VALERII KULAGIN

BIOMEDICAL ENGINEERING AT THE GEORGIA INSTITUTE OF TECHNOLOGY

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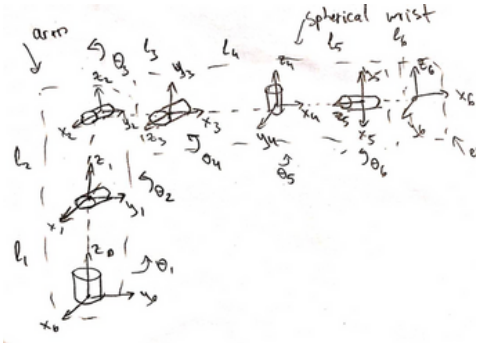
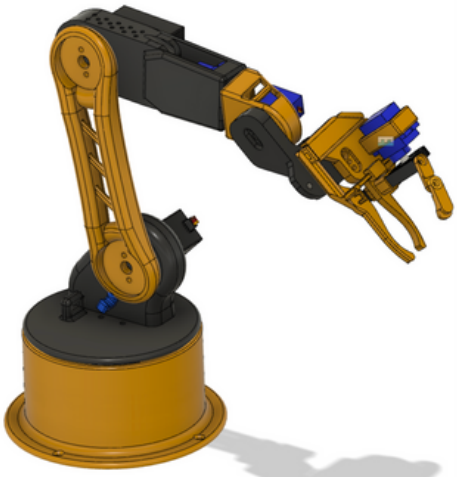
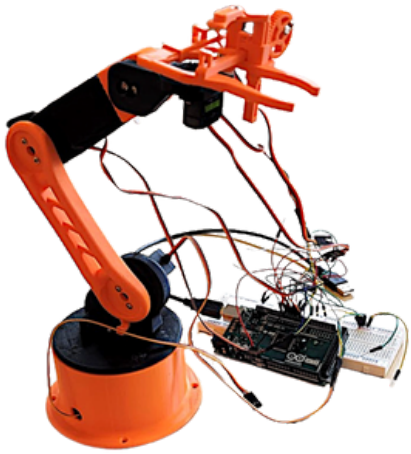
PIPETTING ROBOT ARM







What?

- Made a cost-effective **automated liquid pipetting device** to reduce human error

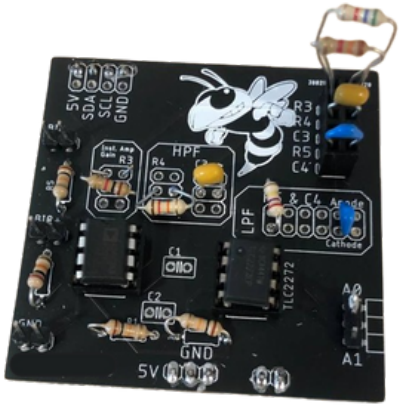
How?

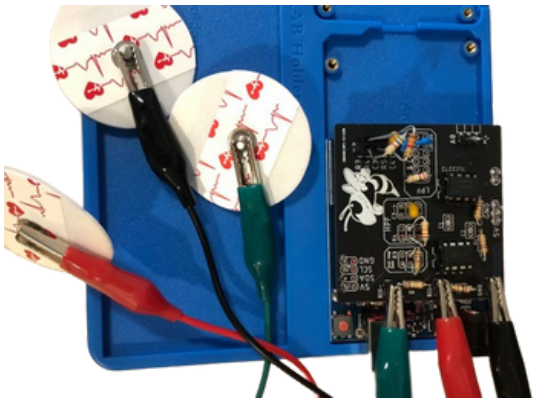
- Developed 3D model of 7 DOF robotic arm using **Autodesk Fusion 360** and **SOLIDWORKS**
- **3D printed** the arm and assembled a circuit with servo motors based on **Arduino** Mega
- Programmed the arm using **MATLAB** and principles of **inverse kinematics**, **resolved rates** and **trajectory planning**

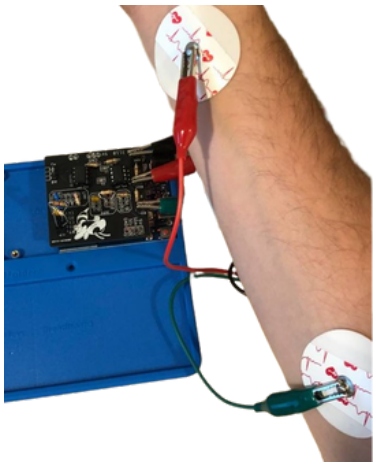
Results

- Robotic arm was able to hold pipette and press down on it
- The arm was able to smoothly move into requested position with ± 2 mm accuracy

EMG MOTION RECOGNITION







What?

