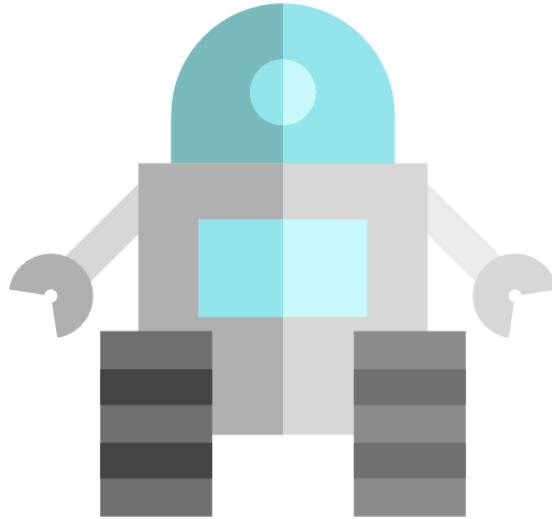# Botsyn

The social *robotics* network

CS5001 Senior Design Fall 2017

Joseph Kollin
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Stephen Enochian
John Mikolay

Advisor:

Dr. Phillip Wilsey

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Project Abstract

Botsyn is a social networking robotics platform intended for educational purposes. The project combines web and mobile applications (Android & iOS) with intuitive embedded software to allow users to control their robots over the Internet.

Users will be able to connect their robots to our platform through the embedded software and then view and/or control their robots from a computer or mobile device in real-time using our web and mobile apps. Users will also be able to manage the permissions for their individual robots to allow other Botsyn users to connect to their creations from anywhere with an Internet connection.

Botsyn is designed to foster robotics development and encourage young, like-minded robotics enthusiasts to share their creations. Besides developing and testing the application itself, our primary goal is to introduce the platform to at least one secondary school in the tri-state area. We hope to get feedback on our platform's ease-of-use as well as its viability as a possible learning tool for schools and robotics clubs.

Project Description

Background Description

The aim of this project is to create a web and mobile (Android and iOS) platform to allow users to control one another's robots through a robust, user-friendly UI. Our web and mobile app will allow users to connect their robot to our network via custom embedded software, control their robot in real-time, and stream video live to other members of the platform. In addition, the application will contain an affordable web store which will allow community members to purchase custom robotics kits and parts compatible with our application.

Problem Statement

Technology is ubiquitous in the modern world and getting students involved in it as early as possible is key to progress. Student involvement with robotics at an early age is rare and would be beneficial to their education. This platform will provide an affordable, enjoyable, and intuitive means by which students could get involved with elementary robotic systems. In addition, getting students to take an interest in robotics at an early

age can be a challenge. Some students may assume it to be challenging or boring. The real-time control and streaming features of the site will promote excitement and sociability between students who are members of the community.

Inadequacy of Current Solution

Currently a platform exists called letsrobot.tv which allows users to connect their robots, randomly control any other member's robots, and chat live. We would like to provide a similar service to the *letsrobot* site but less convoluted and more user friendly. Also, their application fails to appeal to a younger audience and lacks restrictive measures for robotic system control between multiple users.

Background Skills / Interest

Our team has extensive experience in web development and robotics from our separate co-op experiences and personal projects. Some of the types of development and frameworks that we have interest in or experience with include:

Full Stack Web Development

- JavaScript -- Node, Express, Vue, Angular
- UI/Design -- CSS, SASS, Twitter Bootstrap
- Database -- MySQL, PostreSQL, MongoDB, DynamoDB
- IaaS/PaaS -- AWS services, Heroku

Mobile Development

- Android native -- SDK, external NDKs
- Cross platform -- Apache Cordova, PhoneGap

Robotics Development

- Embedded -- RPi, Arduino, GPIO/PWM control
- Design -- 3D modeling/printing

Approach

Our team will utilize the agile methodology to develop the application. During the planning stages of the project, we will use a combination of Google Drive and Slack. We will be doing the bulk of development during the Christmas break, during which, we will maintain a Kanban board in Trello and burndown charts to record and ensure regular

progress. By using Kanban, we will be able to logically partition tasks and break the project up into discrete, manageable chunks. We will split up project tasks according to our individual experience.

Goals

- Develop a web application which will allow users to:
    i. Connect their robotic system to our platform
    ii. Interact with their and other users' robotic systems in real-time
    iii. Purchase robotics parts and custom kits compatible with our platform
- Develop open-source, embedded software to allow users' robots to easily communicate with our application
- Introduce the application to at least 1 local secondary school

Final Presentation Expectations

For the final demo, we hope to deliver a live demonstration of the application's controls as well as the components of the website.

