CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Finn Barry; Kyle Worcester-Moore

Project Number

S0301

Project Title

Focusing Waves: How Stationary Barriers Focus Wave Energy

Abstract

Objectives/Goals

The purpose of this project was to understand how different shaped seawalls (half circles, parabolas, V, and straight walls) would affect the height of oncoming ocean waves. Our goal is to understand how wave energy can be extracted most efficiently by placing shaped walls perpendicular to the oncoming waves. The hypothesis that a parabolic wall shape would generate larger waves to form, from which more energy could be extracted, was supported by the results of the experiment.

Methods/Materials

The effect of these seawall shapes on wave height were observed using a small scale model of each seawall shape in a lap pool. For roughly 25 seconds, an ultrasonic distance sensor above the water surface measured each wave#s height. This process was repeated at several locations around each wave barrier.

Results

A parabolic seawall produced the highest waves at its focal point . The half circle produced the second highest waves and produced high waves at every measured location.
Results from this experiment indicate that the parabola seawall shape produced the most energy from a single location; however, the half circle wall shape may produce the most energy if multiple wave energy extractors are distributed inside the half circle.

Conclusions/Discussion

Further research to measure the extractable wave energy around these seawall shapes, using existing wave power methods should be performed to verify that these findings hold true in real applications.

Summary Statement

This project investigated how different shaped sea walls effect wave height and energy.

Help Received

Parents gave suggestions on construction.

Name(s)

Jasmine J. Cha

Project Number

S0302

Project Title

The Snitch on the Stitch

Abstract

Objectives/Goals

My objective to discover which suture technique could withstand the most stress, and whether a more intricate design would resist more weight.

Methods/Materials

I used chicken breasts because these are the closest material to tendon. I used a suture kit obtained from a practicing surgeon to suture the chicken, then made a weight system using a ring stand and metal rod. Following this, I attached binder clips onto the chicken, pierced nails through the clips (for stability), then hung mass weights onto the clips in increments of 100g every 30 seconds. I continued hanging masses until the chicken tore completely from the suture site.

Results

After testing out three different suturing techniques in three separate trials, the horizontal sutures endured an average of 333.336g more than the normal sutures. On the other hand, vertical sutures withheld about 66.667g more than normal sutures before tearing. The normal, and most simple, suture pattern resisted the least amount of stress compared to the vertical and horizontal suturing techniques, which withstood more weight and had more complex designs.

Conclusions/Discussion

In the end, the hypothesis that if the suture technique being tested has a more intricate design and goes over the incision more, then that method will withstand the most weight, had been confirmed. The vertical and horizontal sutures had a more elaborate design, and this enabled the chicken breasts to bear more weight. The horizontal sutures endured more stress than the vertical design because they are the only tested method that had a technique in which the suture went across the chicken breast, not just over the incision, and this may have aided in the greater amount of weight that the chickens with this performed method could bear. With this knowledge, a further experiment could be tested in which different suturing techniques that had a more complex design than a horizontal suture (i.e. Kraków running/locking sutures) should be tested in order to further confirm the validity of the hypothesis that if a suture techniques runs across the chicken breast horizontally, and not just across the incision, that the subject will uphold the most stress.

Summary Statement

My project was centered around discovering which suture technique could endure the most weight without tearing the tendon.

Help Received

Used Mr. Betzelberger's classroom for my trials; Athletic trainer Diana Putignano obtained a suture kit from a practicing orthopedic surgeon.

Name(s)
Maggie S. Chen

Project Number
S0303

Project Title
3D Printing of a Hydrogel Patch with Drug-Loaded Nanoparticles for Combinational Therapy

Abstract

Objectives/Goals

The goal of the project is to make a multilayer hydrogel patch with drug-loaded nanoparticles using 3D printing for combinational therapy. The hydrogel structure provided a supporting platform for holding the nanoparticles, while the drug-carrying nanoparticles offered controlled release of the drug. Since the patch was created through a 3D printer, it could not only be made for patient-specific sizes, shapes and drug doses, but also be made as a multilayer structure with each layer loaded with different drugs for combination therapy.

