Object Tracking Using Ambient Backscatter Technology

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***Abstract*—**Ambient backscatter is a new technology that uses ambient signals to enable communication. The system utilizes existing ambient RF radiations as the source of power and also utilizes the same as wireless medium for communication between devices. It leverages the ambient RF signals that are already around us, it does not require a dedicated power infrastructure as in RFID. The basic thought here is that there is a ton of energy in our environment specifically in the form of high-amplitude RF waves from broadcasts, and we should be able to use that energy to do work. With the help of this ambient backscatter technology, we keep in track of the objects/things which we wish to safe guard by keeping them as a transmitter. There is exchange of pulses (RF signals) that takes place between the transmitter and the receiver. When the receiver to which the object is connected is taken away (to some particular distance), the backscattering stops and hence we may use the micro-controller to intimate the user with the help of a message using GSM and track the location of the object using GPRS.

Keywords*-*Ambient backscatter, RF signals, RFID, GSM,GPRS.

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I. INTRODUCTION

The world around us is full of electromagnetic signals, many of them generated by devices we design. These transmissions can be detected, and even harvested by other devices. They can also interfere with unintended receivers. There has been a lot of talk recently about replacing batteries in IoT sensors and devices with energy harvesting systems. Some people have even postulated that high energy RF signals, like TV station transmissions, can be harvested to power devices. This idea is not wholly practical for several reasons. However, one of the main ones is there's just not enough power. You would need to be able to power a microprocessor, a sensor, and a wireless circuit at least, and possibly even memory. There are low power processors, sensors, and memory, but wireless connections come with a price. That is, until ambient backscatter comes into the equation.

Ambient Backscatter transforms existing wireless signals into both a source of power and a communication medium. It enables two battery-free devices to communicate by backscattering existing wireless signals. Backscatter communication is orders of magnitude more power-efficient than traditional radio communication. Further, since it leverages the ambient RF signals that are already around us, it does not require a dedicated power infrastructure as in RFID.The new technology is called 'ambient backscatter' and works by absorbing the many types of transmissions – from radio waves, Wi-Fi, mobile networks and that are all around us in the air. Prototype devices talk to each other by using antenna to intercept and reflect these signals back and forth. We can repurpose wireless signals that are already around us into both a source of power and a communication medium.

The new technology could greatly speed the development of the Internet of Things – the concept of imbuing our built environment with internet connectivity – as current technology is hamstrung by the need to supply each device with its own power source. In the design of ambient backscatter there are three main parts viz. transmitter, receiver and harvester. Harvester is the circuit which extracts energy from ambient RF signals to provide power to the complete board. The device say 'A' inserts additional information to be sent to the other device say 'B' over the existing received ambient encoded TV signals from TV tower. The devices work at UHF TV frequency bands.

Antenna

In radio, an antenna is the interface between radio waves propagating through space and electric currents moving in metal conductors, used with a transmitter or receiver. In transmission, a radio transmitter supplies an electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce an electric current at its terminals that is applied to a receiver to be amplified. Antennas are essential components of all radio equipment, and are used in radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, satellite communications and other devices.

An antenna is an array of conductors (elements), electrically connected to the receiver or transmitter. During transmission, the oscillating current applied to the antenna by a transmitter creates an oscillating electric field and magnetic field around the antenna elements. These time-varying fields radiate energy away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Dipole Antenna

In radio and telecommunications a dipole antenna or doubletis the simplest and most widely used class of antenna the dipole is any one of a class of antennas producing a radiation pattern approximating that of an elementary electric dipole with a radiating structure supporting a linecurrent so energized that the current has only one node at each end.A dipole antenna commonly consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors. A common example of a dipole is the "rabbit ears" on broadcast television sets.

Several different variations of the dipole are also used, such as the folded dipole, short dipole, cage dipole, bow-tie, and batwing antenna. Dipoles may be used as standalone antennas themselves, but they are also employed as (driven elements) in many more complex antenna types, as the Yagi antenna, parabolic antenna, reflective array, turnstile antenna, log periodic antenna, and phased array. The dipole was the earliest type of antenna; it was invented by German physicist Heinrich Hertz around 1886 in his pioneering investigations of radio waves

Figure 1: Antenna

II. LITERATRURE SURVEY

The ambient backscatter technique is a communication technology that uses ambient radio frequency signals to enable battery-free devices to communicate with other device. This paper proposes the ambient backscatter technique using multiple antennas. Since the tag only plays a role of reflecting signals, a signal is transmitted with a power allocation in the case of multiple antennas. At the receiving end, the higher power signal is detected first via the received signal. Next, signal from other antenna is detected by using the first detected signal. Since the backscatter technique generally uses energy detection, it has a low data rate using a single antenna. The proposed method can obtain a higher data rate than conventional methods by using multiple antennas. Also, it can be usefully used for the Internet of Things system, which requires high data rate through the proposed backscatter method.

