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The human hand is a complex system, with a large number of degrees of freedom (DoFs), sensors embedded in its structure, actuators and tendons, and a complex hierarchical control. Current prosthetic hands have limited functionality and are cost prohibitive. The novel design incorporates five individually actuated fingers in addition to powered thumb roll articulation, which is unseen in commercial products. The old commercial products having one or two DoFs while BeBionic's new novel design contains six DoFs. Fingertip grip force is displayed via LEDs for feedback control. The hand contains a battery and micro-controller. Multiple options for signal input and control algorithms are presented. A prototype will serve as a platform for future programming efforts.

keywords
Prosthetic hand, Degrees of freedom (DoFs)

INTRODUCTION

The design of fully functioning artificial hand replacements with physiological speeds-of-response and strength (or better) that can be controlled almost without thought is the goal of upper extremity prosthetics research. Unfortunately, current prosthetic components and interface techniques are still a long way from realizing this goal. The current state-of-the-art prosthesis can be considered to be a tool rather than a hand replacement. The major factors limiting prostheses to tools are practical ones due to the severe weight, power, and size constraints of hand/arm systems as well as the difficulty in finding a sufficient number of appropriate control sources to control the requisite number of degrees of freedom. Of these, it is the lack of independent control sources that imposes the most severe impediment to the development of today’s prosthetic hand/arm systems. The design of artificial arms and hands is a multidisciplinary endeavour. The design team needs an understanding of the mechanics of mechanisms, such as gears, levers, and points of mechanical advantage, and electromechanical design, such as switches, dc motors, and electronics. 'Mechatronics' is the new word used to describe this marriage of mechanical and electronic engineering. In addition to mechatronics, the prosthetics designer must also have knowledge of musculoskeletal anatomy and muscular-as well as neurophysiology.

1 MECHANICAL DESIGN

1.1 Finger Linkage Design

The finger design process began with determining what motion was required for each finger. The human hand was simply viewed gripping various household objects such as a cup and marker commonly found in a person’s daily routine. The location of the various joints were measured and translated to drawings. The four main fingers can also be spread apart sideways and rolled slightly culminating in an impressively large amount of total degrees of freedom. Fortunately, to perform the majority of common gripping tasks, only a small amount of motion should actually be required. The human finger achieves a conformal adaptive grip by bending the knuckles as an object is grasped.
1.2 Finger Joint Design

Once the finger motion assembly was chosen, the next step was to choose how to power that finger joint. Electric DC motors are by far the simplest and best option for this application. In the ideal world, a user would be able to command a finger to go to a location and the finger would be able to stay there without constantly applying power. For example, if a heavy tool is to be grasped, the hand would close its fingers around that object until it is held securely. Once the sufficient gripping force is achieved, the motors would stop. In a traditional electric motor situation, a constant voltage would have to be applied to a stalled motor in order to produce a constant output force. This would be very bad for the system because it would be inefficient and constantly wasting available power. Additionally, almost no electric motors can handle being stalled for even short periods of time, even at low power; motors are not designed to be heaters. Therefore, the proper mechanical drive train would include some type of active braking or force holding aspect which would somehow allow the motor to be turned off without having the fingers move when force is applied.

Worm gears stood out as a clear option for a system of this nature. Worm gears provide very high reductions in small spaces, and they also have non-back driving tendencies. In some mechanical systems that can be a problem, but in this system it would be a desired trait. Additionally, a worm gear transmission isolates mechanical shock to the input gear only, and nothing before the input gear, so a motor would be protected from system shocks. Worm gears however have one major drawback, they are very inefficient. Common worm gears have 1 screw start, or “lead”, and rely on sliding friction between the input worm and the driven worm gear. Efficiencies of 50% are considered common even with low friction brass gears, compared to 95-98% efficiencies common in spur gear transmissions.

1.3 Motor Design

Proper motor selection was an important aspect of this design because all 6 degrees of freedom could be powered by the same type of motor. A range of different motors were compared based on their speed and torque in addition to their size and cost/availability. The Pololu DC brushed gear motors are a perfect fit for this application. They are very tiny, yet still quite powerful. They are convenient to work with by have 2 face mount screws, and a flatted output shaft. The best feature of these motors though is the fact that Pololu offers dozens of different gear reductions all in the same motor package size. This means that even after the entire hand has been built and tested, if it is discovered that there is too much friction in the system and more torque is needed, a new motor can simply be swapped in and nothing else on the design would have to change.

1.4 Compound Thumb Design

Once the main finger gearboxes and components had been designed, the most challenging aspect of the novel prosthetic hand was evaluated. The process of designing the thumb joint began similar with finger but by placing a duplicate finger gearbox into the rough hand assembly, replacing the finger which has two links with a single jointed thumb shape. The initial placement highlighted the difficulty of packaging so many motors and moving parts into such a confined area. Several thumb positions had to be examined: a pinching position aligned with the index finger, a fist with fingers overlapping, and the thumb rotated up into a key grip position. The thumb should also be made of polycarbonate and be flexible enough to act as a spring in order to apply a constant holding
force without active power application. The other primary thumb position would be when the thumb is rotated up to perform a key grip. The thumb would be very useful for holding onto a spoon or fork when it pushes down onto the side of a partially closed index finger. Therefore, the thumb needed to be able to satisfy those three main conditions.

2 CONTROL CONSIDERATION

2.1 Electronic Speed Controller

When selecting the proper speed controller for your application, you must look at your required voltage, maximum current draw, average current draw and features. In this case, the features required are full forward and reverse (some small speed controllers are 1 direction only designed for remote control airplanes), good low speed control, and PWM input, the remote control and hobby signal input standard. In this case, the FingerTech Robotics “TinyESC” stands out as simply the best controller for this application. The designer of this controller wanted to make the device as small and light as possible so it could fit into miniature robots. These controllers have been used reliably for years in combat robots such as 1 and 3 lb Battlebots with much success and a proven track record. At a tiny 0.16 oz including long wires. The TinyESC’s are a perfect match for the prosthetic hand.