User Stories and Design Diagrams

User Stories

Marketing Page User Stories

- As a User, I want to be able to sign up and sign in to the application from a marketing site so that I can take part in Botsyn.
- As a User, I want to be able to view legal documents such as terms of use so that I can come to understand the legal scope under which Botsyn operates.
- As a User, I want to be able to view pricing information for Botsyn so that I can understand its cost relative to my status.
- As a User, I want to be able to view general information and instructions for how to use Botsyn so that I can confidently utilize the application.

Core Application User Stories

- As a User, I want to be able to add robots to the application so that I can sync my robot to the application itself.
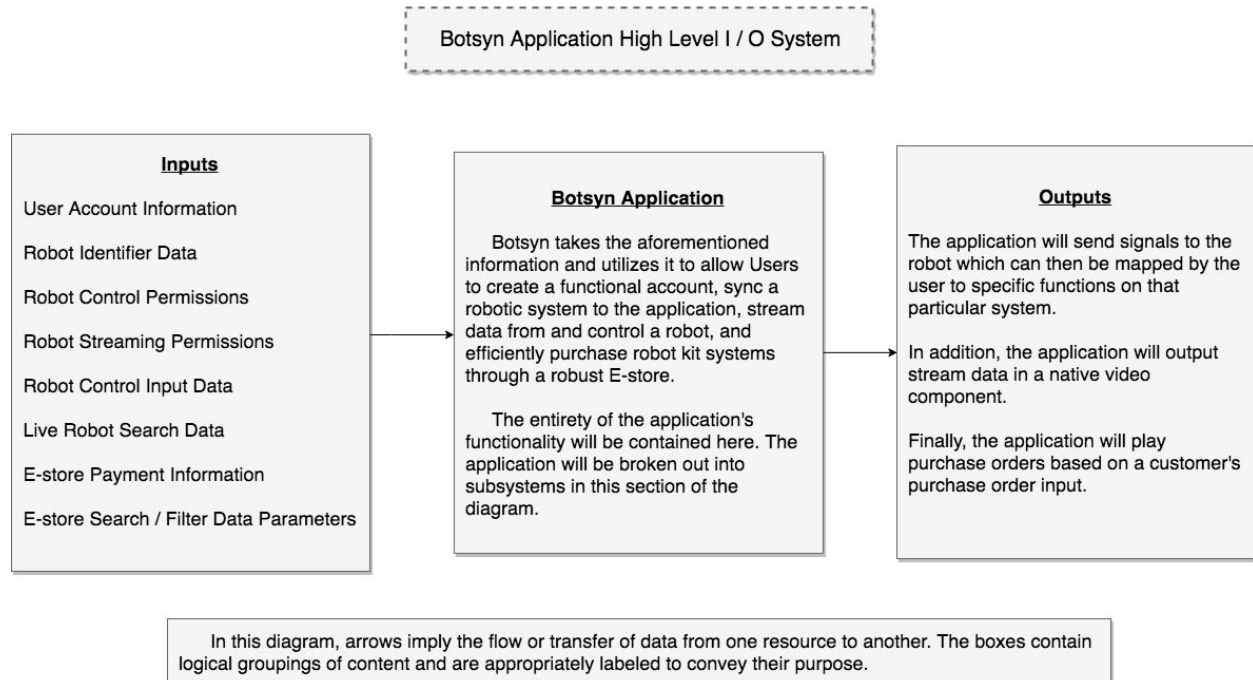
- As a User, I want to be able to connect my robot(s) to the application so that I can relay information between both the site and my robot.
- As a User, I want to be able to search for robots by name so that I can find my own robot or one of my friends'.
- As a User, I want to be able to control permissions for the robot so that I can determine who can view streams of or control the robot.
- As a User, I want to be able to control my robot through the application so that I can gain experience and utilize the application.
- As a User, I want to be able to stream video from my robot to the site so that I can show my friends what my robot it doing and so that I can control the bot remotely.
- As a User, I want to be able to view a gallery of available streams for robots so that I can quickly find which robots are available or being utilized.
- As a User, I want to be able to participate in a live chat so that I can communicate with others watching the stream of a particular robot.

