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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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INSIDE THIS ISSUE:

MOBILE VOTING SYSTEM USING IRIS RECOGNITION AND CRYPTOGRAPHY TECHNIQUES

With the advancement of electronics and computer science, mobile communication technology leads us to a fast moving entirely different world. In this scenario, we have lot of responsibilities, one of it is voting for our country, but even we don't have time for it, and also our votes may not useful to our nation, because of fake votes and cheating process happened during the election. This problem is rectified by the latest voting system as "Mobile Voting System" which is discussed in this paper. The mobile voting system uses the efficient techniques, iris recognition and cryptography for the secured voting process. The iris recognition and cryptography avoids the fake votes and cheating process. The election commission spends lot of money, for each election unnecessarily, which will be minimized by this system. This system enables the voter to vote to the Nation from his place itself.

Mobile voting system use the iris recognition and cryptography techniques, for voting purpose, the encryption algorithm is uploaded in the mobile phone. As like the eye scanner which scans the iris is fixed in the mobile, so the mobile phone having camera is preferred for that. To obtain the voting the voters eye iris is recognized. During the transmission from the source (mobile) to destination (election database system) the data is encrypted using the encryption algorithm. The data sending and receiving is doing with the help of the mobile networks.

As democracies across the globe fight challenges related to electronic voting systems, here a mobile phone-based voting system that incorporated into the current large-scale election process, gives the promising research. Traditionally, voting process is organized in centralized or distributed manner called voting booths. The earlier process of election is quite complex and time consuming. People were waiting in queue for long time. To reduce this problem mobile voting system is introduced. This mobile voting system provide many benefits like we don't need to go to polling booths, no need to use paper ballots and we have time and cost efficiency and it also avoid tiredness and violence . In our system there is no expensive hardware is used. For the different reasons, voters may not able to come to the voting booths physically, but now with the use of this new system he can vote remotely. For example, he can vote from home or while travelling abroad or sitting in the Office. That's why there is more demand for remote voting. In this system procedures are easy, transparent and most secure.

Today the most common way for remote voting is postal voting, where voters cast their votes by cell Phones...Internet voting was introduced to provide more flexibility. Because of the inherited security vulnerabilities Of the Internet and computerized systems. In general, Phone Voting System (MPVS) provides mobility feature. Internet voting there is awide range of criticism. Mobile However this technology accesses certain security threats for its successful implementation in election. Without eliminating these security threats like buying a vote and Coercion, online registration, secrecy of ballot, anonymity of voter and double voting this latest technology can't be allowed. An efficient and reliable system is essential for the trustworthy and successful implementation of this technology. In our system we design mobile application for e-voting (electronic voting) process.

The proposed system uses mobile phone device having: small in size, low power, low-price as compared to computers and Direct Recording Electronic voting System, Electronic Voting Machine's, provide mobility feature and security. Proposed system uses Global System for Mobile Communication technology which is a secure and globally used mobile technology in the current situation. Mobile phone also uses Subscriber Identity Module technology which provides user identity privacy, user identity verification and subscriber data secrecy providing more security to the proposed system.

The key features of our proposed Mobile Phone Voting System is :

Eligibility:

1.Authorized voter can cast their vote.

2.Uniqueness: Each user can cast their only one vote.

3.Integrity: Valid vote should not be modified or deleted.

4.Fairness: The election result should not be accessible before the official time ended.

5.Secrecy: No one can able to find how voter cast their vote.

6.Cost-effectiveness: Election system should be efficient and affordable.

IRIS RECOGNITION

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of one or both of the irises of an individual's eyes, whose complex random patterns are unique, stable, and can be seen from some distance.

Retinal scanning is a different, ocular-based biometric technology that uses the unique patterns on a person's retina blood vessels and is often confused with iris recognition. Iris recognition uses video camera technology with subtle near infrared illumination to acquire images of the detail-rich, intricate structures of the iris which are visible externally. Digital templates encoded from these patterns by mathematical and statistical algorithms allow the identification of an individual or someone pretending to be that individual. Databases of enrolled templates are searched by matcher engines at speeds measured in the millions of templates per second per (single-core) CPU, and with remarkably low false match rates.

Several hundred million persons in several countries around the world have been enrolled in iris recognition systems for convenience purposes such as passport-free automated border-crossings and some national ID programs. A key advantage of iris recognition, besides its speed of matching and its extreme resistance to false matches, is the stability of the iris as an internal and protected, yet externally visible organ of the eye.