2.2 Microcontroller Selection

The Arduino family of microcontrollers has recently become the standard hobbyist and robot controller for its low cost, large amount of features, and ease of use. The single greatest reason why it is so popular though is because there are thousands of code libraries and examples from various people’s projects. There is a tremendous network of community support and online forums where troubleshooting and examples are discussed. For these reasons, it seemed obvious to design the hand around one of the Arduino microcontrollers. The Pro Mini is essentially perfect for this application of limited space. There are no connectors attached, so wires can be hard soldered to the board for the absolute smallest size possible. It is difficult to find another controller with the same amount of analog inputs in anything close to this size or cost.

Features:
- Dimensions: 0.7x1.3” (18x33mm)
- Atmega328 running at 16MHz with external resonator (0.5 MHz)
- USB connection off board
- Supports auto-reset
- 5V regulator
- Max 150mA output
- Over current protected
- Weighs less than 2 grams
- Reverse polarity protected
- DC input 5V up to 12V
- On board Power and Status LEDs
- Analog Pins: 8
- Digital I/Os: 14 (Sparkfun Electronics, 2012)

3 CONTROL STRATEGY

3.1 Attributes

1. Low mental loading or subconscious control. The prosthesis should be able to be used without undue mental involvement. The prosthesis should serve the user; the user should not be the servant of the prosthesis

2. User friendly or simple to learn to use. Any device should be intuitive and natural. An amputee should be able to learn to use the prosthesis quickly and easily.

3. Independence in multifunctional control. Control of any function or degree of freedom, should be able to be executed without interfering with the other control functions of a multifunctional prosthesis.

4. Simultaneous, coordinated control of multiple functions (parallel control). User should have the ability to coordinate multiple functions simultaneously in effective and meaningful ways without violating the first and third attributes.

3.2 Myoelectric Control

3.2.1 Myoelectric

Myoelectric control derives its name from the electromyogram (EMG), which it uses as a control input.
When a muscle contracts, an electric potential (the EMG) is produced as a by-product of that contraction. If surface electrodes are placed on the skin near a muscle, they can detect this signal. The signal can then be electronically amplified, processed, and used to control prosthesis. While the intensity of the EMG increases as muscle tension increases, the relationship is a complex nonlinear process that depends on many variables, including the position and configuration of the electrodes. Although the EMG is nonlinear it is broadly monotonic, and the human operator perceives this response as more or less linear. In most current EMG systems, the signal data is then segmented into small intervals of which features (i.e. characteristic parameters related to user intent) are extracted. Several parameters in the time, frequency, and time-frequency domains can be used as features, such as the root mean square, mean absolute value, mean frequency, and wavelet transform coefficients. Detection of a certain number of intended actions requires the same number of unique muscle activity patterns. Each pattern is described by a specific set of features that are entered into a classifier, which determines the movement intended by the user. A grasp type determines two things: the starting pose of the hand, and the relative timing between flexion of the individual fingers and thumb. When a certain grasp type is detected by EMG sensing, the control system will automatically move the relevant joints to their starting angles. This process is called pre-shaping. Once the grasp is pre-shaped, hand opening/closing and wrist movement signals control the execution of the grasp. The interaction between high level EMG user input and low-level prosthesis control signals can be described by a set of state machines. Through the control signals contained in the sensing vector, the user can change the state of the control system, which determines the automated low-level behaviour of the prosthesis.

### 3.2.2 Signal Processing

A conventional myoelectric processing stream consists of differentially amplifying and band limiting the EMG signal. The amplified signal is then changed into a dc signal by rectification, by full wave rectification, root mean squaring (RMS), or some other appropriate nonlinear processing. The rectified signal is then filtered to obtain the envelope of the EMG signal. This voltage level can then be fed to the motor as a dc voltage level. All these processing steps introduce time delays into the overall control loop. The major delay is introduced by the time constant of the smoothing (envelope) filter circuit. These delays can in turn reduce the bandwidth of the entire motor controller system.

Surface EMG signal amplitude (RMS) is approximately 100 μV for a moderately contracted forearm muscle. This signal must be amplified to a signal with an amplitude in the range 1 to 10 V before it can be used. This implies that a gain of upward of 10,000 is needed. The bandwidth for the surface EMG signals is 10 to 300 Hz, with most of the signals’ energy in and around 100 Hz. Differential amplifiers are used to amplify the EMG signal because the small EMG signal is often superimposed on large common-mode signals that, at these gain levels, would saturate an amplifier in a single-mode configuration.
### 3.2.3 Myoelectrodes

Most commonly used myoelectrode is Platinum alloy electrode. As it is cheaper in cost than other surgical electrodes. Electrodes should be choosing like that it reduce the cost for the total system and the complications. The specification as given below.

**Specifications:**

- **Electrode material:** Platinum alloy
- **Number of electrodes:** Two
- **Exposed contact area per electrode:** 3.68 mm (0.125”) diameter (10.64 mm2) Spacing between contacts: 10.0 mm (0.3937”) center of distal disk to center of proximal disk
- **Lead wires:** Fluoropolymer insulated 316 SS lead wires, coiled and tubed in silicone Lead OD: 1.27mm (0.050”) OD of silicon tubing

![Figure 10: Robotic human hand](image)

### Conclusion

The ease of manufacturing of the components for one hand was proven by having outside companies actually produce the parts needed. It is clear that there are going to soon be many more prosthetic hand options as more companies decide to enter the market and produce competitive hands. A lasting test platform has been developed which will make programming and algorithm development have real functional tests. With the commonly available hobby and remote control industry components developed today, there is less need to seek out the absolute top of the line precision industrial components. In a large company there is a standard way of designing and creating new systems, and that mostly involves using the highest level of components possible because the designers are not directly paying for the research and development, nor do that care much about the final cost of a high end item. When an individual designs a new system, not working for a company, they are able to challenge traditional design and manufacturing methods to produce an equivalent product more quickly and easily.

