

## Antismuggling System for Trees in Forest with Solar Power Generation

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**Abstract:** The purpose of this project work is to design an anti-smuggling system which is useful in Protected Forest areas. The Theft and illegal movement of commercial trees like Sandalwood, Teak, Sagwan., etc have been a major concern. It is also a theft to Forest Flora and fauna. As concerned citizens our ideology is to prevent such smuggling activities by using latest technologies. Hence a SMART SOLAR based Module has been devised which operates in a particular area and maintains database of the identified trees. Trees are made Smart with sensors embedded in them, forming a Sensor Network that communicates using GPRS with the Server, based on Internet of Things (IoT) concept. The Server uses the most latest technology of Amazon Cloud Web Services. The forehand information about the trees, avoids theft and also any other damage to trees can be prevented.

**Keywords:** Renesas Microcontroller, Sensors, GPRS, Solar Power and Amazon Web Service etc.

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### I. Introduction

For ages we have been perturbed by illegal activities like smuggling of Precious and commercial trees such as Teakwood, Sandalwood, Sagwan etc., from the protected Forest areas. These trees are very expensive and have a lot of commercial demand in the world market. The trees are generally considered to be protected by marking them some tags manually. This will not be useful and reliable since anyone can hamper it. Also during Natural calamities trees may somehow get damaged.

A SMART automated unit has been thus devised to tackle these issues. The Combination of Latest Wireless communication systems and Embedded solutions offer us such modules. The Module is intended to operate in a particular area and this Module will consist of two Units:

- 1) Tree Unit
- 2) Main Server Unit (base station).

Each Tree is supposed to have one small Embedded System-Unit with: Renesas Microcontroller, Sensors, GPRS and Solar power. The presence of above said parts will send the present condition of the tree to the Base station, using GPRS module. The data sent by GPRS is in the form of data string/frame via Internet, hence IoT network is formed here. The data frame is deciphered by the Server at the Base Station.

The Base station has a server which maintains the database of all such trees. The communication to base station is based on latest technology using Amazon Web Services. DotNet is the software used in the Server to decipher the received data frame from the Trees in the forest.

At the main server only authorized person will have access to the database. The database is analyzed to check whether the tree is safe or being pulled away. However the database keeps continuously updating about the present condition of trees and emergency situations need to be attended by the Forest authorities. For example if the tree is fallen the "Flex Sensor" data will be an extreme value than the normal set threshold value. The abundance of solar energy in the forest area can be harnessed by having a Small Solar panel and boost circuitry which can charge the battery. The battery will in turn provide a back-up for the units.

### II. Literature Survey

The concept of Commercial and Precious tree protection and preventing their theft is the prime idea of this thesis and that too using latest technologies.

The ideas are clearly defined in [1] **Anti-Smuggling System for Trees in Forest using Flex Sensor and Zigbee** Volume 3, Issue 9, September 2014,. This paper explains as to how to restrict the smuggling activities and to save the forest-areas on Earth using some preventive measures. The system that was developed

using a mini Sensor network using zigbee module , Flex sensor , GSM Module and GPS using the platform of Visual Basic.

The concept has been further strengthened in [2] **Preventive System for Forests** Volume 4 Issue 1, Jan - Feb 2016, which talks of the main three units to be used in the Module to be designed like Tree Unit , Area/Sub Server Unit and Server Unit. It concentrates on Zigbee and GSM technologies while maintaining the Server on VisualBasic.