Methods/Materials

1)Nanoparticle Synthesis: Nanoprecipitation Method; Double Emulsion Method
2)3D Printing: 20% PEGDA (Polyethylene (glycol) Diacrylate) + 0.5% LAP (lithium acylphosphinate) as the photoinitiator
3)Drug Release Testing

Results

*Both the double emulsion and nanoprecipitation methods produce stable nanoparticles. These nanoparticles can be encapsulated in the hydrogel.
*3D printing of the patch allowed for any computerized design and a multilayer structure.
*The nanoparticles were able to encapsulate drug molecules, and were able to release them from the hydrogel platform in a more controlled fashion than the free drug particle release from a hydrogel platform.
*The multilayer drug release proved to be controlled and staggered as well.
*The hydrogel patch proved to be effective in stopping the growth of E. Coli bacteria.

Conclusions/Discussion

The hydrogel patch provides a stable, controlled, and localized drug delivery platform. The nanoparticle encapsulation system is effective in staggering release rate, and thus can be used for controlling drug release. 3D printing allowed the nanoparticles to be encapsulated in a designer patch. Computer-control allows for any computerized design, and multiple layers can be printed. Combining nanoparticles with 3D printing allows for a multilayer patch with different drug nanoparticles in each layer. Thus, combinational therapy is achieved, and the drug release is controlled and localized. This hydrogel patch has been proven to have the ability to release multiple kinds of drug particles, and is effective in stopping the growth of E. Coli bacteria.

Summary Statement

I created a multilayer hydrogel patch with drug-loaded nanoparticles using 3D printing for combinational therapy.

Help Received

Used lab equipment at University of California, San Diego under the supervision of Professor Liangfang Zhang.

Name(s)

Shannon S. Chen

Project Number

S0304

Project Title

Design and Construction of a Miniature Helium Airship

Abstract

Objectives/Goals

This project aimed at developing a design concept for a miniature helium airship that had a minimal size and sufficient lift to carry necessary payloads for outdoor applications. The concept was validated by successful fabrication and flight demonstration of a mini-airship.

Methods/Materials

The mini-airship had a gas bag and a non-rigid hull expanded by a carbon skeleton frame. This unconventional combination eliminated the permeability requirement of the hull and reduced the strength requirement of the gas bag. Lightweight materials thus could be used for construction. The skeleton frame, though flexible, allowed streamline hull shaping and provided mounting support for the propellers and payloads. To select the most efficient propeller, the thrust, rotation speed, and power consumption of various propellers were measured with a homemade test set which used a solar cell to detect the propeller rotation. A new parameter, the ratio of propeller thrust to total power consumption, was defined and used for propeller selection. Calculations based on more than 30 equations were performed repeatedly to reach a design that had sufficient thrust and lift.

Results

The mini-airship had a volume of only 1.1 cubic meters and a weight of 0.895kg. A payload lift capacity of 0.25kg was achieved at a buoyancy ratio close to 1. Outdoor flight test demonstrated a speed of >3.3 m/s. This was the smallest airship that ever achieved such combined performance. Its hull shape was scaled from Model 111 in the NACA report TN-614 for low drag at low Reynolds numbers. The hull length to maximum diameter ratio was scaled from the original value of 5 to 2.5 for easy handling of the airship. Unexpectedly, a dependence of the propeller thrust on the third power of the propeller diameter was observed. To explain the observation, an integral equation was derived from the blade element theory which states that if the product of the chord and the lift coefficient of the blade element is a constant along the radius of the blade, the propeller thrust is proportional to the third power of the diameter.

Conclusions/Discussion

For the first time, a non-rigid hull and a gas bag was combined to form a mini-airship. The mini-airship had the smallest hull volume for the lift capacity and outdoor flight ability it demonstrated. These results represented a significant breakthrough in the development of mini-airship for practical applications.

Summary Statement

Based on a new design concept, a mini-airship was fabricated which had the smallest hull volume for the 0.25kg lift capacity and >3.3 m/s outdoor flight speed it demonstrated.