### References

Fractal Robots is an emerging new service that promises to revolutionize every aspect of human technology. Fractal robots are objects made from cubic bricks that can be controlled by a computer to change shape and reconfigure themselves into objects of different shapes. These cubic motorized bricks can be programmed to move and shuffle themselves to change shape to make objects like a house potentially in a few seconds. This technology has the potential to penetrate every field of human work like construction, medicine, research and others. Fractal robots can enable buildings to be built within a day, help perform sensitive medical operations and can assist in laboratory experiments. This technology is called Digital Matter Control and is implemented here with a machine called robotic cubes and the entire technology is called Fractal Robot Technology. Also Fractal Robots have built-in self-repair which means they can continue without human intervention.

keywords
Keywords:- Robotic cube, Contact pads, Self-repair.

INTRODUCTION

The birth of every technology is the result of the quest for automation of some form of human work. This has led to many inventions that have made life easier for us. Fractal Robot is a science that promises to revolutionize technology in a way that has never been witnessed before. The principle behind Fractal Robots is very simple. You take some cubic bricks made of metals and plastics, motorize them, put some electronics inside them and control them with a computer and you get machines that can change shape from one object to another. Almost immediately, you can now build a home in a matter of minutes if you had enough bricks and instruct the bricks to shuffle around and make a house! It is exactly like kids playing with Lego bricks and making a toy hose or a toy bridge by snapping together Lego bricks—except now we are using computer and all the work is done under total computer control. No manual intervention is required. Fractal Robots are the hardware equivalent of computer software.

1 Fractal Robots

A fractal is anything which has a substantial measure of exact or statistical self-similarity. Wherever you look at any part of its body it will be similar to the whole object. The robot can be animated around its joints in a uniform manner. Such robots can be straight forward geometric patterns/images that look more like natural structures such as plants.

2 Construction details

Considerable effort has been taken in making the robotic cubes as simple as possible after the invention has been conceived. The design is such that it has fewest possible moving parts so that they can be mass produced. Material requirements have been made as flexible as possible so that they can be built from metals and plastics which are cheaply available in industrialized nations but also from...
ceramics and clays which are environmentally friendlier and more readily available in developing nations. The cube therefore is hollow and the plates have all the mechanisms. Each of these face plates have electrical contact pads that allow power and data signals to be routed from one robotic cube to another. The plates also have 45 degree petals that push out of the surface to engage the neighboring face that allows one robotic cube to lock to its neighbor.

3 Movement Mechanism

The petals are pushed in and out of the slots with the aid of a motor. Each petal could be directly driven by single motor or they could be driven as a pair with the aid of a flexible strip of metal. The petals have serrated edges and they engage into the neighboring robotic cube through the 45 degree slots.

4 Fractal Robot Control

The commands to control a fractal robot is the same as the commands to control a single robot which is move left, right etc. and hence the computer program to control the robot is greatly simplified in that whatever software that is developed for a large scale robot, it also applies to the smaller scale with no modifications to the command structure.

5 Movement Algorithms

There are many mechanical designs for constructing cubes, and cubes come in different sizes, but the actual movement method is always the same. Regardless of complexity, the cubes move only between integer positions and only obey commands to move left, right, up, down, forward and backward. If it can’t perform an operation, it simply reverses back. If it can’t do that as well, the software initiates self-repair algorithms. There are only three basic movement methods.

- Pick and place
- N-streamers
- L-streamers

6 Applications

- Bridge Building
- Defense Technology
- Medical Applications
- Space Exploration

Conclusion

It may take about 4-5 years for this technology to be introduced and tried out all over the world. But once the first step is taken and its advantages well understood it will not take much time for it to be used in our everyday life. Using Fractal Robots will help in saving economy; time etc and they can be used even for the most sensitive tasks. Also the raw materials needed are cheap, making it affordable for developing nations also. This promises to revolutionize technology in a way that has never been witnessed before.

References

The AVR Based Automatic Pot Hole Filling Robot

Ajinkya R. Chanshetty, Sharad P Dhamdhere, Arun D. Limgaonkar (Sonar), Sunil K. Patil
Department of Instrumentation Engineering, DYPIET, Pimpri, Pune-18

It is an AVR microcontroller based application of robot used for filling the potholes on the roads. Pothole patching methods are divided into two distinct categories, hot mix and cold mix. Just as the nomenclature suggests, cold mix is a suitable material for the winter months and hot mix is used during the warm spring and summer seasons. Both the hot and cold mix is applied with similar methods. The most widely used method is known simply as "throw-and-go". Basically the mixture is poured into the container and filled in that pothole with the help of robot. Mainly Infra red detectors are used for the detection of pothole. A pothole is being created on the path of a Robot. A robot detects it. A robot uses an embedded based program for its operation. The robot then takes the necessary action i.e. in which direction is it supposed to move, it then fills up the pothole and goes ahead.

keywords
AVR Microcontroller (ATMEGA16), IR detector, DC motor, Servo motor, PCB

INTRODUCTION
A pothole (sometimes called a kettle and known in parts of the Western United States as a chuckhole) is a type of disruption in the surface of a roadway where a portion of the road material has broken away leaving a hole. Most potholes are formed due to a fatigue of the road surface. As fatigue fractures develop they typically interlock in a pattern known as crocodile cracking. The chunks of pavement between fatigue cracks are worked loose and may eventually be picked out of the surface by continued wheel loads thus forming a pothole.

The formation of potholes is exacerbated by low temperatures as water expands when it freezes to form ice and puts greater stress on an already cracked pavement or road. Once a pothole forms, it grows through continued removal of broken chunks of pavement. If a pothole fills with water the growth may be accelerated, as the water "washes away" loose particles of road surface as vehicles pass. In temperate climates, potholes tend to form most often during rainy spring months when the sub grade is weak due to high moisture content causing sinkholes and by corroded sewer pipes. However, potholes are a frequent occurrence anywhere in the world, including in the tropics. Potholes can grow to feet in width, though they usually only become a few inches deep, at most. If they become large enough, damage to tires and vehicle suspensions occurs. Serious road accidents can occur as a direct result, especially on motorways where vehicle speeds are greater. They are frequently almost invisible to road users. Pothole patching is the process of repairing an asphalt based road imperfection. Pothole patching is a year-round activity performed by city and county street department crews to maintain the area’s roads and bridges. Pothole patching methods are divided into two distinct categories, hot mix and cold mix. Just as the nomenclature suggests, cold mix is a suitable material for the winter months and hot mix is used during the warm spring and summer seasons. Both the hot and cold mix is applied with similar methods. The most widely used method is known simply as "throw-and-go".