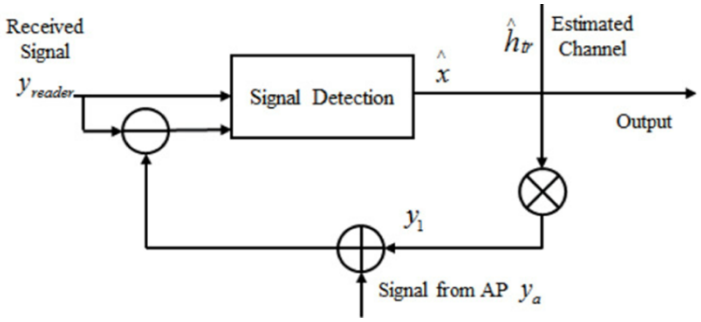

Figure 2: Transmitter Section

Ambient backscatter communication technology has been introduced recently, and is quickly becoming a promising choice for self-sustainable communication systems, as an external power supply or a dedicated carrier emitter is not required. By leveraging existing RF signal resources, ambient backscatter technology can support sustainable and independent communications and consequently open up a whole new set of applications that facilitate Internet of things (IoT). In this article, we study an integration of ambient backscatter with wireless powered communication networks (WPCNs). We first present an overview of backscatter communication systems with an emphasis on the emerging ambient backscatter technology. Then we propose a novel hybrid transmitter design by combining the advantages of both ambient backscatter and wireless powered communications. Furthermore, in the cognitive radio environment, we introduce a multiple access scheme to coordinate hybrid data transmissions. The performance evaluation shows that the hybrid transmitter outperforms traditional designs.

III. PROPOSED SYSTEM

Ambient Backscatter transforms existing wireless signals into both a source of power and a communication medium. That doesn't mean that the devices aren't powered though, just that they don't need a battery. But powering them up is using radio waves that are ubiquitously moving through the air, ambient backscatter devices would simply grab some of those radio waves and convert them into the small amount of power that

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they need in order to work. It can't do much with that limited power source, but it would be enough to send a signal, store information, and light up an LED.

With the help of this ambient backscatter technology, we keep in track of the objects/things which we wish to safe guard by keeping them as a transmitter. There is exchange of pulses (RF signals) that takes place between the transmitter and the receiver. When the receiver to which the object is connected is taken away (to some particular distance), the backscattering stops and hence we may use the micro-controller to intimate the user with the help of a message using GSM and track the location of the object using GPRS.