E-store User Stories

- As a User, I want to be able to purchase robotic kits with instructions so that I can sync a robotic system which I created to the application.
- As a User, I want to be able to purchase individual parts for the robots so that if some part of my robot malfunctions or is damaged, I will be able to repair it easily.
- As a User, I want to be able to checkout as a guest so that I can purchase kits without being an official member of the site.
- As a User, I want to be able to checkout with my Botsyn account so that I can easily complete the checkout process and keep track of my order history.
- As a User, I want to be able to view my order history so that I can reorder kits if one is damaged or broken.
- As a User, I want to be able to search available products by name so that I can easily find the product that I am hoping to purchase.
- As a User, I want to be able to filter the search by reviews, pricing, etc. so that I can more easily find what I am looking for if a search returns a large number of results.
- As a User, I would like to be able to review products which I have purchased so that I can inform other potential customers of the quailty of the product.

Design Diagrams

Level 0 Diagram

Botsyn Application High Level I / O System

Inputs

User Account Information

Robot Identifier Data

Robot Control Permissions

Robot Streaming Permissions

Robot Control Input Data

Live Robot Search Data

E-store Payment Information

E-store Search / Filter Data Parameters

Botsyn Application

Botsyn takes the aforementioned information and utilizes it to allow Users to create a functional account, sync a robotic system to the application, stream data from and control a robot, and efficiently purchase robot kit systems through a robust E-store.

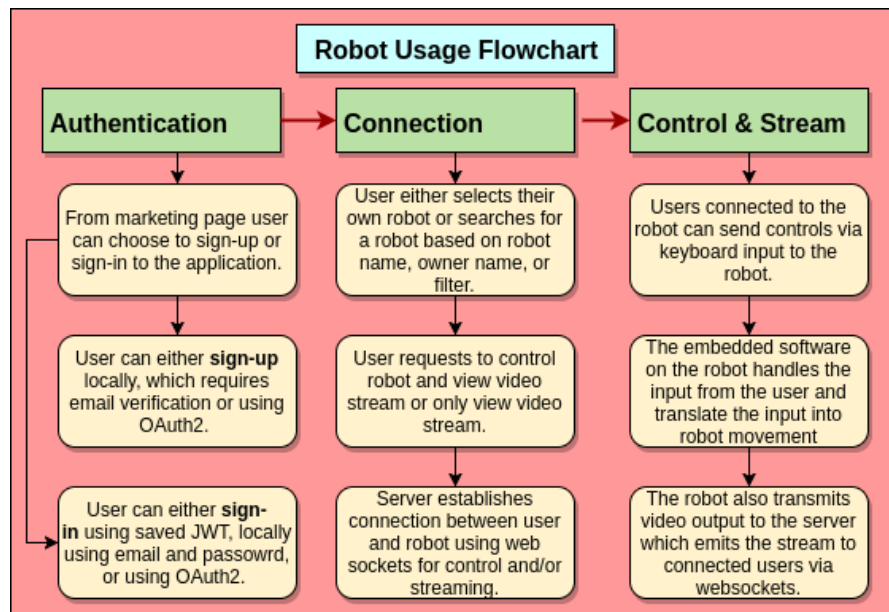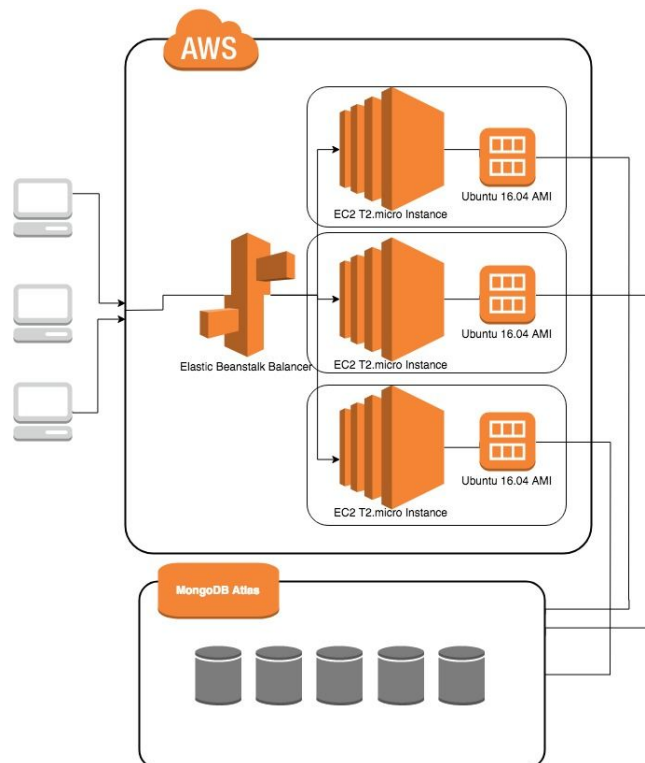The entirety of the application's functionality will be contained here. The application will be broken out into subsystems in this section of the diagram.