The patching mix is thrown into the pothole along with any debris or water present and compacted with the shovel by manual labor. This method is widely utilized due to the easy application and high rate of production, but the failure rate is extremely high. The next step in a higher quality application is the "throw-and-roll". In the throw-and-roll method, the patching mix is once again thrown into the pothole manually regardless of any water or debris. Next, a truck slowly drives over the repaired pothole and the mix is compacted. The goal is for the compacted patch to have a crown in the range of 0.125-0.25". This process will take approximately two more minutes per pothole compared to the throw-and-go method. Al-
though more time consuming, it makes for a more durable patch due to the compaction of the patching mix with the truck tire. The best-known pothole patching method is the semi-permanent repair. In this method, the pothole is completely removed of any water or debris. Next, the pothole needs to be squared. All uneven edges will be cut with a pavement saw making the hole into a square or rectangular shape. The pothole is cleaned once again before the patching mix is applied. Finally, the area is compacted with a single drum roller or a vibratory plate compactor.

The semi-permanent method provides the tightest and longest lasting patch. However, it is more time consuming and requires more workers and equipment in the field. One variation of this method involves the use of a forty kilowatt or larger propane torch (these are also known as "roofing torches"). The torch is used to dry and heat the pothole and once the hole has been dried and warmed it is painted with bonding compound or "tack".

Tarmac is then applied and compacted as above. The method is used by some council in England. When done properly such a repair may last as many years as a throw-and-go will last weeks. During the "semi-permanent" repair, a material known as a "tack" may also be used. Tack is a liquid form material used to promote adhesion of the pothole patch mix and the pothole surface. If tack is utilized during the repair, it is either sprayed or brushed on the clean and squared pothole. Next, the pothole patching mix is applied and compacted in the desired method and a final coat of the tack is sprayed on top of the patch overlapping the edges a few inches.

According to the Federal Highway Administration, whichever method is used, patches applied in the winter months typically will not hold up as well as patches applied during the warmer months. The goal for winter patching should be to repair the road as quickly as possible to increase the safety and comfort of the roads. With that stated, the throw-and-go method is favorable as long as a high quality material is utilized. The goal is to fully repair the road and create patches that will last to the extent of the road’s life.

1 Design Objective and Technical Challenges

1.1 Other constraints –

- The application assumes that there is no alternate path available for traversing.
- The alternate path is devoid of potholes.

- Restricted size of potholes.

1.2 Motivation:

Reduction in:

- Man power.
- Maintenance of Vehicles.
- Losses of fragile goods in transportation.

2 System Model

2.1 Sensor Circuit

The resistance of the sensor decreases when IR light falls on it. A good sensor will have near zero resistance in presence of light and a very large resistance in absence of light. We have used this property of the sensor to form a potential divider. The potential at point 2 is Rsensor/(Rsensor + R1). Again a good sensor circuit should give maximum change in potential at point ‘2’ for no-light and bright-light conditions. IR sensors are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance - the more the bend, the more the resistance value. They are usually in the form of a thin strip from 1”-5” long that vary in resistance from approximately 10 to 30 kilo-ohms. They are often used in gloves to sense finger movement. The IR point Bend Sensor was developed through testing a thin potentiometer which would show analog feedback from finger movement. The bend-sensitive carbon-based ink was developed at that point IR Distance sensors are a low-cost, easy to use analog distance sensor. IR sensors produce a constantly updated analog output signal depending upon the intensity of the reflected IR, which in turn can be used to calculate approximate range. These sensors are perfect for obstacle avoidance, line following, and even map building! Browse a large selection of IR Sensors with different distance ranges, applications, and output types.

2.2 Working

In our project we are using AT mega 16 AVR microcontroller. The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. It is having 40 pins. By execution of powerful instructions in a single clock cycle, the ATmega16 achieves
throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The detection of pot hole is done by IR sensor. It has a emitter n receiver ports. As the pot hole is detected the LED starts to glow. The motion of motor starts in forward and backward direction as per the position of the pot hole. The flipper is opened by the servo motor, and the soil falls in the pot hole. Then the robot moves in the backward direction and rolls the soil twice to thrice.

2.2.1 Power Supply
The basic step in the designing of any system is to design the power supply required for that system. The steps involved in the designing of the power supply are as follows,

1. Determine the total current that the system sinks from the supply.
2. Determine the voltage rating required for the different components.

2.3 Features of Designed Robot

2.3.1 Advantages
The Designed Robot has following Advantages

- It reduces requirement of man power as it is automatically operated.
- It helps in the maintenance of vehicles.
- It can be safely operated and is secure in nature.
- It reduces the possibility of losses of fragile goods during transportation.
- Higher level of skill is not required for its operation.
2.3.2 Disadvantages

The Designed Robot has following Disadvantages

- The test’s procedures can be sometimes time consuming.
- Actual Testing requires an arrangement called “Erina”.

2.3.3 Applications

The Designed Robot has following applications

- It is helpful for the automatic seed plantation in agriculture industry.
- It can be also implemented for emergency services for pot hole filling on roads.

2.3.4 Future Scope

The performance of the proposed Robot can be enhanced by-

- Connecting Front Camera to avoid accidents.
- Siren (alarm) can be implemented for indication of pot hole detection.

3 Results and Discussion

4 Conclusion

With the the Development of Robot -

- The aim for the atomization in manufacturing units by the mean of employing process or sequence of programmed operation with little or no human labor using electro-mechanical techniques is successful.
- The goal of less or no probability of error; with real time management is achieved.
- Easy operating format by use of computer is obtained.
- Elimination of the stressed watch by human operators on systematic working to achieve desired production in the industry is made.
- By developing an autonomous nature of the system, the same is made a reliable one.
- A solution for the simultaneous accomplishment of assembling work done in the industries by the means of single computes has not only provided ease in operation but also provides autocratic nature for monitoring purposes is designed.