Help Received

Dr. Bob Boyd and Mr. Peter Starodub provided mentorship and guidance. Parents provided transportation and financial supports.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Tucker Dunbar; Gregory Murphy

Project Number

S0305

Project Title

Liquid Armour

Abstract

Objectives/Goals

To make flexible, lightweight, bulletproof armor by implementing shear thickening fluids into para aramid fabric.

Methods/Materials

ballistic Kevlar
polyethylene glycol 400
silica dust

Results

Currently retesting...

Conclusions/Discussion

From out initial platform (with cornstarch, water, plastic bags and Kevlar), the results of our project had shown the promising applications of liquid armor with shear thickening fluid. We are currently re-testing our design with more substantial chemicals. It is foreseeable that functional liquid armor is a feasibility. However, at this time, no final statements can be made.

Summary Statement

The future applications of shear thickening, non-newtonian fluids into para aramid fabrics to make a flexible, lightweight, bulletproof material for armour.

Help Received

My father, a firearms instructor, supervised the gun handling and monitored proper gun safety whilst performing the trials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Conrad J. Frisch

Project Number

S0306

Project Title

Evaluating Bernoulli's Principle through the Use of a Hovercraft

Abstract

Objectives/Goals

We evaluated two different Plenum designs. One design utilized a six hole pattern, a second design utilized 12 holes. The surface area through which the air escaped through our holes was kept constant.(18.8 square inches). Our hypothesis speculated that the smaller hole design would carry more weight.

Methods/Materials

Our design called for altering the diameter and the number of holes through which gas can escape in a 41in round 3/4in thick plywood board. Bernoulli's principle states that the smaller the orifice, the greater the velocity and therefore the lower pressure. Will will make six holes each of 1 inch in diameter. That will give a gas escape surface area of

6 x Pi x 0.5^2 = 4.71 in^2

We will then make another model in which the gas will escape with 24 holes each of 0.5 inches in diameter.

12 x Pi x .707^2 = 4.71 in^2

Because Bernoulli's principle deals with pressure differentials, it is our hypothesis that smaller more numerous holes will enable to craft to hover more effectively than larger, but less numerous holes.

All holes will be made in a circular pattern approximately 1.5 feet from the center of the plywood. The leaf blower will be placed in the center of the plywood.

Results

Two trials were performed using the 6 hole (surface area = 18.8 sq in) design from 0 to 250 pounds. At zero load the height mean was 2.55 inches; at 250 pounds the mean was 1.6 inches. The slope of the line was y = -0.0037x+2.5188.

The 12 hole design (surface area =18.8 sq in) at zero load had a mean height 2.97 inches; at 250 pounds the mean was 2.25 inches. The slope of the line was y= -0.0029x + 2.9888, and less steep than the 12 hole design. The slope of these data were significantly different from each other ($p<0.01$).

Conclusions/Discussion

We built a 41 inch diameter inch hovercraft that utilized Bernoulli's principle. We found that the smaller holes were more effective than larger holes (of the same surface area) in elevating a board above a concrete floor with 0 to 250 pounds of weight. Our findings support the hypothesis that the faster air

Summary Statement

Bernoulli's Principle is evaluated through the use of a hovercraft with two different size orifices for air to escape.

Help Received

Frank Frisch, my father, helped with the construction of the hovercraft.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Hao Yang He

Project Number

S0307

Project Title

Factors of Thrust from Directed Airflow

Abstract

Objectives/Goals

The purpose of this experiment was to determine differences in airflow propulsion by changing variables of fan blades, air ducts and power input. It was hypothesized that air accelerated due to a combination of the largest amount of fan blades, a convergent duct and a greater amount of power would generate the largest amount of thrust.

Methods/Materials

For this experiment, I acquired sheet metal to craft out the necessary air-ducts and fan pieces. The fan pieces, consisting of either 8, 12 or 16 blades was attached to a DC motor. Batteries (0.175 and 0.35 watts) were used to power and spin the fan to accelerate air through either a divergent, cylindrical or convergent air duct. An electronic balance was positioned constantly at the back of the air duct to measure amount of thrust generated based on the force of air pushed against it.

Results

Results suggest that thrust was directly proportional to the amount of power input as well as the convergence of the air ducts. Increasing the power input by twice the amount quadrupled the amount of thrust produced. A switch to more convergent ducts also significantly increased the power output of the system. However, the results also show that larger amounts of fan blades resulted in a decrease in thrust, contradicting the hypothesis.