Visible wavelength (VW) vs near infrared (NIR) imaging

All publicly deployed iris recognition systems acquire images of an iris while being illuminated by light in the near infrared wavelength band (NIR: 700–900 nm) of the electromagnetic spectrum. The majority of persons worldwide have "dark brown eyes", the dominant phenotype of the human population, revealing less visible texture in the VW band but appearing richly structured, like the cratered surface of the moon, in the NIR band. (Some examples are shown here.) Using the NIR spectrum also enables the blocking of corneal secular reflections from a bright ambient environment, by allowing only those NIR wavelengths from the narrow-band illuminator back into the iris camera.

Iris melanin, also known as chromospheres, mainly consists of two distinct heterogeneous macromolecules, called eumelanin (brown–black) and pheomelanin (yellow–reddish), whose absorbance at longer wavelengths in the NIR spectrum is negligible. At shorter wavelengths within the VW spectrum, however, these chromospheres are excited and can yield rich patterns. Hussein, et al. provide a comparison between these two imaging modalities. An alternative feature extraction method to encode VW iris images was also introduced, which may offer an alternative approach for multi-modal biometric systems.

OPERATING PRINCIPLE

An iris-recognition algorithm can identify up to 200 identification points including rings, furrows and freckles within the iris. First the system has to localize the inner and outer boundaries of the iris (pupil and limbos) in an image of an eye. Further subroutines detect and exclude eyelids, eyelashes, and secular reflections that often occlude parts of the iris. The set of pixels containing only the iris, normalized by a rubber-sheet model to compensate for pupil dilation or constriction, is then analyzed to extract a bit pattern encoding the information needed to compare two iris images.

In case of Dagan's algorithms, a Gabor wavelet transform is used. The result is a set of complex numbers that carry local amplitude and phase information about the iris pattern. In Dagan's algorithms, most amplitude information is discarded, and the 2048 bits representing an iris pattern consist of phase information (complex sign bits of the Gabor wavelet projections). Discarding the amplitude information ensures that the template remains largely unaffected by changes in illumination or camera gain (contrast), and contributes to the long-term usability of the biometric template.

For identification (one-to-many template matching) or verification (one-to-one template matching), a template created by imaging an iris is compared to stored template in a database. If the Hamming distance is below the decision threshold, a positive identification has effectively been made because of the statistical extreme improbability that two different persons could agree by chance ("collide") in so many bits, given the high entropy of iris templates.

ADVANTAGES

The iris of the eye has been described as the ideal part of the human body for biometric identification for several reasons:

It is an internal organ that is well protected against damage and wear by a highly transparent and sensitive membrane (the cornea). This distinguishes it from fingerprints, which can be difficult to recognize after years of certain types of manual labor. The iris is mostly flat, and its geometric configuration is only controlled by two complementary muscles (the sphincter papillae and dilator papillae) that control the diameter of the pupil. This makes the iris shape far more predictable than, for instance, that of the face.

The iris has a fine texture like fingerprints is determined randomly during embryonic gestation. Like the fingerprint, it is very hard (if not impossible) to prove that the iris is unique.

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Wireless Power Transmission via Solar Power Satellite

A major problem facing on Planet Earth is provision of an adequate supply of clean energy. It has been observed that we face three simultaneous challenges population growth, resource consumption, and environmental degradation. All converging particularly in the matter of sustain energy supply.

Space-based solar power (SBSP) is the concept of collecting solar power in space (using an "SPS", that is, a "solar-power satellite" or a "satellite power system") for use on Earth. It has been in research since the early 1970s.