- Developed a device for **forearm motion recognition** using EMG electrodes
- Explored quality of motion recognition depending on electrode placement

How?

- **Soldered** a circuit to read voltage and filter noise from several **EMG** sensors
- Explored three electrode placements and performed **hardware validation**
- Programmed the EMG device using **C++** and **MATLAB** and preformed **frequency analysis**
- Analyzed correlation of EMG signal with grip force measured with **dynamometer** and rotation torque with **torque meter**

Results

- Validated hardware performance with R^2 equal to 94%
- The device was able to recognize grip vs wrist rotation with p-values up to 1.07×10^{-5}

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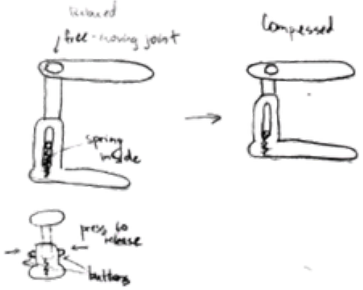
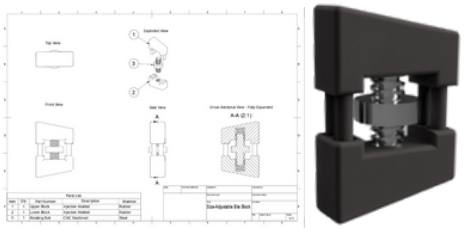
DENTAL BITE BLOCK





What?

- Designed a **size adjustable dental bite block** to alleviate temporomandibular joint dysfunction (TJD)
- Performed **engineering analysis** to determine **design requirements**

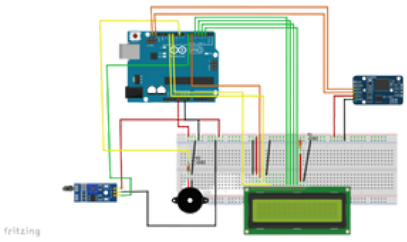
How?

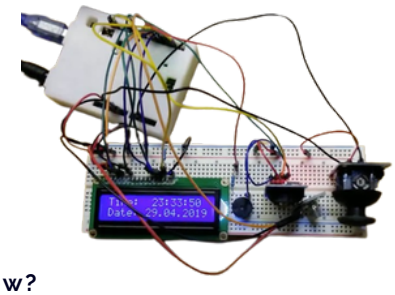
- Used **Autodesk Fusion 360** for design and engineering drawings
- Used **rapid prototyping** techniques (3D printing)
- Recorded progress in **design evolution and evaluation matrix**

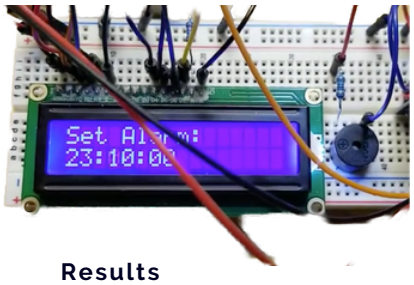
Results

- Final design was able to adjust between 24-32mm accounting for more than 90% of adult population

REMOTE CONTROLLED ALARM







What?

- Made a fully functional remote controlled alarm

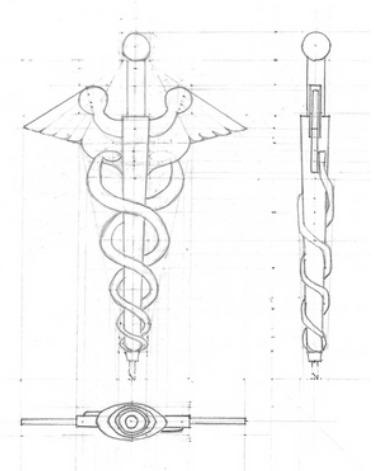
How?