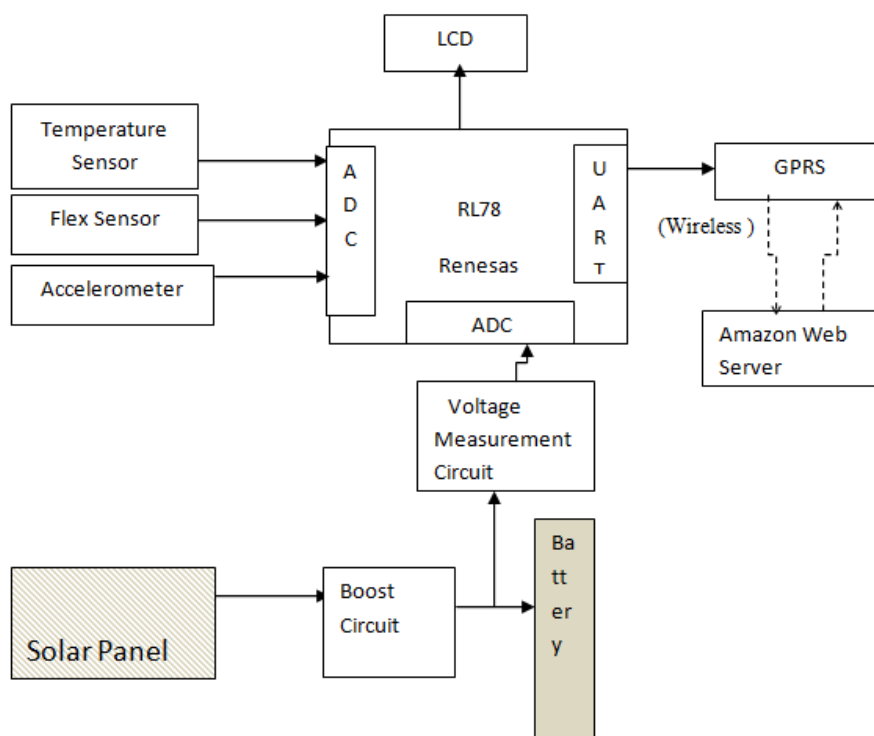
Android based Anti-Smuggling Module has been discussed in **Anti-Smuggling Alarm System for Trees in Forest Using Android** [3]. The idea of using accelerometers and temperature sensors forming a mini sensor networking is introduced here.

Also Android based concept is very ideal for current scenario since almost all Mobile handsets are Android based. The anti-smuggling squad can immediately receive messages on their handsets during any interruption to the trees.

**Accelerometers** are based on MEMS Technology – Micro Electro Mechanical Systems [4] . Details on MEMS are referred from **Lee, G. H. Yoon, J Park, S. Seok, K. Chun, K. Lee, Development and analysis of The vertical capacitive accelerometer, Sensors and Actuators A 119 (2012) 8-18**. The paper in details discusses on MEMS accelerometer which is also referred as vertical capacitive torsional accelerometer (TXL).

### III. Module Design

This discusses about the Method in which this Module is designed in Fig.1. The Module developed is an integration of hardware and software. The hardware is developed using sensors – Temperature Sensor, Flex Sensor and Accelerometer. Also GPRS and Solar Panel are connected to the Module.



**Figure 1:** Proposed system Block Diagram

#### 1.1. SENSORS Selection

The sensors are like an organ system of this unit since they are ones which predict or inform about the tree's condition. Though small in size their capacity to sense the environment around them like temperature, moisture etc., make them most important part of any unit. Hence we need sensors that are reliable and rugged, at the same time they should be economical.

For the Hardware design here 3 sensors has been selected.

- Temperature sensor – LM35
- Flex sensor – To sense the tree's bending movements.
- Accelerometer –ADXL335 - To sense the 3 axes movements of the tree.

All the 3 sensors will give a varying analog output which should be interfaced to a Microcontroller via an ADC.

### 1.2. MicroControllerR5F102AA

The microcontroller Board in Fig.2 should be compact and should have inbuilt ADC to sense the outputs of various sensors. It should also be rugged, consume less power and economical. Hence the latest microcontroller from Renesas electronics – RL78 series R5F1022AA - a 64 pin is selected.



Figure .2: R5F102AA Microcontroller Board

#### 3.2.1 RL78 Features

The RL78 Renesas MicroController Series offers designers the Gen-next design implementation with reducing system power, enhancing integration and provision for a cost-effective platform.They are also available in extensive range of small packages and with operating temperature range from -40Deg to +85Deg.

### 1.3. Liquid Crystal Display

JHD162A is the LCD which is interfaced to the microcontroller. It operates under +5V supply range. It acts as a display unit and also serves as a testing unit during software development phase. The Panel of this LCD has 2 rows and 16 columns. Pixel arrangement is 5x8. The block diagram is shown in Fig.3.