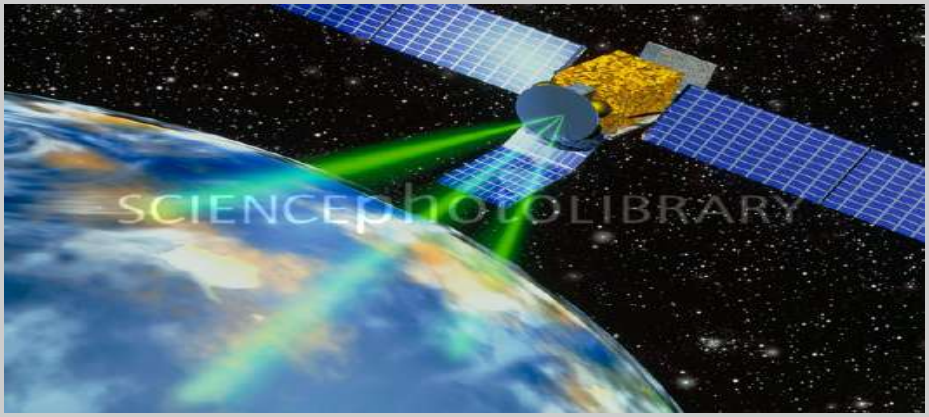
SBSP would differ from current solar collection methods that means used the collected energy would reside on an orbiting satellite instead of on Earth's surface. Some projected benefits of such a system are a higher collection rate and a longer collection period due to the lack of a diffusing atmosphere and night time in space.

Part of the solar energy (55–60%) is lost on its way through the atmosphere by the effects of reflection and absorption. Space-based solar power systems convert sunlight to microwaves outside the atmosphere, avoiding these losses, and the downtime (and cosine losses, for fixed flat-plate collectors) due to the Earth's rotation.

Besides the cost of implementing such a system, SBSP also introduces several new hurdles, primarily the problem of transmitting energy from orbit to Earth's surface for use. Since wires extending from Earth's surface to an orbiting satellite are neither practical nor feasible with current technology, SBSP designs generally include the use of some manner of wireless power transmission. The collecting satellite would convert solar energy into electrical energy on board, powering a microwave transmitter or laser emitter, and focus its beam toward a collector (retina) on Earth's face. Radiation and micrometeoroid dam age could also become concerns for SBSP.

SBSP is considered a form of sustainable or green energy, renewable energy, and is occasionally considered among climate engineering proposals. It is attractive to those seeking large-scale solutions to anthropogenic climate change or fossil fuel depletion (such as peak oil).

SBSP is being actively pursued by the Japan and China. In 2008 Japan passed its Basic Space Law which established Space Solar Power as a national goal and JAXA has a roadmap to commercial SBSP. In 2015 the China Academy for Space Technology (CAST) briefed their roadmap at the International Space Development Conference (ISDC) where they showcased their road map to a 1 GW commercial system in 2050 and unveiled a video and description of their design. A proposal for the United States to lead in Space Solar Power has recently received high level attention after it won the D3 (Diplomacy, Development, Defense) competition sponsored by the Secretary of Defense, Secretary of State, and USAID Director. As of May 21, 2015, there was an on Change.org and a second active petition at Whitehouse website.



DISCONTINUATION

The project was not continued with the change in administrations after the 1980 US Federal elections. The Office of Technology Assessment concluded that "Too little is currently known about the technical, economic, and environmental aspects of SPS to make a sound decision whether to proceed with its development and deployment. In addition, without further research an SPS demonstration or systems-engineering verification program would be a high-risk venture."

In 1997 NASA conducted its "Fresh Look" study to examine the modern state of SBSP feasibility. In assessing "What has changed" since the DOE study, NASA asserted that the "US National Space Policy now calls for NASA to make significant investments in technology (not a particular vehicle) to drive the costs of ETO [Earth to Orbit] transportation down dramatically. This is, of course, an absolute requirement of space solar power."

Conversely, Dr. Pete Worden claimed that space-based solar is about five orders of magnitude more expensive than solar power from the Arizona desert, with a major cost being the transportation of materials to orbit. Dr. Worden referred to possible solutions as speculative, and that would not be available for decades at the earliest.

On Nov 2, 2012, China proposed space collaboration with India that mentioned SBSP, " . . . may be Space-based Solar Power initiative so that both India and China can work for long term association with proper funding along with other willing space faring nations to bring space solar power to earth.