Outputs

The application will send signals to the robot which can then be mapped by the user to specific functions on that particular system.

In addition, the application will output stream data in a native video component.

Finally, the application will play purchase orders based on a customer's purchase order input.

In this diagram, arrows imply the flow or transfer of data from one resource to another. The boxes contain logical groupings of content and are appropriately labeled to convey their purpose.

Level 1 Diagram

Robot I/O Diagram

Authentication

Clients are authenticated using JSON web tokens (JWTs) via either a local authentication (email and password) or an OAuth2 authorization using Google or Facebook.

After successful authentication, the client is redirected to the main app. The client also stores a new JWT received by the server in browser's local storage to be used for successive authentications. Tokens have a lifespan of one week after creation.

Connection

After the client gains access to the application, they will be able to connect to and manage their robots as well as connect to other users' robots.

Robots will be able to be controlled by one client at a time but their video output stream will be able to be viewed by multiple users.

Robot connections will be established using web sockets and persist until the client disconnects.

Control & Stream

The robot's will use embedded software to manage control input from the client via web sockets.

Universal input will be sent to the robots (forward, backward, left right), but it will be up to the user to determine how those inputs are used to actually control robot itself.

The embedded software will also emit a video stream to the robot's connected clients using web sockets.

Input

Output

Level 2 Diagram

Robot Usage Flowchart

Authentication	Connection	Control & Stream
From marketing page user can choose to sign-up or sign-in to the application.	User either selects their own robot or searches for a robot based on robot name, owner name, or filter.	Users connected to the robot can send controls via keyboard input to the robot.
User can either **sign-up** locally, which requires email verification or using OAuth2.	User requests to control robot and view video stream or only view video stream.	The embedded software on the robot handles the input from the user and translate the input into robot movement
User can either **sign-in** using saved JWT, locally using email and passowrd, or using OAuth2.	Server establishes connection between user and robot using web sockets for control and/or streaming.	The robot also transmits video output to the server which emits the stream to connected users via websockets.

Application Architecture Diagram / Implementation

Project Tasks and Timeline

Joseph Kollin Task List

- Develop a secure payment system.
- Create a catalog of available inventory.
- Develop a search system to allow users to search for catalog items and filter the results.
- Store and link purchase history to users' accounts.
- Develop a live chat client for each connected robot.

Dane Isburgh Task List

- Develop a robust user accounts system.
- Develop a system to add, search for, and connect robots.
- Develop an interface which will allow users to manage their robots (permissions, connections, etc.).
- Develop a robot control interface that will display video output from the robot and allow the user to send control input.

John Mikolay Task List

- Develop an admin messaging system to display and allow responses by email to users' queries.
- Develop an admin site which will convey real time user information in an efficient dashboard.
- Develop an admin site which will allow an admin to manage user accounts (block, delete, etc.).
- Develop an admin console which will allow an admin to view and manage robot connections.
- Create an admin site which will allow an admin to view the e-store's purchase history.

Stephen Enochian Task List

- Develop a single page marketing component to allow users to sign up and sign in to the application.
- Compile and link to relevant legal information (privacy policy, terms of service, etc.).

- Develop a contact component / form to allow users to notify admins of issues, questions, etc.
- Develop a general information / instructions component accessible from the main application and the marketing site to educate users.
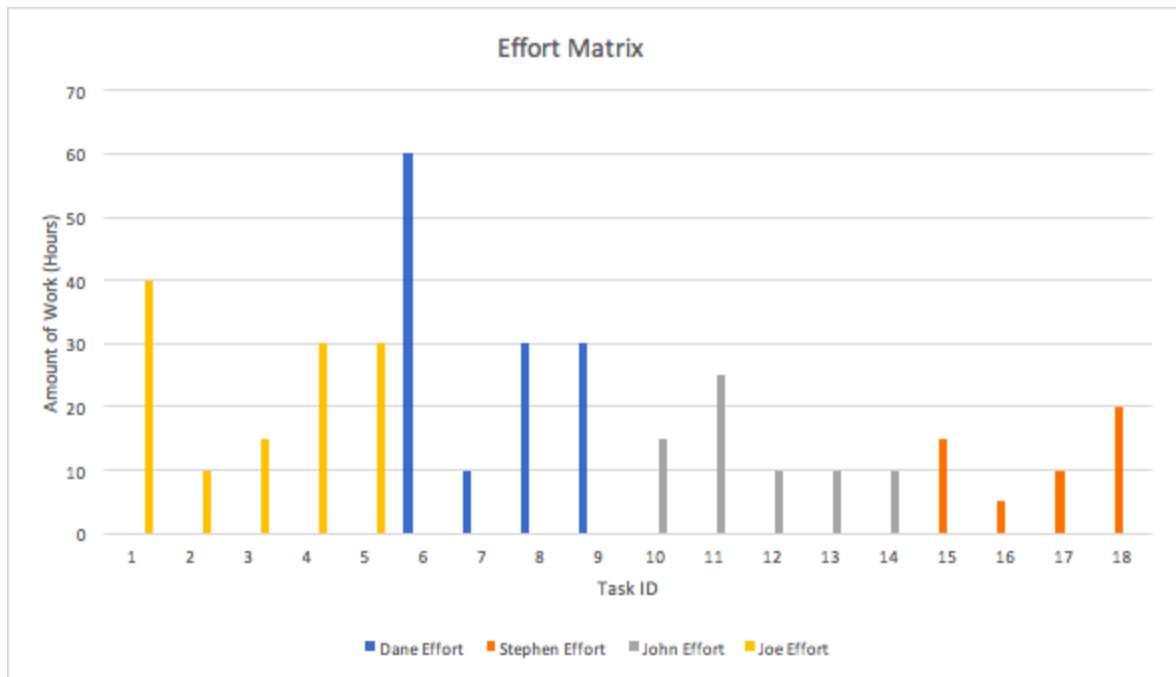
Development Timeline