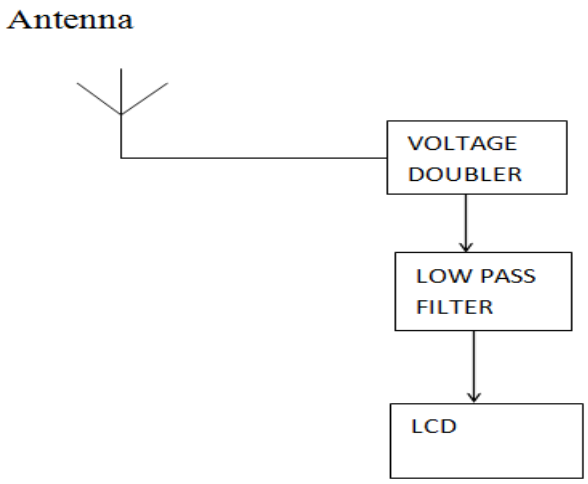

Figure 3: Transmitter Section

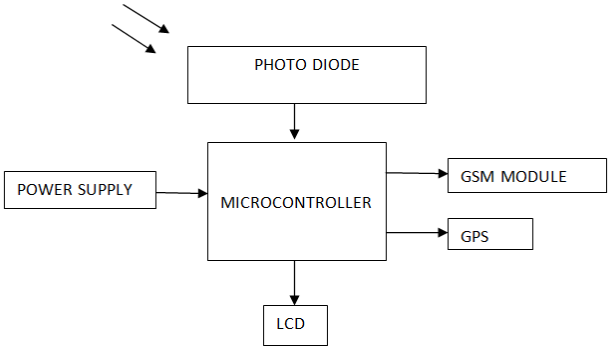

Figure 4: Receiver Section

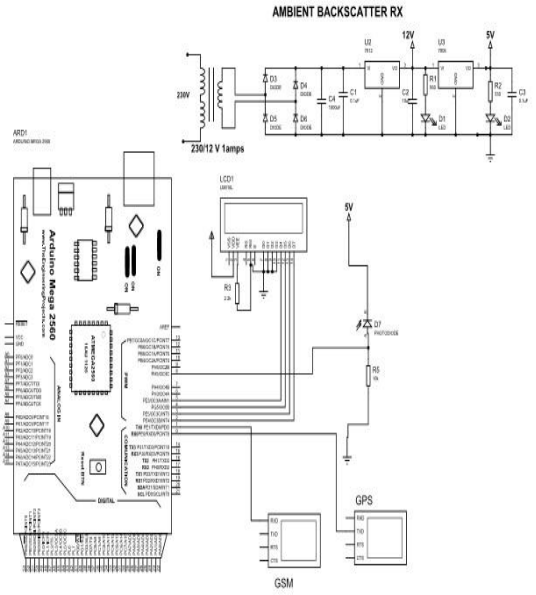

Figure 5: Circuit Diagram

Photo Diode

Infrared (IR) technology addresses a broad variety of wireless applications, especially in the areas of sensing and remote control. Today's newest products such as cell phones, digital cameras, and DVD players as well as remote controls for every market segment rely on IR sensing and control devices. ROHM Semiconductor has been driving technology advances that have led to a growing number of IR sensing and communication applications for over 40 years. Focusing on near infrared devices and applications, Photo-Optic technologies are used for optical sensing and optical communications with numerous general market applications, since light is less complex than RF when implemented as the signal source. Optical sensors are used in industrial, consumer and other applications for sensing movement, position, proximity, ambient light, speed, and direction.

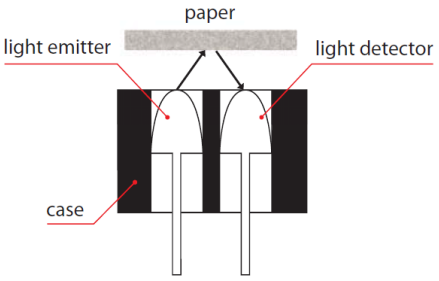

Figure 6:Reflective Type Photo Sensors Detect Light Reflected By A Target Object.

ARDUINO

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing plat form based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, andother physical outputs. Arduino projects can be stand-alone, or they can be communicating with software running on your computer. The boards can be assembled by hand or purchased pre-assembled.

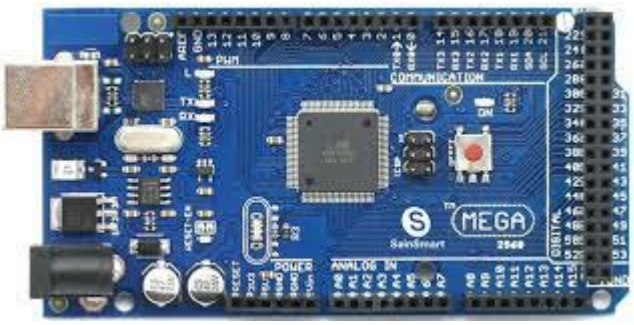

Figure 7:Arduino

GSM

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is estimated that many countries outside of Europe will join the GSM Partnership.

GSM was devised as a cellular system specific to the 900 MHz band, called "The Primary Band". The primary band includes two sub bands of 25 MHz each, 890 to 915 MHz and 935 MHz to 960 MHz. GSM-PLMN has allocated 124 duplex carrier frequencies over the following bands of operation.

GPS

The Global Positioning System (GPS), originally Navstar GPS, is a satellite-based radio navigation system owned by the United States governmentand operated by the United States Air Force. It is a global navigation satellite system that provides geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. Obstacles such as mountains and buildings block the relatively weak GPS signals.

The GPS does not require the user to transmit any data, and it operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information. The GPS provides critical positioning capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver. The GPS concept is based on time and the known position of GPS specialized satellites. The satellites carry very stable atomic clocks that are synchronized with one another and with the ground clocks. Any drift from true time maintained on the ground is corrected daily. In the same manner, the satellite locations are known with great precision. GPS receivers have clocks as well, but they are less stable and less precise.

GPS satellites continuously transmit data about their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the precise position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).