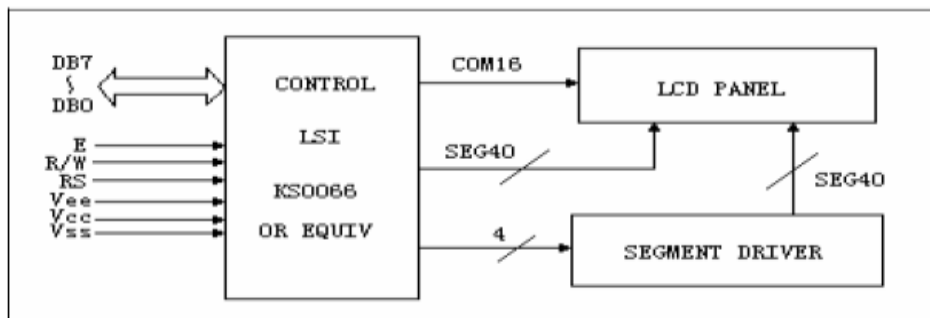


Figure 3: LCD – JHD162A

#### 1.3.1. Interfacing JHD162A with Microcontroller

Alpha Numeric displays form an integral part of the Embedded Systems.The Data displayed here is controlled by the Microcontroller. The Control pins like Read Strobe, Read/Write and Enable are controlled through the Microcontroller Ports .The 8 data is also provided through a Microcontroller Port.

No	HEX Value	COMMAND TO LCD
1	0x01	Clear Display Screen
2	0x30	Function Set: 8-bit, 1 Line, 5x7 Dots
3	0x38	Function Set: 8-bit, 2 Line, 5x7 Dots
4	0x20	Function Set: 4-bit, 1 Line, 5x7 Dots
5	0x28	Function Set: 4-bit, 2 Line, 5x7 Dots
6	0x06	Entry Mode
7	0x08	Display off, Cursor off
8	0x0E	Display on, Cursor on
9	0x0C	Display on, Cursor off
10	0x0F	Display on, Cursor blinking
11	0x18	Shift entire display left
12	0x1C	Shift entire display right
13	0x10	Move cursor left by one character
14	0x14	Move cursor right by one character
15	0x80	Force cursor to beginning of 1st row
16	0xC0	Force cursor to beginning of 2nd row

Table .1 : LCD – Commands Table

#### 1.4. GPRS

GPRS is interfaced to UART0 of the Microcontroller board. Commands for GPRS are sent through UART as serial data to the GPRS module.



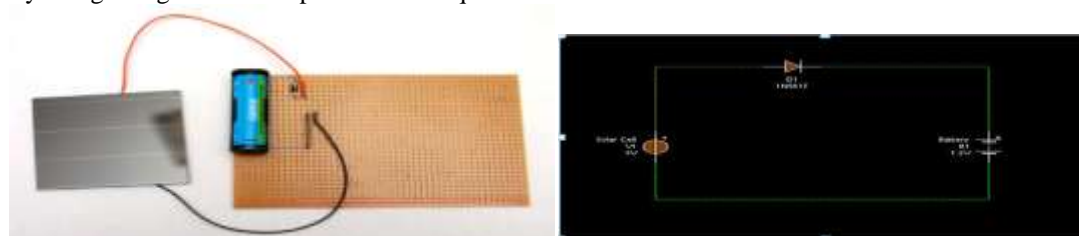
**Figure 4: GPRS**

#### 1.5. SOLAR VOLTAGE



**Figure 5: Solar Pane**

A solar cell made from a monocrystalline silicon wafer. Solar Panels use light energy (photons) from Sun to generate electricity through photovoltaic effect. The load carrying structure can either be at the top or back layer. Wafer-based crystalline silicon cells or thin film cells based on cadmium telluride or silicon are used in the latest Panels. The conduction wires can be taken as shown below from the terminals of the Module. Also a battery being charged from the panel and its equivalent circuit is shown below.

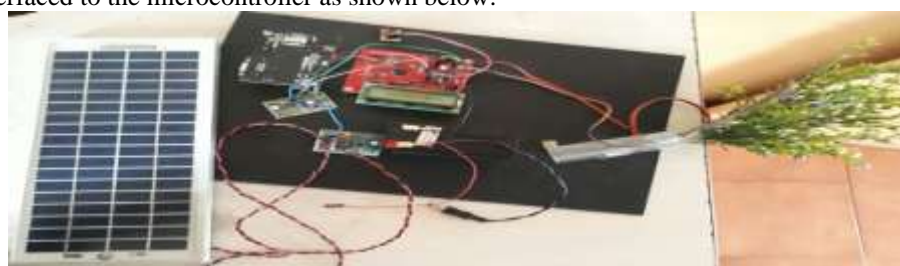


**Figure 6: Connection of Panel electrodes to charge a battery**

The positive terminal is connected through the diode (for safety) to the +ve terminal of the battery to be charged. Since the output voltage from the Panel is not consistent and may drop at times which is insufficient to charge a battery hence a boost circuit as shown below will be used. The schematic shows a diode, the purpose of it is to disallow the current dissipating out from the battery to the solar cell when during low voltage output from the solar panel.