Conclusions/Discussion

This experiment provided an insight to how these factors affect airflow and propulsion as well as highlighting the complexity of fan-blades and factors of its performance, a topic of further research.

Summary Statement

To determine how different air ducts, number of fan blades, and power input can affect overall airflow thrust.

Help Received

My dad helped me with the set up of the experiment such as placing and securing the components. My cousin also helped me with part of the experiment.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Benjamin Kolland

Project Number

S0308

Project Title

Separation Anxiety: A Plan for Safer Model Rocket Deployment

Abstract

Objectives/Goals

Current model rocket deployment systems are limited to single motor ejection charges or separate explosive charges controlled by electronics. The purpose of this project is to design a non-pyro parachute deployment system (because minors cannot handle regulated explosives).

Methods/Materials

A 90cm booster was constructed from 98mm cardboard tubing. The 110cm long payload section had two hatches actuated by model aircraft retract servos. An Eggtimer altimeter I soldered triggered the servos at specified points in the rocket's flight. The final design's 40cm payload had an altimeter bay and single servo released parachute compartment. The hatches were ground tested but when flown they experienced multiple failures. The system was redesigned to use gravity to release the main parachute after a small drogue parachute was ejected at apogee using an explosive charge built into the motor.

Results

The initial design testing went well, so the hatch setup was flown. However, the hatches didn't stay closed during boost or deploy as planned. A new design was built and first RC ground tested, and then flight-tested to 166m with the main parachute RC released at approximately 75m. The motor eject worked to deploy the drogue parachute, and the gravity release design for the main parachute worked perfectly. Three flights using Eggtimer altimeter control were not successful due to altimeter problems, but debugging and five more vacuum tests confirmed the system was functional and deployed the main release at 45m. Two successful flights to 148m and 151m using Eggtimer altimeter control deployed the main parachute as planned at 45m. A high altitude flight to 782m with winds of 12kph landed within 100m of the launch site after successful main deploy at the planned altitude of 102m. Two final flights deployed early due to failure from coupler fatigue.

Conclusions/Discussion

My initial design failed due to gravity and aerodynamic issues, so I debugged and built a new design. It worked after some additional modifications to altimeter programming. I ran multiple static (vacuum) and flight tests, which showed very promising results. In the end, I was able to build a non-pyro deployment release for the main parachute that worked reliably and was easy to prep for flight. This system enables a lower cost, simple alternative to handling black powder charges for parachute deployment.

Summary Statement

This project demonstrates an innovative design for model rocket dual deployment using a safe, non-pyrotechnic system.

Help Received

David Raimondi for suggestions based on his experience with parachute systems, Dave Cornelius for failure analysis help on my initial design, my dad for driving to launches and ground support at launches.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Chloe C. Kuo

Project Number

S0309

Project Title

An Improved Wheelchair for Playing Wheelchair Tennis

Abstract

Objectives/Goals

The purpose of my project is to see if wheelchairs for playing wheelchair tennis can be further improved upon. I intend to design and test a model system that utilizes a hands-free electronic interface that can lock and unlock an axle, thus enabling at times one-handed drive or two-handed drive to occur.

If successful, I hope on a larger context that my results will cause two things to occur:

- stimulate further discussion and engineering research on additional innovations for wheelchairs used in wheelchair tennis and other sports played by disabled athletes, and
- explore further safety and performance mechanisms that can be engineered into manual wheelchairs utilized by the broader population of disabled people.

Methods/Materials

Metal Pipes, Beams, and Disks, Arduino Uno Microcontroller, Servomotor, Electronic Components, Voice Recognition Module, Universal Joints, Couplers

I broke down the creation of my model wheelchair test system into four different phases:

1) Integration of an Arduino microcontroller to a small electronic components 2) Integration of voice recognition in the Arduino interface to operate the axle coupling mechanism 3) Construction of a scale model test wheelchair 4) Integration of the electronic interface and mechanical framework

Results

After constructing 3 prototype wheelchair models, I successfully created a model wheelchair, which I performed tests on. Following a flowchart I created, I tested my project in 4 different experiments that were designed to represent all possible situations that could be encountered. My wheelchair returned expected results for each test.