Task Id	Description	Duration (Hours)	Start	Finish	Predessor's
1	Develop a secure payment system.	40	11/1/17	12/1/2017	N/A
2	Create a catalog of available inventory.	10	12/1/17	12/8/2017	N/A
3	Develop a search system to allow users to search for catalog items and filter the results.	15	12/8/17	12/15/2017	2
4	Store and link purchase history to users' accounts.	30	12/15/17	12/29/2017	1,6
5	Develop a live chat client for each connected robot.	30	12/15/17	12/29/2017	N/A
6	Develop a robust user accounts system.	60	9/1/17	11/1/2017	N/A
7	Develop a system to add, search for, and connect robots.	10	11/1/17	11/11/2017	6
8	Develop an interface which will allow users to manage their robots (permissions, connections, etc.).	30	11/11/17	12/11/2017	7
9	Develop a robot control interface that will display video output from the robot and allow the user to send control input.	30	11/11/17	12/11/2017	7
10	Develop an admin messaging system to display and allow reponses by email to users' queries.	15	12/10	12/24/2017	11
11	Develop an admin site which will convey real time user information in an efficient dashboard.	25	10/29/17	11/18/2017	N/A
12	Develop an admin site which will allow an admin to manage user accounts (block, delete, etc.).	10	11/18/17	11/25/2017	11

	Description				
13	Develop an admin console which will allow an admin to view and manage robot connections.	10	11/25	12/10/2017	7, 11
14	Create an admin site which will allow an admin to view the estore's purchase history.	10	1/1	1/8/2017	4,11
15	Develop a single page marketing component to allow users to sign up and sign in to the application.	15	11/7/17	11/22/2017	N/A
16	Compile and link to relevant legal information (privacy policy, terms of service, etc.).	5	11/1/17	11/6/2017	N/A
17	Develop a contact component / form to allow users to notify admins of issues, questions, etc.	10	11/27/17	12/6/2017	N/A
18	Develop a general information / instructions component accessible from the main application and the marketing site to educate users.	20	11/7/17	12/29/2017	15, 16, 17
19	Application Review Testing 1	>25	1/7/2018	1/13/2017	1-18
20	Fixes/Polishing for tasks 1-18	>25	1/14/2018	1/20/2018	1-18
21	Application Review Testing 2	>40	1/21/2018	Continuous	1-20
22	Video Tutorials	40	1/21/2018	2/28/2018	1-20
23	School Demo	20	Beginning of March		1-20, 22

*A review will be done in the beginning of January to create more specific tasks and estimates. Until our review we can project that from January up to the expo we will be testing and finalizing the app. However; until after our review we won't have a specific timeline for tasks to ensure we have room to add our review conclusions to the timeline.