- Created a circuit diagram using **Fritzing**
- Programmed the display and infrared remote control using **C++**
- Assembled a circuit with LCD, infrared sensor, buzzer, joystick and RTC module

Results

- Alarm was able to track time with power off
- Alarm was successfully controlled using a conventional remote

CADUCEUS SYRINGE



What?

- Designed a medical device with complex shape to demonstrate expertise with 3D modeling software for engineering design course

How?

- Created an engineering sketch of a syringe designed to administer two liquids at the same time.
- Used the sketch as a basis for generating 3D model and rendered it using **Autodesk Fusion 360** software.

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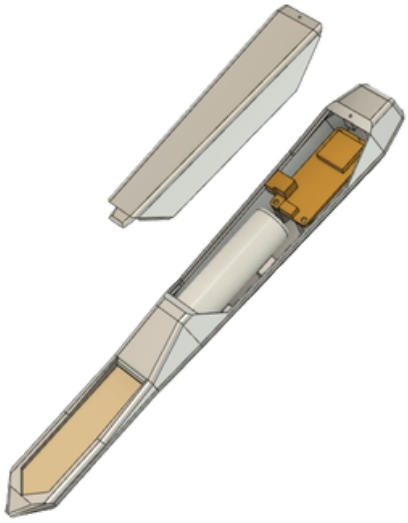
SMART IRRIGATION SYSTEM (CREATEX CAPSTONE)



What?

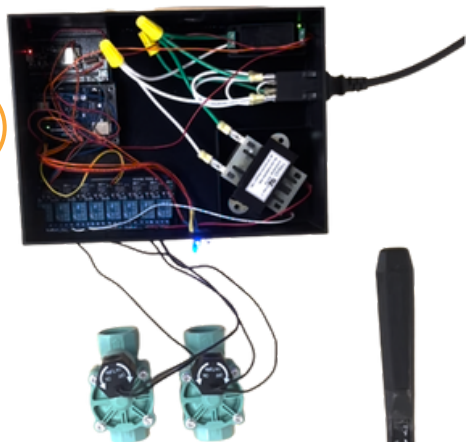
- Designed a **wireless soil moisture sensor** for smart irrigation system for household water conservation that can be installed easily by homeowners
- Performed **customer discovery**, **competitor analysis** and **engineering analysis**

How?

- Used **Autodesk Fusion 360** for design and engineering drawings
- 3D printed the case using **polyjet 3D printer** Stratasys J750
- **Soldered** and assembled waterproof sensor with **long range** (LoRa) **radio** communication

Results

- Final design was waterproof and able to measure soil moisture in real soil
- The sensor was able to transmit LoRa signal from underground

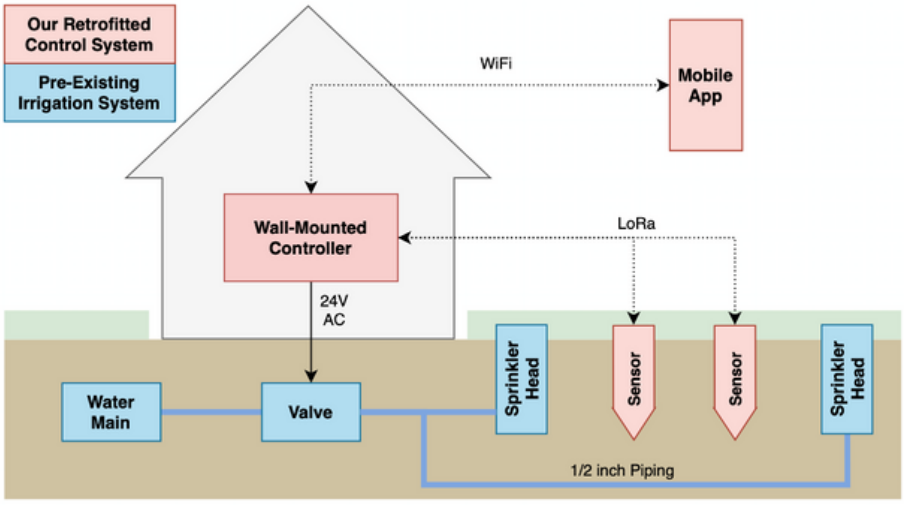


Control box

Mobile app

Valves

Sensor



Soil moisture detection → Moisture Data Analysis → Irrigation → Water conservation