Conclusions/Discussion

- I was able to design, build, and test a user controlled, hands-free, one-handed drive system in a model wheelchair so my hypothesis is correct.
- I believe that the innovations I have developed can be applied to conventional wheelchairs for disabled people.
- For future experiments, I would like to build a real tennis wheelchair and test it by playing competitive wheelchair tennis. I would also like to optimize the one-handed driving system by including braking and motorization.
- A one-handed drive system that can be selectively engaged and disengaged should be seriously considered as an improvement for future wheelchairs.

Summary Statement

My project sought to test the feasibility of designing and building an improved wheelchair for playing wheelchair tennis.

Help Received

Machinist cut out parts I designed for my wheelchair.

Name(s)

Rei J. Landsberger

Project Number

S0310

Project Title

Design and Testing of a Fluid Based Solar Tracker

Abstract

Objectives/Goals

To design a simple solar tracking mechanism, and test whether it improves energy output for a solar panel.

Methods/Materials

The heart of the system is a balancing fluid that moves between two 1 inch glass tubes mounted on each side of a pivoting solar panel frame. When the panel does not directly face the sun, then one tube is more exposed. The heated fluid pushes through ¼ inch polyethylene tubing to the other tube and its weight tilts the frame to better face the sun. Methanol was chosen because its vapor pressure rises steeply with increasing temperature. The support base and pivoting frame are built from ¼ inch foam board. Roller-blade bearings support the pivoting platform at a 30 degree angle nearly parallel to the earth's axis at the local latitude. The solar panel connects to a 12V, 5W water pump serving as its load, and a watt-meter measures electric power output.

Results

Data were collected by recording the watts produced by the tracking solar panel at 30-minute time intervals between 9:00AM and 4:00PM. To compare our Tracker power output to a non-tracking panel that might be fixed to a rooftop, measurements were also recorded at each time with the panel facing south and inclined 30 degree to the horizontal. A final comparison was made with a fixed panel whose angle would be seasonally adjusted to match the sun at noon: steeper in winter, flatter in summer. The 3 data sets - tracking, fixed, and seasonally adjusted fixed - were averaged over four sunny days.

Conclusions/Discussion

Through observations and from the data gathered, it was concluded that the fluid-based solar tracker increases the energy made by the solar panel and was a reliable design.

Summary Statement

My project focused on creating and testing a self-correcting, fluid-powered solar tracking design to increase energy output of a solar panel.

Help Received

My father helped to build my design and to supply me with materials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Jonathan J. Sessa

Project Number

S0311

Project Title

Increasing Efficiency in Turbine Blades

Abstract

Objectives/Goals

The main objective of this project is to test the efficiency of different design aspects in single stage turbine blades.

Methods/Materials

Six turbines of varying blade length, angle, and curvature are compared to a flat control blade of average length. All turbine blades are 3D printed using ABS plastic. A 6 liter air tank with release valve is used to regulate air volume. A metal C.N.C cut housing allows the blades to rotate freely. A non-contact tachometer records the max rotations per minute of the turbines.

Results

The turbines that were symmetrical from top to bottom were able to achieve the highest rotations per minute. More specifically, the turbine with blades of average length and a drastic curve was able to archive the highest rotations per minute.

Conclusions/Discussion

The turbines with longer blades and the turbines with non-symmetrical blades tended to wobble in the turbine housing causing more friction. This ultimately resulted in them slowing and even stopping before they could reach high speeds. The turbines with symmetrical blades were able to stay stable, but the turbines with shorter-symmetrical blades did not have enough surface area to reach as high speeds as the turbines with medium length blades.

Summary Statement

With the use of multiple forms of manufacturing, this project shows how different design aspects affect the efficiency in single stage turbine blades.