Effort Matrix

*Task ID numbers correspond with the Task ID's in the Development timeline.
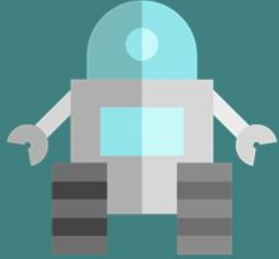
ABET Concerns Essay

Botsyn is designed to be a web and mobile application that will allow potentially thousands of users to connect to each other's robots in real-time. Economically, we plan to use a freemium pricing model to monetize the app and supplement the cost of hosting. For development and production, we are using Amazon Web Services (AWS) to host our staging and full-scale applications as well as manage our data stores. We do not have any funding and will be required to pay for a majority of these services out-of-pocket. The project can be broken down into three separate websites: 1) a staging site for testing, 2) an administration site for user and robot management, and 3) a full-scale production web application and API. We will also be developing mobile applications for iOS and Android; these applications will be made available in their associated app stores and thus we will not incur any additional costs for their development/hosting. The sites will be hosted on AWS Elastic Cloud Compute (EC2) instances. The staging and admin sites will be hosted on the same instance and the total cost of hosting will be approximately $10/month. Upon the project's completion, we will develop a full-scale production app capable of handling a large volume of users using a combination of AWS's EC2, Elastic Beanstalk, SES, Elasticache, and other services. Because of the services required, the cost of the initial production site will be approximately $100/month but will increase as usage increases. Ultimately, the production website will allow us to effectively monetize the application through the freemium pricing model. The model will give users certain permissions for a limited period of time every month free-of-charge but will then charge to increase usage time or permissions. This will allow us to earn the minimum amount required to host the site and maintain its services.

The scope of the Botsyn project will certainly allow for all of us to further our professional skills. The project in its entirety requires that we establish a public presence, work closely with local educators, and develop a robust, user-friendly platform. This will allow each of us to gain experience marketing a completed product, communicating with industry professionals, and developing a platform from scratch. From a technical perspective, the project does require a great deal of specialized expertise. Specifically, it requires a working knowledge of web application architectures as well as a thorough understanding of hosting platforms, Mongo database technologies, and the Vue.Js web application javascript framework. While the marketing and communication skills required for this endeavor are important, the technical aspect of this project will most directly contribute to our professional development as computer scientists.

Botsyn will enable users to gain remote access to their robots through our application. From a security perspective we will need to ensure that only authorized users are able to gain control of a person's robot. Our database will also be holding encrypted user passwords. We will need to ensure that the techniques we use for encrypting/decrypting these passwords is secure from malicious actors. To achieve this we will research and implement proven architecture designs and utilize code scanning tools to check for vulnerabilities our app may be exposed to. An admin site will also be implemented for our application that will allow us to disable users and monitor application usage for suspicious activity.

Our project is designed to grow the awareness, usage, and accessibility of robotics within the private, personal, and education sectors (via STEM initiatives). Socially, this initiative provides the flexibility to utilize robotics in a non-traditional sense for many of these organizations which are used to localized operation using pre-owned equipment. Further, the convenience of sharing resources helps reduce the economic barrier many may experience while growing their STEM and specifically robotics initiatives. As students excel in their STEM studies, they gain useful skillsets and strengthen their adaptability in an ever-changing world. These skills - when honed at an impressionable age - can open doors to future endeavours and interests many students may not have previous considered. Finally, as we grow our program and initiatives, we would explore nonprofit/education pricing and flexibility to better work with those with limited budget/resources.
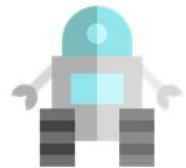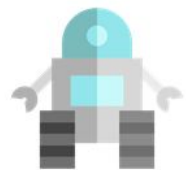
Slideshow
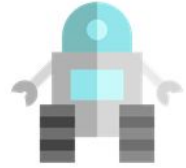
Goals

- Develop a web application which will allow users to:
  - Connect their robotic system to our platform
  - Interact with their and other users' robotic systems in real-time
  - Purchase robotics parts and custom kits compatible with our platform
- Develop open-source, embedded software to allow users' robots to easily communicate with our application
- Introduce the application to at least 1 local secondary school

Who is the Botsyn Team?

Dane Isburgh - (513) 535-3654 - isburgdk@mail.uc.edu

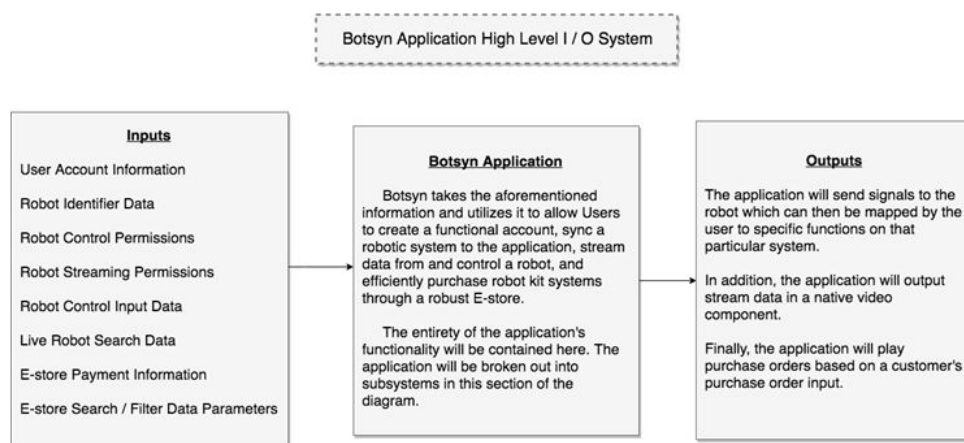Joe Kollin - (440) 241-2039 - kollinjr@mail.uc.edu

