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EWH CHAPTER OF THE YEAR COMPETITION REPORT

Chapter/University Name: Cornell University
Date: April 5, 2015

PROGRAMS/PROJECTS DESCRIPTION

Design projects:
This year we are working on 4 projects across the two technical sub-teams (the biological /structural subteam and the electrical/computer engineering subteam) with details listed below.

<u>Anti-Microbial Baby Holster</u>

To combat deadly neonatal infections, we designed antimicrobial fabrics that could be used to make a holster for the baby during its earliest months of development after birth. This doubles as a sling for Kangaroo Mother Care, a technique found effective for keeping premature babies warm. Coatings of aloe-vera and chitosan were cured onto cotton which was laid on e.coli-covered agar to test for ability to repel bacteria. We encountered problems in fabric contamination prior to curing and employed the Taguchi Method to eliminate variables and create a sterile way to create the fabrics. Also, it required careful planning of resources and time to test all possible permutations of bacterial and fabric coating concentrations since lab time was limited. Thus lab work was done every day for 5 weeks. See Appendix Figure 1 for test results.

<u>Autologous Blood Transfusion Device</u>

Due to the paucity of blood-donation banks in sub-saharan Africa, where the leading cause of maternal mortality is due to ectopic pregnancy ruptures, the most feasible way to replace blood during surgery is by autologous blood transfusion. We propose a foot-pedal device that can efficiently remove blood from the patient during surgery and reintroduce the blood after putting it through a closed and sterile filtration system that will remove all clots and air. Challenges were encountered in designing an anti-coagulant introduction system as well as a method to remove air from the blood. This was solved by using the pump's suction to pull anticoagulant into the stream of blood being removed and running it through a two-bag system to evacuate air. See Appendix Figure 2 for CAD models. Prototype is in the process of being built.

<u>SMS-linked Vital Signs Monitor</u>

Since many hospitals in developing nations lack medical personnel, we designed a portable and low cost vital signs monitor that is connected to a base station that can coordinate between a network of monitors and alert a nurse if a patient's vitals fall into a dangerous zone. This new component, the base station, posed some challenges in determining an appropriate method of communication between each monitor and the base station. We eventually decided upon using RF since it makes long-range communication possible with little power expenditure. Another challenge was finding a way for multiple monitors to transit data to a single station without having data collisions. Our solutions was to create a multi-threaded application within the base station to spawn a new thread each time a change was to be made in the patient database when information is transmitted. See Appendix Figure 3 for CAD models and test results.

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Smart Diagnostic EKG

To combat a lack of trained medical personnel, we created a smart EKG that is capable of processing the signal and determining if the patient has one of 40 possible diseases diagnosable by EKG. One of the biggest challenges was in finding an appropriate data training set to implement the machine learning. We managed to obtain a large dataset and manipulated it to fit our needs. Another problem was finding a way to implement the real-time analysis. To make this as low-cost as possible, we created a machine-learning algorithm on a single microprocessor. Since this project was recently started, we have not yet been able to test it and are instead focusing on creating the analysis algorithm and the EKG itself.

STEM activities:

Last year, we worked with a local Girl Scout Troup (8 girls) who were middle school to early high school aged. We taught them how to solder and create their own Simon Says game breadboard from a kit to encourage interest in engineering amongst young girls. They told us they thought it was an interesting experience unlike ones they've had in class and were amazed at the working circuit board they built themselves. We hope to host this again this at the end of the year with another troupe.

Working in the Field

Trip to Peru:

This January, Cornell EWH sent 5 of our members on a week-long trip to Peru to work with mobile clinics and obtain a cross-cultural perspective on the medical needs of developing nations as well as how medical devices are implemented there. We reached out to and partnered with MEDLIFE International to work with their clinics. We fully funded the entire trip (clinic cost and travel cost) by raising over $7500 through a crowdfunding campaign run with Cornell to obtain donations from alumni as well as the College of Engineering. Members were able to work directly in the clinics with doctors and interact with patients, allowing them to generate a number of new project ideas, such as for a dehumidifying chamber for infants and a scoliosis brace. See Appendix Figure 4

Future activities:

We hope to find new travel opportunities to better our understanding of medical needs in developing communities by having more regular trips to local resource-poor hospitals to see existing problems as well as continuing to send students abroad on trips like the one to Peru.