Help Received

Mark Terryberry from Haas Automation mentored throughout the manufacturing of the turbine housing; Jim Earman from Jimani Inc. allowed use of his 3D printer; Michael Sessa from Sessa Mfg. Mentored throughout the construction of pneumatic system.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Vedaad Shakib

Project Number

S0312

Project Title

Computer Simulation of Free-Surface Fluid Flow Using MPS

Abstract

Objectives/Goals

When mixed liquid and gas fluid flows undergo violent motions, a free surface forms between the liquid and the gas. If the motion is severe enough, such as the breaking of a dam or oil lubrication in an engine, the shape of the free surface becomes increasingly complex. Traditional numerical simulations of fluid flows, for example finite difference, finite volume and finite element technologies are incapable of simulating such severe free-surface fluid flows due to their reliance on grids, the decomposition of the volume into small, regular shapes, to interpolate velocity and pressure fields. Severe free-surface motions entangle the grids, making these methods rather useless. Therefore, grid-less methods are necessary for solving severe free-surface flows. One such proposed method is the #Moving Particle Semi- Implicit# (MPS) method, developed by S. Koshizuka and Y. Oka in 1996. Instead of utilizing a grid, MPS relies on an approximation kernel function to reconstruct the velocity and pressure field at each given particle position based on the surrounding particles. These values are necessary to approximate the spatial differentials of these fields, which are integral to solving the Navier-Stokes equations, the governing equations of fluid motion, for each particle. This research project attempts to code a unique implementation of the MPS theory using modern algorithms to optimize performance in the C programming language.

Methods/Materials

The software consists of an input phase, where the walls and fluid of the problem are artificially constructed, and a time-stepping algorithm, where the gravity and viscosity are modeled using an explicit algorithm and the conservation of mass is solved using the solution of a pressure Poisson equation.

Results

The program's performance is tested with a sample dam break problem. The software's output closely resemble experimental values extracted from literature, validating the feasibility of the implementation of the MPS method.

Conclusions/Discussion

The program is extremely sensitive to user-inputted values, illuminating the need for a stabilizer. The next step in extending this project is to enhance the robustness of the solutions by incorporating numerical methods and then to further improve the performance through a split-tree search algorithm and an Algebraic Multi-Grid solver for the pressure Poisson equation.

Summary Statement

This project computationally solves the differential equations proposed in the Moving Particle Semi-Implicit theory in order to create a coherent software that is able to simulate free-surface fluid flows with violent motions over time.

Help Received

Name(s)
Joshua Stevens; Matthew Walters

Project Number
S0313

Project Title
Construction of a Fused Deposition Modeling Style Rapid Prototyping Machine

Abstract

Objectives/Goals
To build a 3D printer capable of producing high quality prints similar to the quality of commercially produced printers, at a lower cost, and to gain a greater understanding and appreciation for the mechanisms and electronic systems involved in 3D printing.

Methods/Materials
3D printed parts, Steel frame pieces and hardware, RAMPS electronics, Wade's Extruder Reloaded, J-style hotend, Wood and acrylic build area.

Results
We have constructed a fully functional 3D printer, at fraction of the cost of a commercially produced 3D printer, and we have gained the understanding necessary to fully design a custom rapid prototyping machine.

Conclusions/Discussion
Commercially produced printers are definitely much easier to operate and set up, but several times more expensive in most cases, and don't offer the educational benefits of designing or building your own.

Summary Statement
Our project is a self-built 3D printer capable of producing 3D parts similar to those made by commercially built printers, and it was assembled for a fraction of the cost.

Help Received
Used 3D printer and some tools at the Center for Advanced Research and Technology, Clovis, CA

Name(s)

Sidharth S. Subbarao

Project Number

S0314

Project Title

Dexterity of a Soft Robotic Gripper

Abstract

Objectives/Goals

The objective of my project is to investigate how the flexibility of a robotic hand affects its performance in terms of dexterity. The experiment compares a conventional claw gripper and a bio-inspired soft robotic hand for their ability to maintain grip and lift objects of various shapes. The soft robotic hand is made of silicone rubber and operates on air pressure allowing it to inflate and curl around the object it grips. Both the claw gripper and the soft robotic hand are evaluated individually by mounting them upon a 3-axis robotic arm.