References


Wireless Smart Sensors

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Smart environments represent the next evolutionary development step in building, utilities, industrial, home, shipboard, and transportation systems automation. Like any sentient organism, the smart environment relies first and foremost on sensory data from the real world. Sensory data comes from multiple sensors of different modalities in distributed locations. The smart environment needs information about its surroundings as well as about its internal workings; this is captured in biological systems by the distinction between exterioreceptors and proprioceptors.

PDA BSC (Base Station Controller, BST Preprocessing). Intelligent wireless sensor-based controls have drawn attention of the industry on account of reduced costs, better power management, ease in maintenance, and effortless deployment in remote and hard-to-reach areas. They have been successfully deployed in many industrial applications such as maintenance, monitoring, control, security, etc. In this research, the focus is on the issues of portability, reliability, flexibility and robustness while using wireless connectivity in industrial applications such as instrumentation and predictive maintenance, and to design a workable solution. This paper extends our earlier work by expanding the scope of the applications; investigate design choices for the proposed system, and presents detailed experimental results of the implementations with their analysis.

INTRODUCTION

Intelligent wireless sensor-based controls have drawn attention of the industry on account of reduced costs, better power management and ease in maintenance. The challenges in the hierarchy of: detecting the relevant quantities, monitoring and collecting the data, assessing and evaluating the information, formulating meaningful user displays, and performing decision-making and alarm functions are enormous. The information needed by smart environments is provided by Distributed Wireless Sensor Networks, which are responsible for sensing as well as for the first stages of the processing hierarchy. The importance of sensor networks is highlighted by the number of recent funding initiatives, including the DARPA SENSIT program, military programs, and NSF Program Announcements. The figure shows the complexity of wireless sensor networks, which generally consist of a data acquisition network and a data distribution network, monitored and controlled by a management center. The plethora of available technologies makes even the selection of 1 components difficult, let alone the design of a consistent, reliable, robust overall system. The study of wireless sensor networks is challenging in that it requires an enormous breadth of knowledge from an enormous variety of disciplines. In this chapter we outline communication networks, wireless sensor networks and smart sensors, physical transduction principles, commercially available wireless sensor systems, self automation. The proposed Smart Sensor Platform is an attempt to develop a generic platform with ‘plug-and-play’ capability to support hardware interface, payload and communication needs of multiple sensors, and actuators. An RF link (Wi-Fi, Bluetooth, Mote or RFID) facilitates communications in a point-to-point topology. The design also provides means to update operating-, monitoring- pa-
rameters, operational thresholds, and sensor and RF link specific firmware modules ‘over-the-air’. It is composed of two main components – a sensor-wireless hardware interface and system integration framework, which facilitates the defining of interaction between sensors/actuators based on process needs. The intelligence necessary to process the sensor signals, monitor the functions against defined operational templates, and enable swapping of sensor and RF link, resides on the microcontroller of the hardware interface. A variety of industrial sensors (position, accelerometers, gyros, temperature, shock etc.) and actuators (motors) have been interfaced and successfully tested with the platform. The key contribution of this work is the versatility of the developed system and its ability to be configured for diverse applications. The system built using COTS components is modular, extendable and cost effective. These networks are equipped with an infrastructure that encompasses elements of monitoring, computing and communication and give to his manager that could be the government, civil, industrial and commercial sectors the ability of instrument, observe, and react to events and phenomena in a specified environment. WSSN tend to expand exponentially in a way so that these small devices can be easily deployed anywhere and collect any information from the environment. Since this technology is still emerging in the social, market penetration is still begging starting, but there are a number of research groups active in joining the study and monitoring of many phenomena. In this respect, there are already centers for collecting and processing data that are sending by the WSSN, this is the case of Sensor Signal and Information Processing Center (SENSIP) led by the University of Arizona in the United States. There are also research centers who are only working in this area is the case of Center for Embedded Networked Sensing (CENS) led by different universities in the United States. Parallel to this, the development of monitoring systems based on miniaturized micro solid state technology allows a large monitoring systems using Micro-Electro-Mechanical Systems (MEMS) sensors which include a type of nano scale electrical, thermal, mechanical, optical or flow, among others. On the other hand, the environmental monitoring is one of the main areas of application of this technology due to its characteristics that allow the measurement of parameters in different environmental settings such as crop management, protection of forest fires, agriculture, earthquakes, active volcano, it is also possible to use macro-instruments for measuring parameters of large-scale such as landslides, atmospheric meteorology, and finally pollution studies or even for planetary exploration.

**keywords**

CENS-Center for Embedded Networked Sensing
SENSIP-Sensor Signal and Information Processing Center
BSC-Base Station Controller

1 POTENTIAL INDUSTRIAL APPLICATIONS TO BENEFIT BY WIRELESS CONNECTIVITY:

The following are some of the industrial applications of interest for testing the smart sensor platform. Instrumentation applications are open/closed loop control applications, involving sensors and actuators, where the objective is to control certain parameters (e.g., speed and position), or state of the system. All the system elements may always be in communication with each other, requiring real time performance and their effect on the control parameters is defined. They also require in-built fault-tolerance capability to tackle communication/physical node failures. Predictive-maintenance involves tracking the state of equipment/machine/system, and to take action, if they enter a disallowed state. The state could be a diverse set from mechanical parameters (speed or position) to physical parameters (temperature, pH level, etc.). To conserve energy, these applications are not active all the time. They can be further categorized based on their payload transmission intervals into - event-based monitoring, periodic monitoring and store-and-forward systems. In event based monitoring, a strict violation condition is specified and breach (an event) of which ‘wakes’ the system to perform a pre-defined action such as recording the violation and/or issuing an alert. Rest of the time it remains in a passive or power save mode. In periodic monitoring, the state of equipment is periodically determined and a pre-defined action is performed - typically used to monitor equipment use or wear and tear profiles, keeping machine down-times low and help locate the problem before the machine breaks down. In, store and forward applications, the communication link is not available all the time and the system has to store the data and forward it when the link is available. The link unavailability can be due to channel problems - interference, noise, etc.; or to improve overall system performance - scheduling in a group to prevent data collision in an open access channel or for improving battery life by buffering the transmission data. The applications above employ different types of sensors and actuators (mentioned earlier), having different capabilities, interfaces, and supporting different protocols for data and communications. Formation of systems from such diverse distributed sensor elements entails versatile control modules. In addition, the operational challenges
are exacerbated when different RF links have to be used to satisfy the requirements of bandwidth, payload, delay, jitter, range, noise immunity and others (including cost) for communication.