Voltage Doubler

A voltage multiplier is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, typically using a network of capacitors and diodes. Voltage multipliers can be used to generate a few volts for electronic appliances, to millions of volts for purposes such as high-energy physicsexperiments and lightning safety testing. The most common type of voltage multiplier is the half-wave series multiplier, also called the Villard cascade.

A voltage doubler uses two stages to approximately double the DC voltage that would have been obtained from a single-stage rectifier. An example of a voltage doublers is found in the input stage of switch mode power supplies containing a SPDT switch to select either 120 V or 240 V supply. In the 120 V position the input is typically configured as full-wave voltage doublers by opening one DC connection point of a bridge rectifier, and connecting the input to the junction of two series-connected filter capacitors.

LCD

A liquid crystal display (commonly abbreviated 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 often utilized in battery-powered electronic devices because it uses very small amounts of electric power.Connection to the LCD is through a 14-pin interface,

physically arranged 1x14. We only need to use six lines to write to the display. And since four of these lines are tri-stated when not in use, they can be shared by other hardware. Table 3.1 shows the LCD pin connections. The data bus is eight bits wide, but we're only using four bits.

LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm2) and integrated optical components may be used to shape the radiation pattern.

Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays and were commonly seen in digital clocks. Recent developments have produced LEDs suitable for environmental and task lighting. LEDs have led to new displays and sensors, while their high switching rates are useful in advanced communications technology.

Figure 8: A 4x zoom photo of an ultra-violet LED has been shown in picture

The design of our ambient backscattering transmitter builds on conventional backscatter communication techniques. Designing an ambient backscatter receiver is challenging for two main reasons: First, ambient signals already encode information and hence backscattering additional information over these signals can be difficult. Second, the backscattered information should be decodable on an ultra-low-power device without using power hungry hardware components such as ADCs and oscillatorsThe dipole antenna receives the RF signal in the ambient and harvests energy that is sufficient to energize the LED connected to the transmitter circuit. The receiver side uses power supply since controller, GSM and GPS draws morepower. The voltage received by the antenna is very less and so to produce sufficient power to glow an LED, voltage doubler circuit is used in which capacitor and diodes are used. Fast recovery diode is required for better results.

The photo diode in the receiver side to which the object is connected, intimates the micro-controller that the transmitter is beside the receiver and is safe and is displayed on LCD until the LED is glowing and is near the receiver. As soon as the receiver is taken away, the photodiode informs the controller and in turn the microcontroller activates the GSM and sends a message to the number specified noting that the object is missing and enables the user to track the missing object with the help of GPS.

Arduino

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programmingThe Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Program for Arduino may be written in any programming language with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

IV. RESULTS AND DISCUSSIONS

Application

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This technology is going to be incredibly useful in the near future. Not only does it allow device-to-device communication without the use of wireless modules. It also could enable a generation of battery-less devices that can harvest energy from the air.

The researchers give the example of building such communicating sensors into a bridge, monitoring the integrity of the concrete and steel. If an irregularity is detected, a signal is sent. This technology could be cheaply integrated into a range of structures, without the worry that the power supply would run out.

Wearable's

Currently if you want to compare step counts with someone your device will need to upload those counts to a server and then your device will have to download them. With this kind of technology, your wearable could communicate directly with each other, enabling a more organic approach to data.

The Internet of Things

The Internet of Things will have vast networks of low power sensors that will need to communicate with each other. By utilizing this kind of system these sensors could use much less power, leading to a more efficient and reliable system.

Payment Processing

This last example is from the study itself. They created "bus passes" that could transmit money directly from card to card. Imagine being able to pay someone electronically without needing a cell signal or Wi-Fi. Can be used for Home Monitoring: The tech could also be used to allow smartphones to send text messages even if their battery is dead, or to tag various items such as keys, wallet or phone to transmit their location if they are lost.