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High Altitude Aeronautical Platforms (HAAPS)

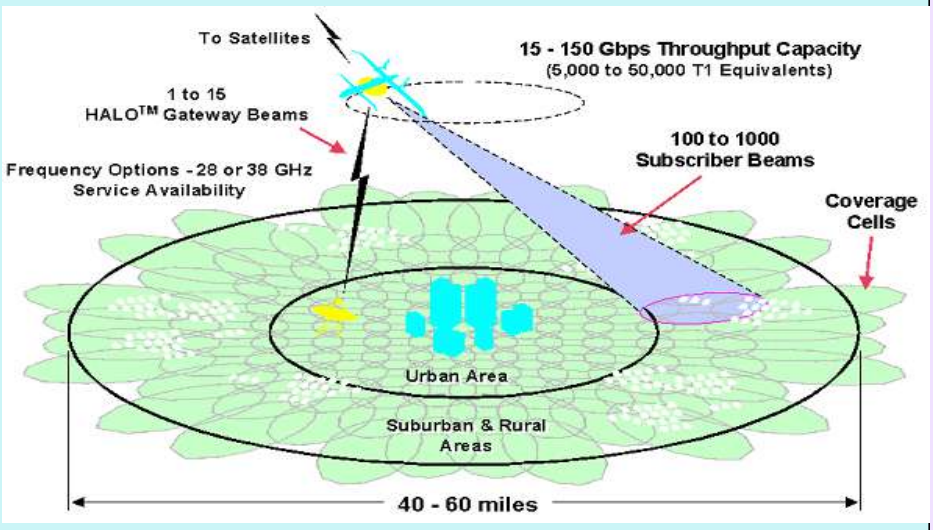
High Altitude Aeronautical Platform Stations (HAAPS) is the name of a technology for providing wireless narrowband and broadband telecommunication services as well as broadcasting services with either airships or aircraft's. The HAAPS are operating at altitudes between 3 to 22 km. A HAAPS shall be able to cover a service area of up to 1000 km diameter, depending on the minimum elevation angle accepted from the user's location. The platforms may be airplanes or airships (essentially balloons) and may be manned or un-manned with autonomous operation coupled with remote control from the ground. HAAPS mean a solar-powered and unmanned airplane or airship, capable of long endurance on-station possibly several years.

A high altitude telecommunication system comprises an airborne platform typically at high atmospheric or stratospheric altitudes with a telecommunications payload, and associated ground station telecommunications equipment. The combination of altitude, payload capability, and power supply capability makes it ideal to serve new and metropolitan areas with advanced telecommunications services such as broadband access and regional broadcasting. The opportunities for applications are virtually unlimited. The possibilities range from narrowband services such as paging and mobile voice to interactive broadband services such as multimedia and video conferencing.

For future telecommunications operators such a platform could provide blanket coverage from day one with the added advantage of not being limited to a single service. Where little or unreliable infrastructure exists, traffic could be switched through air via the HAAPS platform. Technically, the concept offers a solution to the propagation and rollout problems of terrestrial infrastructure and capacity and cost problems of satellite networks. Recent developments in digital array antenna technology make it possible to construct 100+ cells from one platform. Linking and switching of traffic between multiple high altitude platforms, satellite networks and terrestrial gateways are also possible. Economically it provides the opportunity for developing countries to have satellite-like infrastructure without the funds flowing out of the country due to gateways and control stations located outside of these countries.

ARCHITECTURE

The platform is positioned above the coverage area. There are basically two types of HAAPS. Lighter-than air HAAPS are kept stationary, while airplane based HAAPS are flown in a tight circle. For broadcast applications, a simple antenna beams signals to terminals on the ground. For individualized communication, such as telephony, "cells" are created on the ground by some beam forming technique in order to reuse channels for spatially separated users, as is done in cellular service. Beam forming can be as sophisticated as the use of phased-array antennas, or as straightforward as the use of lightweight, possible inflatable parabolic dishes with mechanical steering. In the case of a moving HAAP it would also be necessary to compensate motion by electronic or mechanical means in order to keep the cells stationary or to "hand off" connections between cells as is done in cellular telephony.



HALO Network Concepts

High-Altitude Long Operation (HALO) aircraft present a new layer in the hierarchy of wireless communications -- a 10-mile tall tower in the stratosphere above rain showers and below meteor showers (i.e., high above terrestrial towers and well below satellite constellations).

HALO airplane will be the central node of a wireless broadband communications network. The HALO Network, whose initial capacity will be on the scale of 10 Gbps, with a growth potential beyond 100 Gbps. The packet-switched network will be designed to offer bit rates to each subscriber in the multimegabit-per-second range.