ORGANIZATIONAL ACTIVITIES

Chapter Structure and Statistics

The Cornell chapter has 26 members distributed across 2 main technical subteams and one business/finance subteam. 13 members are part of the ECE/CS sub-team while 12 members are in the biological engineering/structural subteam. The treasurer is head of the business and finance sub-team. Each technical sub-team is headed by one sub-team lead and an overall team-lead oversees both sub-teams.

Sub-team leads are in charge of running meetings/work sessions for their sub-team as well as managing all task assignments for projects under their subteam from the initial brainstorming to the final prototype. The treasurer is tasked with managing the budget. The overall team lead is in charge of administrative duties and establishing contacts with workers in global health fields to obtain input on project designs.

EWH at Cornell is a student-run team and class members can take for credit. Members can choose to take it for between 1-4 graded credits, which requires between 2-14 hours of work outside of weekly meetings. There is a general body meeting each Monday that all members must attend (90% attendance) where sub-teams give updates on their weekly work. Each sub-team also meets at least twice a week for work sessions (ECE/CS meets on Tuesdays and Sundays with 98% attendance while biological/structural meets Mondays and Wednesdays with 98% attendance). However as prototyping and testing phases begin, subteams often meet more often during the week (up to every day). Each member is assigned a specific task in further research or design to complete during the week, often working with fellow members.

Fundraising approaches

Since this chapter of EWH is a student project team, we receive funding from the Cornell College of Engineering. At the beginning of the year, a proposed budget encompassing projected material costs and travel expenses is defended to obtain funding (~$3000). Our chapter is looking to reach out to corporations in order to obtain further sponsorship.

Other chapter activities:

After meeting two representatives of MedTech this semester, we are looking to establish a speaker series with them that can provide insights on better design considerations for the third world as well as important device fields to consider.

Our chapter also hosts social events for the team to encourage members from different subteams to get to know each other. We have had ice-skating nights, potlucks, and dinners at local restaurants in the past.

EWH CHAPTER FEEDBACK.

For outreach events, it would be helpful if the national chapter could help provide some funding in purchasing kits that we could use for demonstrations/events to help encourage interest in STEM fields.