overview

As discussed in the abstract, environmental monitoring systems require robust systems that enable to gathering data by geographical areas and therefore fairly extensive WSSN are one of the most active elements for environmental monitoring. In this regard, we propose an environmental monitoring system based on three key modules (Figure 1), the first module is based on WSSN given their characteristics and potential, the second one is a centralized system for data management, and the third one is composed of remote management and visualization systems that will help to check the environmental parameters. The first module is composed by WSSN that have platforms dedicated of instrumentation and acquisition of different variables for several environments. The second module is based on virtual instrumentation for easy compression and processing of data that is gathering by sensor nodes, this module is responsible for storage the activity generated by each of one the sensors that are in the sensors boards. Finally, for remote management and visualization system has been designed and implemented an application that works from several devices such as smart phones, PDA (Personal digital assistants), desktop PCs between others. This was thought it in this way to ensure a portability of data sensors, from whatever device hence his administrator has the possibility to check whatever parameter that are taking by WSSN.

Conclusion

The design and implementation of a wireless smart sensor platform targeted for instrumentation systems and predictive maintenance was discussed and presented. Tests were carried out to determine system performance for both the instrumentation and maintenance applications, and as the results suggest were quite satisfactory. The experimental results show that a sustained near-real-time system can be set up with the smart sensor nodes, and the versatility of the smart sensor interface allows implementing diverse applications. Future work for the smart sensor platform entails development of multi-hop networking capability among the heterogeneous-radio-equipped smart sensor nodes. A hierarchical network with gateway nodes, network aggregators and end-sensor-nodes is envisaged [20]. Zigbee with its excellent low-power capability provides an excellent alternative for Bluetooth and RFID in terms of power and performance. Support for Zigbee is currently being added and will be reported separately. Store-and-forward applications like cold-chain monitoring require a long-distance wireless link with network coverage over its entire operation area. GPRS with its wide area/long-range connectivity and reasonable bandwidth, thus, forms a suitable candidate. Support for GPRS is also being added and will be reported separately.

References


Jammer

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Jammer is a device used to block a radio transmission by causing interference. They can be used to jam network using two mechanisms ‘electronic and mechanical’. In this seminar the process of jamming has been explain with special emphasis on mobile phone jammer. This topic is importance in today’s world due to many reasons, such as security purpose. The rapid proliferation of all cell phones rise problem such as privacy inversion or academic cheating. Thus network jamming using high frequency noise or Faraday cages. Jamming technology finds immense use in today’s world such as military warfare because jammer use to jam opponents radar or to block transmission of signals and many applications of different types of jammers. This seminar describes circuitry of mobile phone jammer and how anti jamming operation takes place. This we get to know of an interesting field which fields many high profile applications in today’s electronic and telecommunication device and almost all security system.

1 CELL PHONE JAMMER:

cell phone jammer is a device that transmit signal on the same frequency at which the GSM system operates, the jamming success when the mobile phones in the area where the jammer is located are disabled.

2 MECHANICAL JAMMER:

Mechanical jamming is caused by devices which reflect or re-reflect radar energy back to the radar to produce false target returns on the operator’s scope. Mechanical jamming devices include chaff, corner reflectors, and decoys.

3 ELECTRICAL JAMMER

Electronic jamming is a form of Electronic Warfare where jammers radiate interfering signals toward an enemy’s radar, blocking the receiver with highly concentrated energy signals. The two main technique styles are noise techniques and repeater techniques. The three types of noise jamming are spot, sweep, and barrage. In this seminar we study types of jammer, application and Jamming detection and mitigation. Here we also study circuitry of the jammer.

4 CELL PHONE JAMMER

History:
The rapid proliferation of cell phones at the beginning of the 21st century to near ubiquitous status eventually raised problems, such as their potential use to invade privacy or contribute to academic cheating. In addition, public backlash was growing against the disruption cell phones introduced in daily life. While older analog cell phones often suffered from poor reception and could even be disconnected by simple interference such as high frequency noise, increasingly sophisticated digital phones
have led to more elaborate counters. Cell phone jamming devices are an alternative to more expensive measures against cell phones, such as Faraday cages, which are mostly suitable as built in protection for structures. They were originally developed for law enforcement and the military to interrupt communications by criminals and terrorists. Some were also designed to foil the use of certain remotely detonated explosives. The civilian applications were apparent, so over time many companies originally contracted to design jammers for government use switched over to sell these devices to private entities. Since then, there has been a slow but steady increase in their purchase and use, especially in major metropolitan areas.

**DEFINITION:**

A GSM Jammer or cell phone jammer is a device that transmit signal on the same frequency at which the GSM system operates, the jamming success when the mobile phones in the area where the jammer is located are disabled. Communication jamming devices were first developed and used by military. Where tactical commanders use RF communications to exercise control of their forces, an enemy has interest in those communications. This interest comes from the fundamental area of denying the successful transport of the information from the sender to the receiver. Nowadays the mobile jammer devices or cell phone jammer software are becoming civilian products rather than electronic warfare devices, since with the increasing number of the mobile phone users the need to disable mobile phones in specific places where the ringing of cell phone would be disruptive has increased. These places include worship places, university lecture rooms, libraries, concert halls, meeting rooms, and other places where silence is appreciated. To jam a cell phone, all you need is a device that broadcasts on the correct frequencies. Although different cellular systems process signals differently, all cell-phone networks use radio signals that can be interrupted. GSM, used in digital cellular and PCS-based systems, operates in the 900-MHz and 1800-MHz bands in Europe and Asia and in the 1900-MHz (sometimes referred to as 1.9-GHz) band in the United States. Jammers can broadcast on any frequency and are effective against AMPS, CDMA, TDMA, GSM, PCS, DCS, iDEN and Nextel systems. Old-fashioned analog cell phones and today’s digital devices are equally susceptible to jamming. Disrupting a cell phone is the same as jamming any other type of radio communication. A cell phone works by communicating with its service network through a cell tower or base station. Cell towers divide a city into small areas, or cells. As a cell phone user drives down the street, the signal is handed from tower to tower.