#### IV. Demonstration

To demonstrate the scenario of Tree smuggling in a Protected Forest environment the below hardware set-up is made. A small toy tree with all the 3 sensors – Accelerometer, Flex sensor and Temperature sensor – attached is interfaced to the microcontroller as shown below.



**Figure 7: Hardware Set-up**

To demonstrate solar power storage a small solar panel is used - whose voltage is boosted using a boost circuitry and then is used to charge a battery. The boost voltage can be measured via a voltage measuring circuit interfaced to the microcontroller.

**V. Results**

The below observations are made for different positions of the tree and for different temperatures. The messages sent to AWS server through GPRS are also recorded.

**Figure 8 :** Message displayed while waiting for the network.

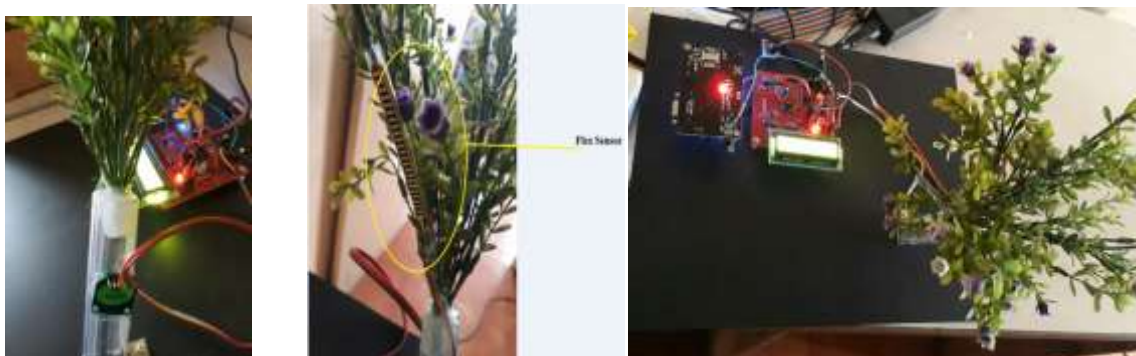


**Figure 9 :** Getting local IP address



**5.1. Tree Status**

The below snaps are the tree status as displayed on the LCD and the same is transmitted to the Server through GPRS in a string format as explained before. These are the readings of the 3 sensors processed and displayed by the Microcontroller.



**Figure 10:** Tree with sensors and Testing Board

**5.2. AWS Messages**

The AWS also was accessed to check the data via internet.

Project Data Viewer

Anti Smuggling

View Data Clear Data Generate Download Data

Time	Date	Temp	Solar	Vibration	Bent
16.58.51	2017-06-10	32	217	1	0
16.58.44	2017-06-10	49	217	0	0
16.58.43	2017-06-10	71	217	0	0
16.56.34	2017-06-10	47	203	0	0
16.56.13	2017-06-10	40	217	0	0
16.55.58	2017-06-10	28	203	1	0
16.55.37	2017-06-10	28	217	1	0
16.55.02	2017-06-10	28	217	1	0
16.53.31	2017-06-10	28	217	0	0
16.52.22	2017-06-10	28	203	1	0
16.52.06	2017-06-10	28	203	0	1
16.51.49	2017-06-10	00	000	0	0



## **VI. Conclusion And Future Scope**

### **A. Conclusion**

The thesis was carried out to avoid smuggling of precious trees in protected area in forests. There are many ways to protect trees but here a smart method of interfacing some sensors around trees with a microcontroller was carried out. The latest method of cloud computing using Amazon web services was implemented which acts as a server for obtaining the tree status remotely. That is to intimate the Forest authorities about the trees's condition on 24x7 basis.

This was possible because the embedded unit has GPRS. Idea was to treat each tree as a Smart tree (with a microcontroller, sensors and GPRS) and bringing many such trees under a network (Internet of Things). However the Trees's condition is under continuous monitoring because of sensors. Hence it's an amalgamation of IoT, WSN and AWS to protect the Nature.

### **B. Future Scope**

Though the claim has been made that a Smart module has been developed to protect trees, future enhancements are required to make the system more rugged.

- The Units / Hardware / Sensors have to be rugged.
- Suitable enclosure has to be made.
- The Module should be placed in untraceable place on trees, not easily accessible to tree-destructors.
- Forest Authorities has to be suitably educated.

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