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APPENDIX - PHOTOS, TABLES, SCHEMATICS AND ADDITIONAL MATERIAL

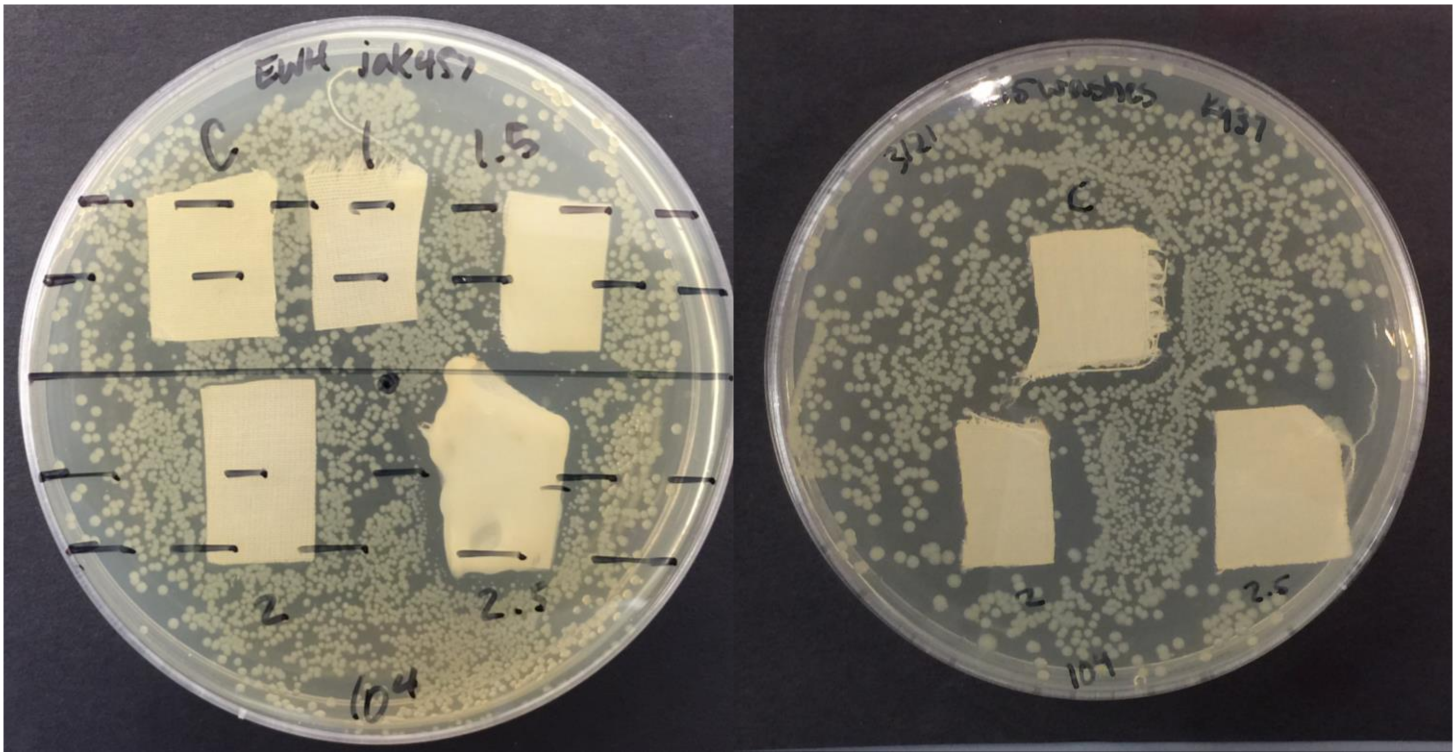

Figure 1: Some preliminary data from anti-microbial fabrics testing showing the effectiveness of Chitosan as an antimicrobial coating. Concentrations of chitosan were tested of 1, 1.5, 2, and 2.5 weight percent solutions. Shown here (left) are fabrics that were allowed to soak in the solutions for 24 hours and then cured at 120 degrees Celsius for 5 minutes before being plated on an agar plate streaked with e.coli at a concentration of 10^4 cells/mL. The 2.5wt% chitosan cured fabric was strong enough to cause disc diffusion, or create a bacteria free zone around it. Further tests were done by washing the fabrics. Shown here (right) are fabrics that have undergone 15 washes. Not pictured are other experiments repeating with various aloe concentrations and other chitosan concentrations, all of which were plated at different bacterial concentrations varying from 10^8 cells/mL to 10^4 cells/mL. These initial effectiveness tests were also repeated for up to 50 washes for the various fabrics created.