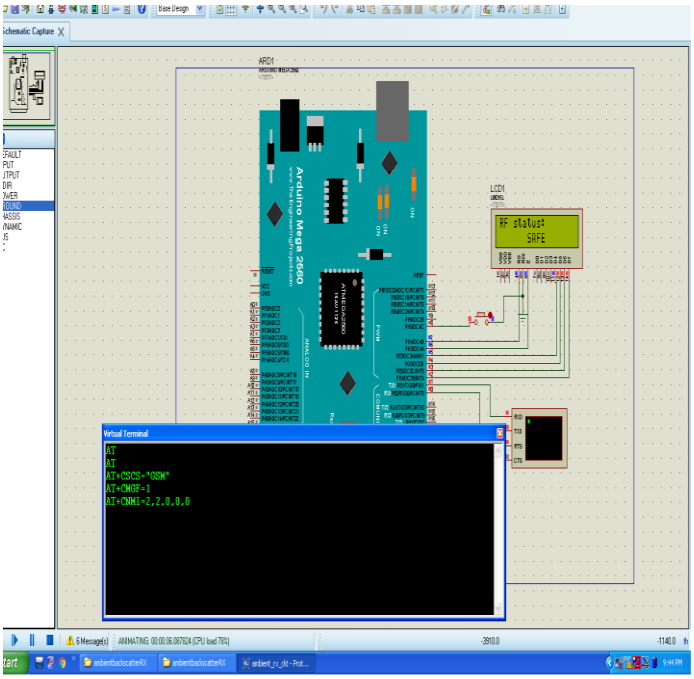

Figure 9: Simulation output of the proposed system

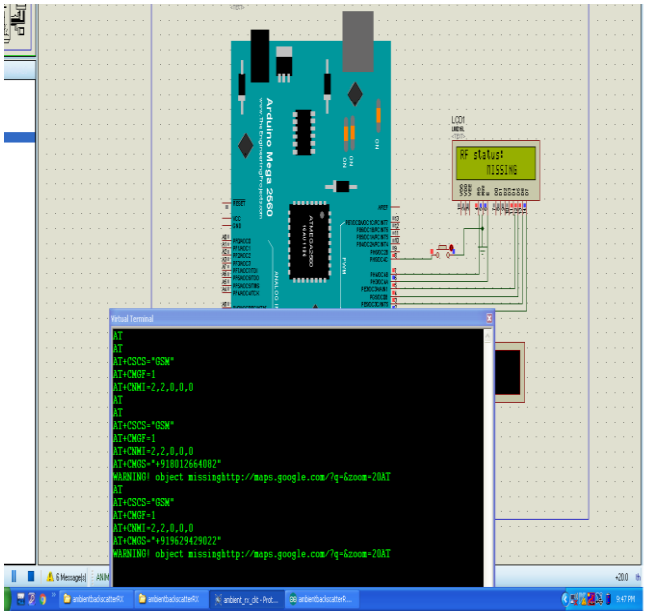

Figure 10: Simulation output showing that RF range is missing

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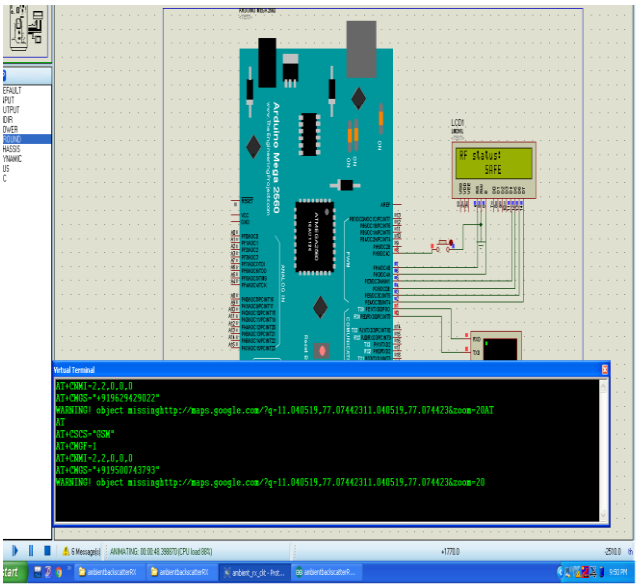

Figure 11:Simulation output

V. CONCLUSION

For the first few decades of their existence, computers were fundamentally limited by the infrastructure on which they rely. Computers were tethered by their power cords and were rendered useless without a nearby power outlet. Wireless communication combined with battery packs liberated these devices for short periods of time so that they could compute and communicate, untethered, as long as their batteries were occasionally recharged or replaced. In this report, we introduce ambient backscatter, a new form of communication that provides connectivity between computers out of what is essentially thin air. In this technique, TV signals and other source of RF signals serve as both the source of power and the means of communication. Because ambient backscatter avoids the maintenance heavy batteries and dedicated power infrastructure of other forms of low-power communication (e.g., RFID and NFC), it enables a bevy of new applications that were previously impossible or at least impractical. We believe that ambient backscatter provides a key building block that enables ubiquitous communication (with no restrictions except the existence of ambient RF signals) among pervasive devices which are cheap and have near-zero maintenance and enables the user to safe guard and track the object connected to the receiver.

VI. ACKNOWLEDGMENT

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