**APPLICATION OF CELL PHONE JAMMER:**

1) Cell phone jammers initially were developed for use by law enforcement and the military. For example, terrorists frequently trigger bombs with cell phones, and jammers often are part of security arrangements for people who may be targeted by these kinds of attacks. 2) Law enforcement can use jammers in other situations as well, such as during a drug raid or a hostage situation. Companies also have begun enlisting jammers to provide security from threats, including corporate espionage, and in places where radio transmissions are potentially dangerous. 3) They are in the field of development and manufacturing of special jamming devices, which are used for both RF jammer as well as cellular communications.
5 MECHANICAL JAMMING

Mechanical jamming is caused by devices which reflect or re-reflect radar energy back to the radar to produce false target returns on the operator’s scope. Mechanical jamming devices include chaff, corner reflectors, and decoys. Chaff is made of different length metallic strips, which reflect different frequencies, so as to create a large area of false returns in which a real contact would be difficult to detect. Modern chaff is usually aluminium coated glass fibers of various lengths. Their extremely low weight and small size allows them to form a dense, long lasting cloud of interference.

5.1 Corner reflectors:

Have the same effect as chaff but are physically very different. Corner reflectors are multiple-sided objects that re-radiate radar energy mostly back toward its source. An aircraft cannot carry as many corner reflectors as it can chaff.

5.2 Decoys:

Are maneuverable flying objects that are intended to deceive a radar operator into believing that they are actually aircraft. They are especially dangerous because they can clutter up a radar with false targets making it easier for an attacker to get within weapons range and neutralize the radar. Corner reflectors can be fitted on decoys to make them appear larger than they are, thus furthering the illusion that a decoy is an actual aircraft. Some decoys have the capability to perform electronic jamming or drop chaff. Decoys also have a deliberately sacrificial purpose i.e. defenders may fire guided missiles at the decoys, thereby depleting limited stocks of expensive weaponry which might otherwise have been used against genuine targets.

6 ELECTRONIC JAMMING

Electronic jamming is a form of Electronic Warfare where jammers radiate interfering signals toward an enemy’s radar, blocking the receiver with highly concentrated energy signals. The two main technique styles are noise techniques and repeater techniques. The three types of noise jamming are spot, sweep, and barrage.

6.1 Spot jamming:

Occurs when a jammer focuses all of its power on a single frequency. While this would severely degrade the ability to track on the jammed frequency, a frequency agile radar would hardly be affected because the jammer can only jam one frequency. While multiple jammers could possibly jam a range of frequencies, this would consume a great deal of resources to have any effect on frequency-agile radar, and would probably still be ineffective. Sweep jamming: is when a jammer’s full power is shifted from one frequency to another. While this has the advantage of being able to jam multiple frequencies in quick succession, it does not affect them all at the same time, and thus limits the effectiveness of this type of jamming. Although, depending on the error checking in the device(s) this can render a wide range of devices effectively useless.

6.1.1 Barrage jamming:

Is the jamming of multiple frequencies at once by a single jammer. The advantage is that multiple frequencies can be jammed simultaneously; however, the jamming effect can be limited because this requires the jammer to spread its full power between these frequencies, as the number of frequencies covered increases the less effectively each is jammed.

Base jamming is a new type of Barrage Jamming where one radar is jammed effectively at its source at all frequencies. However, all other radars continue working normally. Pulse jamming produces noise pulses with period depending on radar mast rotation speed thus creating blocked sectors from directions other than the jammer making it harder to discover the jammer location.
Cover pulse jamming creates a short noise pulse when radar signal is received thus concealing any aircraft flying behind the EW craft with a block of noise. Digital radio frequency memory, or DRFM jamming, or Repeater jamming is a repeater technique that manipulates received radar energy and retransmits it to change the return the radar sees. This technique can change the range the radar detects by changing the delay in transmission of pulses, the velocity the radar detects by changing the doppler shift of the transmitted signal, or the angle to the plane by using AM techniques to transmit into the side lobes of the radar.

DRFM jamming can create false targets behind the EW craft but not in front of it because the jamming signal must be timed after the received radar signal. By analysing received signal strength from side and back lobes and thus getting radar antennae radiation pattern false targets can be created to directions other than one where the jammer is coming from. If each radar pulse is uniquely coded it is not possible to create targets to directions other than the direction of the jammer.

Deceptive jamming uses techniques like "range gate pull-off" to break a radar lock.

7 JAMMING DETECTION and MITIGATION IN WIRELESS BROADCAST NETWORKS

Mobile communication systems are often susceptible to high level of noise injected by adversaries, known as jamming attack. Jamming is difficult to prevent in broadcast networks because a user that can decode a transmission can also jam the transmission. In this paper, we describe a code treesystem that helps the physical layer circumvent jammers. This system works with any spread-spectrum communications system. In our system, the transmitter has more information than any single receiver. Each receiver cooperates with the transmitter to detect any jamming that affects that receiver. Our scheme mitigates the jamming attack while allowing the transmitter to transmit on fewer codes than the number of users. We simulated our system in a theoretical setting using MATLAB. The result shows significant improvement over naively transmitting on a single shared code.

8 TREE CODING SCHEME

8.1 Symmetry of Hopping Patterns

The current use of hopping patterns in a FFH-CDMA system is analogous to a symmetric-key cryptosystem, in which an encryption code and decryption code are easily derivable from each other. For example, in the FFH-CDMA system, encoding and decoding both use the same hopping pattern. By keeping each hopping pattern a secret between the transmitter and receiver, the hopping pattern effectively serves as a cryptographic key for both encryption and decryption. This symmetry presents significant challenges to the design of a broadcast system: a symmetric key should not be shared; otherwise a single compromised user can jam in a way that cannot be rejected by frequency hopping.