John Mikolay - (513) 509-8809 - mikolajd@mail.uc.edu

Stephen Enochian - (937) 269-7195 - enochisg@mail.uc.edu

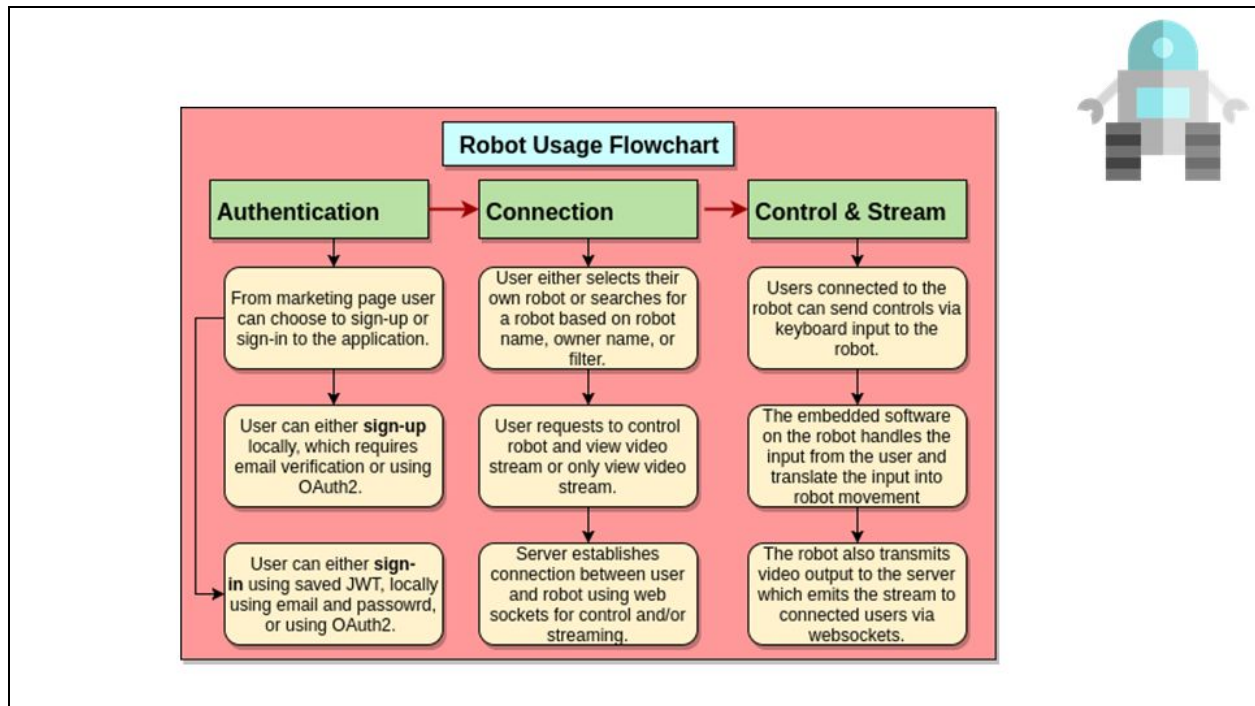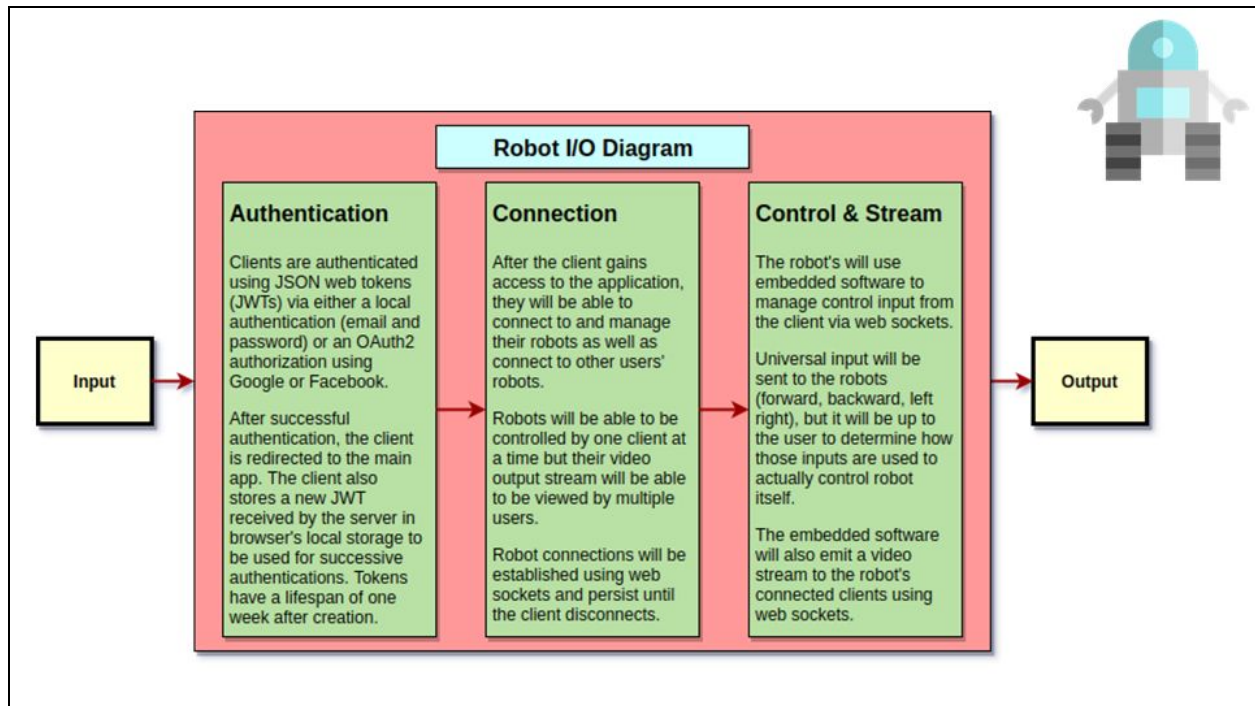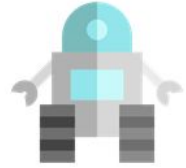Project Adviser, Dr. Philip A. Wilsey - philip.wilsey@uc.edu