The airplane's fuselage can house switching circuitry and fast digital network functions. A MMW antenna array and its related components will be located in a pod suspended below the aircraft fuselage. The antenna array will produce many beams -- typically, more than 100. Broadband channels to subscribers in adjacent beams will be separated in frequency. For the case of aircraft-fixed beams, the beams will traverse over a user location, while the airplane maintains stationary overhead, and the virtual path will be changed to accomplish the beam-to-beam handoff. The aircraft will fly above commercial airline traffic, at altitudes higher than 51,000 feet. For each city to be served, a fleet of three aircraft will be operated in shifts to achieve around-the-clock service. Flight operational tactics will be steadily evolved to achieve high availability of the node in the stratosphere.

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The High Altitude Long Operation (HALO) Network is a broadband wireless metropolitan area network (MAN) consisting of HALO aircraft

operating at high altitude and carrying an airborne communications network hub and network elements on the ground.

The HALO Network combines the advantages of two well-established wireless communication services: satellite networks and terrestrial wireless networks like cellular and personal communication systems. Satellite networks was deployed at low earth orbit (LEO), medium earth orbit (MEO), high elliptic orbit (HEO), and geosynchronous earth orbit (GEO) . Their disadvantages include expensive high-power user terminals, long propagation delays. Also, system capacity will be practically fixed and can be increased incrementally only by adding satellites. In contrast, terrestrial wireless networks have advantages such as low-cost, low-power user terminals, short propagation delays, and good scalability of system capacity. However, their disadvantages include low look angles and complex infrastructures. They require many base stations that must be interlinked over cables or microwave links. They often require significant re-engineering to increase capacity when using cell-splitting techniques.

The HALO network will be located in the atmosphere, at an altitude of 15 miles above terrestrial wireless, but hundreds to thousands of miles below satellite networks. It will provide broadband services to businesses and small offices/ home offices in an area containing a typical large city and its neighbouring towns. To each end user it will offer an unobstructed line of sight and a free-space-like channel with short propagation delay, and it will allow the use of low-power low-cost user terminals.

The HALO network infrastructure is simple, with a single central hub. Consequently, the deployment of service to the entire metropolitan area can occur on the first day the network is deployed; and the subsequent maintenance cost is expected to be low. The system capacity can be increased by decreasing the size of beam spots on the ground while increasing the number of beams within the signal footprint, or by increasing the signal bandwidth per beam. The HALO network can interface to existing networks. It can operate as a backbone to connect physically separated LANs through frame relay adaptation or directly through LAN bridges and routers.

The HALO Network will be able to offer wireless broadband communications services to a "super metropolitan area," an area encompassing a typical large city and its surrounding communities. The aircraft will carry the "hub" of the network from which we will serve tens to hundreds of thousands of subscribers on the ground. Each subscriber will be able to communicate at multi-megabit per second bit rates through a simple-to-install user terminal. The HALO Network will be evolved at a pace with the emergence globally of key technologies from the data communications, millimetre wave RF, and network equipment fields.

The HALO aircraft will be operated in shifts from regional airports. While on the ground, the network equipment aboard the aircraft will be assessed, maintained and upgraded on a routine basis to ensure optimal performance. The HALO/Proteus airplane has been specially designed to carry the hub of the HALO Network. In the stratosphere, the airplane can carry a weight of approximately one ton. The airplane is essentially an equipment bus from which commercial wireless services will be offered. A fleet of three aircraft will be cycled in shifts to achieve continuous service. Each shift on station will have an average duration of approximately eight hours. The HALO/Proteus airplane will maintain station at an altitude above 51 Kilo in a volume of airspace.

The look angle, defined to be the angle subtended between the local horizon and the airplane with the user terminal at the vertex; will be greater than a minimum value of 20 degrees. (The minimum look angle (MLA) for a given user terminal along the perimeter of the service footprint is defined to occur whenever the airplane achieves the longest slant range from that terminal while flying within the designated airspace.) Under these assumptions, the Many types of organizations schools, hospitals, doctors' offices, and small to medium-size businesses around the world will benefit from the low pricing of broadband services provided by the HALO Network. Standard broadband protocols such as ATM and SONET will be adopted to interface the HALO Network as seamlessly as possible. The gateway to the HALO Network will provide access to the Public Switched Telephone Network (PSTN) and to the Internet backbone for such services as the World Wide Web and electronic commerce. The gateway will provide to information content providers a network-wide access to a large population of subscribers

DESIRABLE FEATURES

Some desirable features of the HALO Network include the following:

- Seamless ubiquitous multimedia services
- Adaptation to end-user environments
- Rapidly deployable to sites of opportunity
- Bandwidth on demand for efficient use of available spectrum.