8.2 Tree-Based Approach

In this section, we describe our approach to create an asymmetric system that allows detection and isolation of jammers in a spread-spectrum system. This approach is similar to the key tree proposed by Sherman and McGrew [12]. Each transmitter builds a balanced binary tree of randomly generated hopping patterns. The transmitter associates each legitimate receiver with a unique leaf in this binary tree, and gives this receiver the hopping patterns corresponding to that leaf and all ancestors of that leaf in the tree. For example, in Figure 1, user N2 would have access to hopping patterns H2, H23, H03, and H07. When there are no jammers, a transmitter can transmit on a single hopping pattern; specifically, it would choose the hopping pattern corresponding to the root of the tree. Transmissions on this hopping pattern can be decoded by any legitimate receiver. For example, in Figure 1, the transmitter would send on hopping pattern H07. In general, in order to ensure that every receiver can decode the packet while ensuring power efficiency, the transmitter wants to transmit on a set of hopping patterns such that any user can decode using exactly one hopping pattern in the set. We call such a set a disjoint cover. Once jamming has been detected on some hopping patterns (we discuss jamming detection in Section 3.3), the transmitter should avoid using such hopping patterns in the future. Because each extraneous hopping pattern used for transmission either increases the total power consumption or reduces
the average received signal strength on each hopping pattern, we want to transmit on the smallest possible set of hopping patterns on which no jamming was detected.

8.3 Jamming Detection Algorithm

When the transmitter sends a packet, it will do so on the disjoint cover on which no jamming had been previously detected, so that all legitimate receivers can decode the packet. In order to detect additional jammers, the transmitter additionally transmits on a test hopping pattern, which it randomly chooses from among the descendants of the cover. This redundant test hopping pattern allows the transmitter and receiver to cooperatively detect jamming on any hopping pattern in the cover that is an ancestor of the test hopping pattern. We call this ancestor the detectable hopping pattern. If no jammers are present, each user should get either one or two identical messages, the first encoded using one of the patterns from the cover, and possibly a second encoded using the test hopping pattern. If any user receives the second message without receiving the first message, then it should suspect jamming on the detectable hopping pattern. Any user detecting jamming in this way should report that finding to the transmitter, for example by transmitting a Jamming Detected message using the leaf hopping pattern shared between the transmitter and the detecting receiver (because no jammer knows that leaf hopping pattern). In some instances, jamming on the detectable hopping pattern will not be detected. This can happen either when a jammer jams on the test hopping pattern or when no normal users know the test hopping pattern. Testing can be generalized so that a set of test hopping patterns are used at each step, thus allowing a set of detectable hopping patterns. For example, if the current disjoint cover in use is H03,H45,H67, then the test code set of H01,H4 would make the detectable set be H03,H45.

8.4 Response to Jamming

When a transmitter detects jamming, it will choose a different cover. In particular, if jamming is detected on some hopping pattern $h$ in the current cover, the transmitter will remove $h$ from the cover and add the two children of to the cover. For security reasons, jamming reports are only accepted from hosts that should know hopping pattern $h$. For example, in Figure 1, when jamming is detected on pattern H07, the transmitter splits the cover into H03,H47. If jamming is further detected on H47, the resulting cover would be H03,H45,H67.

Conclusion

1. Jammer radiate interfering signal towards enemy radar, blocking the receiver. ith highly concentrated energy signal.
2. How different jamming technique create false target for self defence.
3. Radar jammer is mainly used in Military bases, Air forces and Arm forces.
4. A tree-based coding mechanism that can detect jamming and reconfigure to reduce the impact of jammers. We showed that the parameter choice of testing level may affect the efficiency of the system, and subsequently optimized this parameter.

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Radio Frequency Identification

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Radio-frequency identification or RFID is the use of a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. Some tags require no battery and are powered and read at short ranges via magnetic fields. RFID holds great promise as a disruptive technology that will reshape the way individuals live. However, the undeniable privacy concerns, not only of data collected by RFID in particular, but also other indiscriminate technologies that are similarly disruptive, have received inadequate focus. The RFID tag contains electronically stored information which may be read from up to several meters away. Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object. A future challenge is to develop privacy standards that go beyond the narrow understanding of privacy while allowing increased efficiency and effectiveness through the use of RFID. We address this challenge by integrating several theoretical lenses of privacy in this paper and applying an integrative approach to data collected using RFID.

keywords

RFID- Radio frequency identification

INTRODUCTION

Radio-frequency identification or RFID is the use of a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. Some tags require no battery and are powered and read at short ranges via magnetic fields. RFID holds great promise as a disruptive technology that will reshape the way individuals live. However, the undeniable privacy concerns, not only of data collected by RFID in particular, but also other indiscriminate technologies that are similarly disruptive, have received inadequate focus. The RFID tag contains electronically stored information which may be read from up to several meters away. Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object. RFID facilitates tracking of inventory and other assets at multiple points in the supply chain, potentially including the item’s history as it passes through multiple owners or processes. Currently, most of the focus is on basic iden-
tification of an item as it passes through the supply chain. This is similar to the way bar codes are used, but with important advantages unique to RFID technology. Powering this vision is the prospect of having proactive visibility to the location and unique identity of each item in the supply chain. Additionally, RFID eliminates the errors associated with the manual scanning of bar codes. Cell phone jammer is a device that transmit signal on the same frequency at which the GSM system operates, the jamming success when the mobile phones in the area where the jammer is located are disabled.

1 Working

In every RFID system the transponder Tags contain information. This information can be as little as a single binary bit, or be a large array of bits representing such things as an identity code, personal medical information, or literally any type of information that can be stored in digital binary format. Passive tags have no power source of their own and instead derive power from the incident electromagnetic field. Commonly the heart of each tag is a microchip. When the Tag enters the generated RF field it is able to draw enough power from the field and information is determined. When the transponder Tag draws power in this way the resultant interaction of the RF fields causes the voltage at the transceiver antenna to drop in value. This effect is utilized by the Tag to communicate its information to the reader. The Tag is able to control the amount of power drawn from the field and by doing so it can modulate the voltage sensed at the Transceiver according to the bit pattern it wishes to transmit.

Conclusion

A future challenge is to develop privacy standards that go beyond the narrow understanding of privacy while allowing increased efficiency and effectiveness through the use of RFID. We address this challenge by integrating several theoretical lenses of privacy in this paper and applying an integrative approach to data collected using RFID.

References


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