Methods/Materials

The Robotic Arm and the claw gripper are built using the parts included in 1.X retail version of the LEGO MINDSTORMS NXT set (8527). The soft gripper is made by pouring a mixture of Ecoflex silicone material into a 3D printed mold and letting it solidify. With an air tube, a hole is punctured at the center of the gripper. The gripper is inflated to curl and grip the objects with the help of a squeeze bulb attached to the other end of the air tube. The materials needed are: Ecoflex 00-30, Ecoflex 00-50, Polaroid Squeeze bulb, polyethylene tubing and a 3d printed mold made of ABS plastic.

Results

The results indicate that the soft robot is adept at gripping curved objects with varying circumference. However, the soft robot could not lift certain objects, such as the small plastic egg, the ruler, and the T.V remote, all of which was held with ease by the claw gripper. The soft gripper could not hold these objects due to their skinny, rectangular nature. The soft gripper's appendages could not curl enough to clasp such objects.

Conclusions/Discussion

The results reveal that the soft gripper is better suited towards holding curved and irregular objects, while the claw gripper excels at holding small or rectangular shaped object. My hypothesis in this experiment was that the soft gripper would outperform the claw gripper in terms of dexterity. My hypothesis was validated, because the soft robot was able to lift the curved irregular objects that the claw gripper could not. The soft gripper could not hold the small rectangular objects because its ability to curl was limited by its larger size. If a smaller version of the soft gripper was made, it would be able to curl around and hold smaller objects. In order to further investigate upon these gripper's uses, further experimentation could be conducted.

Summary Statement

Comparing the dexterity of a conventional claw gripper and a bio-inspired soft silicone gripper that are mounted individually on a robotic arm.

Help Received

Dr.Li of Avid Academy helped me choose the topic; Mr.Ben of Science Buddies helped with trouble shooting while making the soft gripper. My mom helped me get the components and reviewed the report.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Alex C. Tacescu

Project Number

S0315

Project Title

Project Maverick: An Omni-Directional Robotic Mobility System

Abstract

Objectives/Goals

Nearly 40 percent of people age 65 and older had at least one disability. Of those 15.7 million people, two-thirds have difficulty walking. People who cannot walk unassisted, including those with Parkinson's disease or muscular dystrophy, may use a walker as an assist and eventually a wheelchair. Both of these have their deficiencies. A walker requires its user to balance and push along. Wheelchairs provide physical respite but often, muscular atrophy sets in. A wheelchair is also difficult to operate in tight spaces while a rigid walker does not offer a suitable solution either because its user must carry it around. This is where Project Maverick comes in: an omni-directional robotic system that provides mobility for users in a standing or sitting configuration by moving in any direction with an intuitive control system.

Methods/Materials

Linux based microcontroller: BeagleBone Black, Electronic Speed Controller, Absolute positioning sensors, Analog distance sensors, Slip rings, Slew Bearings, Steering and Driving Gearmotor, Gears, belts, pulleys, bearings, Aluminum and 3D prototyped manufactured parts, Power Supply, Oscilloscope and Multimeter

Results

My robotic system is designed to have extreme maneuverability combined with ease-of-use. It accomplishes this by using a new and innovative drive system containing 4 wheels and 8 motors. Each wheel has two independently-controlled motors for steering and driving, providing maximum flexibility. This system is simple and modular, built out of 4 identical wheel assemblies, and is economically feasible to be mass produced. It utilizes a flexible Linux-based controller programmed in Java that allows the implementation of advanced features, such as collision detection and autopilot through tight doorways. The main user input device is a 6-axis 3D controller, providing a simple and intuitive driving system.

Conclusions/Discussion

I believe that my project has a lot of potential on the market, being intended to help people with disabilities regain their mobility. The feedback received from people in the field was positive. I plan on building the first complete prototype and testing it, first on myself, and then on a volunteer. I realize that this might take a few iterations until my project will turn into a product, but I am looking forward to improve the lifestyle of many people around the world.

Summary Statement

My project is a robotic system that provides mobility for people with disabilities, using an innovative drive system with 8 motors that allows the user to move in any direction and a 6-axis 3D controller as an input device.

Help Received

Exelsior and Sunrise Medical machined the parts I designed. I provided 3D models and engineering drawings.