Signal footprint will cover an area of approximately 2,000 to 3,000 square miles, large enough to encompass a typical city and its neighboring communities. Such a high value for the MLA was chosen to ensure a line-of-sight connection to nearly every rooftop in the signal footprint and to ensure high availability during heavy rainfall.

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Skin put Technology

Devices with significant computational power and capabilities can now be easily carried on our bodies. However, their small size typically leads to limited interaction space (e.g., diminutive screens, buttons, and jog wheels) and consequently diminishes their usability and functionality. Since one cannot simply make buttons and screens larger without losing the primary benefit of small size, one has to consider alternative approaches that enhance interactions with small mobile systems.

One option is to opportunistically appropriate surface area from the environment for interactive purposes. For example, there is a technique that allows a small mobile device to turn tables on which it rests into a gestural finger input canvas. However, tables are not always present, and in a mobile context, users are unlikely to want to carry appropriated surfaces with them (at this point, one might as well just have a larger device). However, there is one surface that has been previously overlooked as an input canvas and one that happens to always travel with us: our skin.

Appropriating the human body as an input device is appealing not only because we have roughly two square meters of external surface area, but also because much of it is easily accessible by our hands (e.g., arms, upper legs, torso). Furthermore, proprioception –the sense of how our body is configured in three-dimensional space – allows us to accurately interact with our bodies in an eyes-free manner. For example, one can readily flick each of the fingers, touch the tip of the nose, and clap hands together without visual assistance. Few external input devices can claim this accurate, eyes-free input characteristic and provide such a large interaction area.

In this paper, a method that allows the body to be appropriated for finger input using a novel, non-invasive, wearable bio -acoustic sensor is presented; namely Skinput. The contributions of this paper are:

•Description of the design of a novel, wearable sensor for bio-acoustic signal acquisition.

•An analysis approach that enables to resolve the location of finger taps on the body.

•Assessment of the robustness and limitations of this system through a user study.

•Exploration of the broader space of bio-acoustic input through prototype applications and additional experimentation.

HARDWARE ARCHITECTURE

To expand the range of sensing modalities for always available input systems, a novel input technique that allows the skin to be used as a finger input surface is described in this paper and is named as Skin put. In this prototype system, the focus is on the arm (although the technique could be applied elsewhere). This is an attractive area to appropriate as it provides considerable surface area for interaction, including a contiguous and flat area for projection (discussed subsequently).

Furthermore, the forearm and hands contain a complex assemblage of bones that increases acoustic distinctiveness of different locations. To capture this acoustic information a wearable armband that is non-invasive and easily removable is developed. In this section, the mechanical phenomenon that enables Skinput is discussed, with a specific focus on the mechanical properties of the arm. The Skinput sensor and the processing techniques used to segment, analyze, and classify bio-acoustic signals are studied in this section.

Major Components are

Bio-Acoustics

Sensing

Armband Prototype

Processing

APPLICATIONS

•A method for controlling an iPod with skin-touch based input to select music tracks while jogging.

•It turns the fingers into a controller for the game of Tetris.

•It may be used for dialing your phone on your arm.

ADVANTAGES

The projected interface can appear much larger than it ever could on a device's screen. One can also bring his arm closer to the face (or vice versa) to see the display close up. Dimming the lights creates an even greater color contrast if skin and the text are too similar in color during daylight.

The arm band isn't out yet, but it could dramatically affect the amount of seniors who could successfully operate such cell phones and iPods, seeing how small fonts and screens, not to mention pint-sized buttons and controllers, provide significant barriers for many with failing eyesight or poor motor skills.

