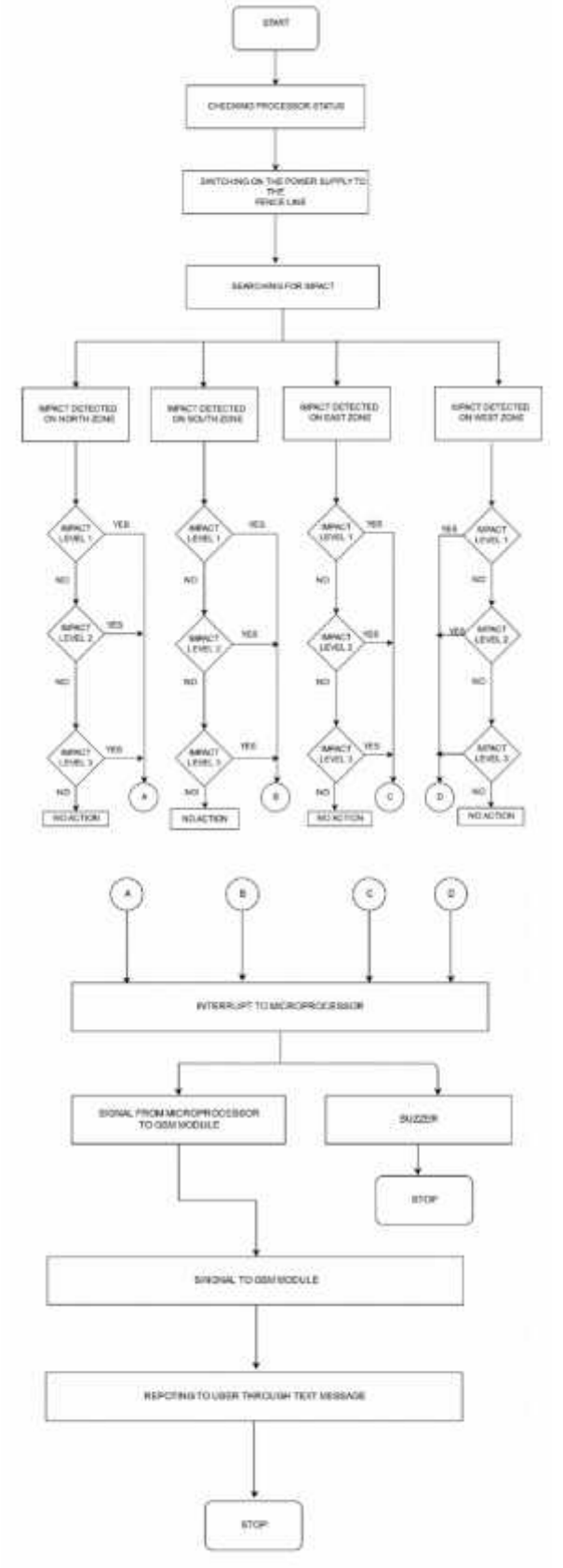

Fig. 7 Flow Chart of Smart Electric Fence

Fig. 8 LCD display during animal intervention

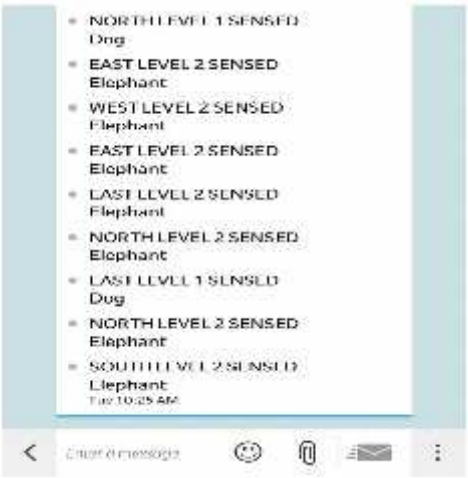

Fig. 9 SMS Received by the user

Advantages

- Provides more security to the farm lands from wild lives.
- Also prevents from thefts.
- Acknowledges impacted area to the user. So they can rush to that place much quicker and prevents crops from severe damage.
- Fault detection is easier in this type of system.
- Also detects the nature of the wild lives by detecting their heights. According to that, suggestions will be given to the user.

CONCLUSION

Smart Electric Fence gives information at the farmer's place. There is no need to go and search for the impacted area. The exact location where the animal has entered the farmland will be send as SMS denoting the post number. So that, the farmer can rush to the impacted location directly. This saves time and avoids severe damages to the crop. Another advantage is that this system can be installed in already existing electric fencing and costs less. And also by detecting the height, the farmer is given a precaution in case of huge animals. The proposed system has been successfully verified by analytical and experimental results.

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