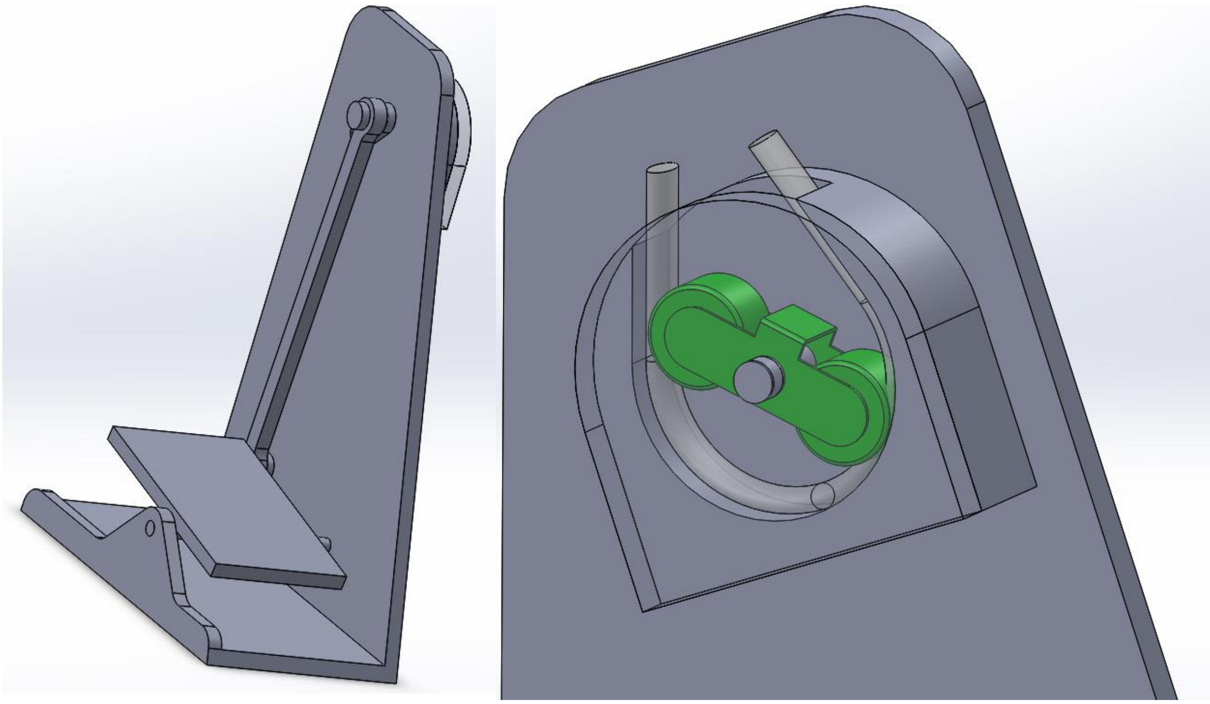

Figure 2: Shown here are the CAD models for the foot-pump portion of the autologous blood transfusion device. The pump consists of a foot pedal (shown left) that can be easily pushed to turn the peristaltic pump (pictured right). The pump wraps around tubing that is connected to a nozzle at one end that can go to the patient to draw out blood. The blood then gets pushed through the tubing using the foot pedal/pump assembly and into two blood bags (not pictured) where air can be let out of the fluid. As the blood goes through the tubing, it will be introduced to citrate anticoagulant that is dripped in and drawn in by the motion of the fluid moving through the tubing. Assembly of the actual prototype in the machine shop is currently in progress.

Figure 3: Shown above is the final assembly of the vital signs monitor that has gone through many stages of development since our submission last year. The monitor has evolved so that a new separate component, the base station, has become the main focus. The premise behind this project is that a network of multiple vital signs monitors placed throughout a hospital or disaster zone could communicate wirelessly through RF transmission to a single base station which keeps track of the state and location of the individual patient hooked up to a monitor. The base station (separate) consists of a single Raspberry Pi microcontroller with an SMS transmission device attached along with a small screen to display the GUI. It is capable of sending SMS texts to a nurse in case a patient falls into a dangerous vital zone. The base station is also able to communicate through Wi-Fi. We are in the process of building a web app which can clearly display the status of each patient with a monitor so that a nurse can observe patient vitals in real-time. We are in the process of testing the base station although the vital signs itself has already been proven able to detect heart rate, blood oxygenation, and temperature comparable to current machines on the market.

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Figure 4: Pictured here are the 5 EWH members who went to Peru to work with MEDLIFE's mobile

clinics. Pictured on the top (left) are members working at the education tent where they taught incoming patients the importance of basic medical practices such as brushing teeth and how to prevent infection. The students would help set up the tents and medical equipment, and then follow an assigned general doctor, OB-GYN, pharmacist, or dentist throughout the day, assisting when possible (top right). After a day with the clinic, the members would have daily meetings where they would discuss their experiences and generate new project ideas and take notes on ideas they wanted to take back to the team. Pictured at the bottom right is the team with Anita, a helpful doctor they met who helped provide inspiration behind the new dehumidifying chamber idea.

Figure 5: Team picture of Cornell's EWH chapter for the 2014-2015 school year (1 member not pictured)