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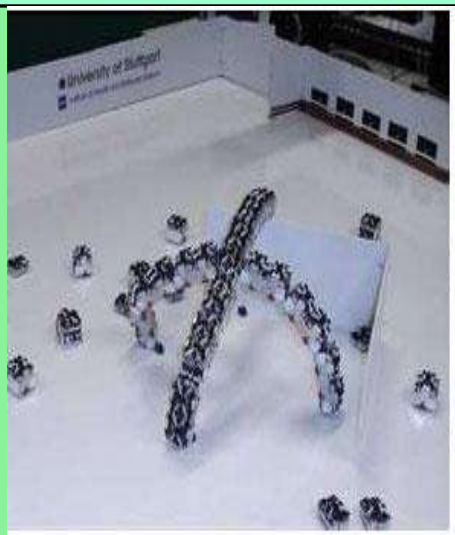
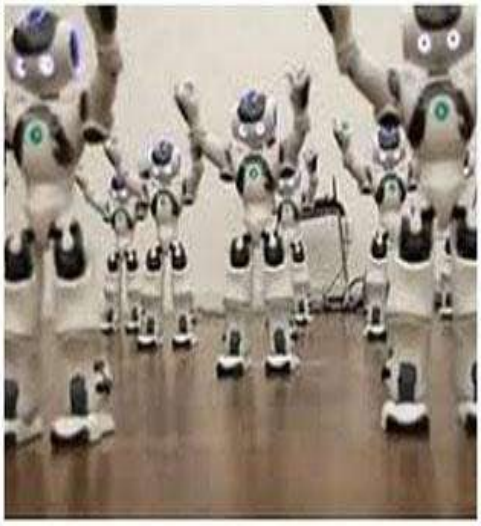
Swarm Intelligence Systems and Application





Swarm intelligence is the emergent collective intelligence of groups of simple autonomous agents. Here, an autonomous agent is a subsystem that interacts with its environment, which probably consists of other agents, but acts relatively independently from all other agents. The autonomous agent does not follow commands from a leader, or some global plan.

For example, for a bird to participate in a flock, it only adjusts its movements to coordinate with the movements of its flock mates, typically its neighbors that are close to it in the flock. A bird in a flock simply tries to stay close to its neighbors, but avoid collisions with them. Each bird does not take commands from any leader bird since there is no

lead bird. Any bird can fly in the front, center or back of the swarm. Swarm behavior helps birds take advantage of several things including protection from predators (especially for birds in the middle of the flock), and searching for food (as each bird is essentially exploiting the eyes of every other bird).

During the course of the last 20 years, researchers have discovered the variety of interesting insect and animal behaviors in nature. A flock of birds sweeps across the sky. A group of ants forages for food. A school of fish swims, turns, flees together etc. We call this kind of aggregate motion Swarm behavior. Recently, biologists and computer scientists have studied how to model biological swarms to understand how such social animals interact, achieve goals, and evolve.

Furthermore, engineers are increasingly interested in this kind of swarm behavior since the resulting swarm intelligence can be applied in optimization (e.g. in telecommunication systems), robotics track patterns in transportation systems, and military applications. A high-level view of a swarm suggests that the N agents in the swarm are cooperating to achieve some purposeful behavior and achieve some goal. This apparent collective intelligence seems to emerge from what are often large groups of relatively simple agents. The agents use simple local rules to govern their actions and via the interactions of the entire group, the swarm achieves its objectives. A type of self organization emerges from the collection of actions of the group.

PRINCIPLES OF SWARM INTELLIGENCE

The objective of this engagement is to provide a comprehensive assessment of the state of the art in Swarm Intelligence; specifically the role of stigmergy in distributed problem solving. In order to do this, working definitions have to be provided along with the essential properties of systems that are swarm-capable; i.e. problem solving is an emergent property of a system of simple agents. The principle of stigmergy implies the interaction of simple agents through a common medium with no central control. This principle implies that querying individual agents tells one little or nothing about the emergent properties of

Consequently, simulation is often used to understand the emergent dynamics of stigmergic systems. Stigmergic systems are typically stochastic in nature; individual actions being chosen probabilistically from a limited behavioral repertoire. Actions performed by individual agents change the nature of the environment; for example a volatile chemical called a pheromone is deposited. This chemical signal is sensed by other agents and results in modified probabilistic choice of future actions.

The advantages of such a system are clear. Being a system in which multiple actions of agents are required for a solution to emerge, the activity of an individual agent is not as important. That is, stigmergic systems are resilient to the failure of individual agents and, more importantly still react extremely well to dynamically changing environments. Optimal use of resources is often a significant consideration in designing algorithms.

Design by

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Si Nano wire Based Solar Cells

Solar cell is thin Si wafer of size 10 x 10 cm, size of a CD. Thickness is in fractions of mm and metal pattern is to make electrical contacts. Solar Cells are Safe, Clean, Durable, Reliable, Quiet and Installable anywhere.

Energy Conversion in Solar cell

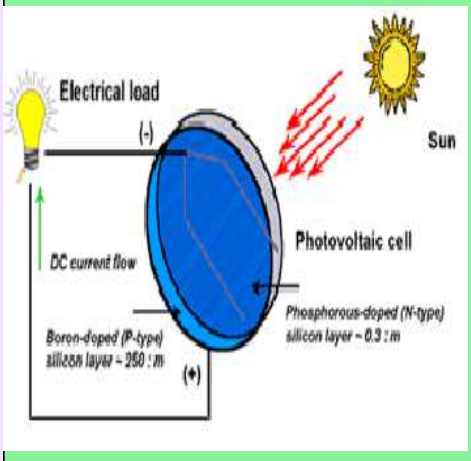
Conversion takes place in following steps

1) Light is shone
2) Electrons are knocked out
3) Electrons and holes move in opposite directions
4) Electrical output is generated between the contacts

Planar Silicon Solar Cells are used for an efficient light absorption. It also provides high purity to avoid recombining. High Reflectance. High Recombination Rate. When they are sliced into Nano-scale, they have a diameters from 1 to 50nm. Nano scale Silicon has a color difference. Nano sized Silicon shows Physical properties, Optical properties, Electronics properties change and Electrons occupy different energy levels.

NANOWIRE PROPERTIES

1) No Lattice Mismatch.



2) Flexibility to create hetero structures.
3) Broad range of materials.
4) Integration of compound semiconductor based optoelectronic devices with silicon based microelectronics.

Si Nanowires Properties

1) Light Trapping - Light falling on the substrate gets reflected and once again gets absorbed by silicon nanowires.
2) Increased Surface Area - Very narrow pointed structures. Diameter in nanometers. Length in micrometers. Greater area made of p-n junctions is exposed to sunlight. Increases absorptivity.
3) Reduced Size
4) Increased absorptivity
5) Reduced Reflectivity
6) Efficient electron transport
7) Reduced recombination

Doping in Nanowires use a catalyst that by itself causes doping. Adding dopants to the catalyst so that dopant atoms will be released and incorporated into the nanowires during growth. Supplying dopant in the form of gaseous precursor while CVD growth. Better controllability and widely used for Si. After doping, thermal treatment required for activation. Junction Formation - The shell or p-n junction in SiNW can be formed by, Diffusion of opposite dopants. But if temperature is high or time is long, doping of the entire nanowire can get reversed. Thin-film deposition of opposite carrier type.

Patterned Chemical Etching

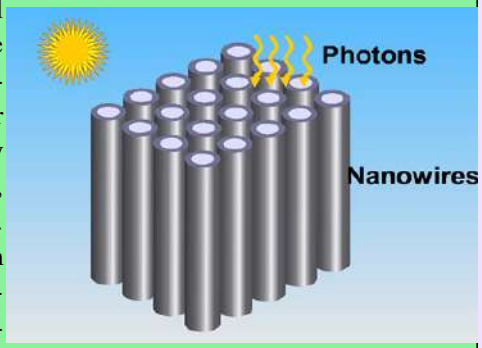
Dip coat n-type Si wafer in aqueous silica bead solution. Formation of a closely packed mono-layer. Deep Reactive Ion Etching using the beads as etch mask to form nanowires. Bead removal in HF and Boron diffusion to form the radial p-n junction.

Benefits of Nanowire geometry

Radial charge separation increases defect tolerance for radial junction. Natural anti reflective structure; Enhanced light trapping and absorption. Relaxed inter-facial strain. Single-crystalline synthesis on non -epitaxial substrates. Solar cells are less expensive and use fewer natural resources. The radial junction nanowire geometry, opening up the possibility to use a small amount of abundant, nontoxic, low cost material to make solar cells with performance close to that of current planar technology. The ability to make single-crystalline nanowires on low cost substrates such as aluminium foil and to relax strain in subsequent epitaxial layers removes two more major cost hurdles associated with high efficiency planar solar cells.

Limitations of sensing with Silicon nanowire FET devices

Generally, the charges on dissolved molecules and macromolecules are screened by dissolved counter ions, since in most cases molecules bound to the devices are separated from the sensor surface by approximately 2–12 nm (the size of the receptor proteins or DNA linkers bound to the sensor surface). As a result of the



screening, the electrostatic potential that arises from charges on the analyte molecule decays exponentially toward zero with distance. Thus, for optimal sensing, the Debye length must be carefully selected for nanowire FET measurements.

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