What is Botsyn?

- The aim of this project is to create a **web and mobile (Android and iOS) platform** to allow users to **control one another's robots** through a robust, **user-friendly UI**.
- Our web and mobile app will allow users to connect their robot to our network via **custom embedded software**, control their robot in **real-time**, and **stream video live** to other members of the platform.
- In addition, the application will contain an **affordable web store** which will allow community members to purchase **custom robotics kits** and parts compatible with our application.

Botsyn Application High Level I / O System

Inputs

User Account Information

Robot Identifier Data

Robot Control Permissions

Robot Streaming Permissions

Robot Control Input Data

Live Robot Search Data

E-store Payment Information

E-store Search / Filter Data Parameters

Botsyn Application

Botsyn takes the aforementioned information and utilizes it to allow Users to create a functional account, sync a robotic system to the application, stream data from and control a robot, and efficiently purchase robot kit systems through a robust E-store.

The entirety of the application's functionality will be contained here. The application will be broken out into subsystems in this section of the diagram.

Outputs

The application will send signals to the robot which can then be mapped by the user to specific functions on that particular system.

In addition, the application will output stream data in a native video component.

Finally, the application will play purchase orders based on a customer's purchase order input.

In this diagram, arrows imply the flow or transfer of data from one resource to another. The boxes contain logical groupings of content and are appropriately labeled to convey their purpose.
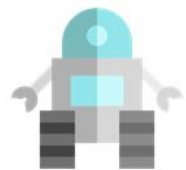
Robot I/O Diagram

Input → →

Authentication

Clients are authenticated using JSON web tokens (JWTs) via either a local authentication (email and password) or an OAuth2 authorization using Google or Facebook.

After successful authentication, the client is redirected to the main app. The client also stores a new JWT received by the server in browser's local storage to be used for successive authentications. Tokens have a lifespan of one week after creation.

Connection

After the client gains access to the application, they will be able to connect to and manage their robots as well as connect to other users' robots.

Robots will be able to be controlled by one client at a time but their video output stream will be able to be viewed by multiple users.

Robot connections will be established using web sockets and persist until the client disconnects.

Control & Stream

The robot's will use embedded software to manage control input from the client via web sockets.

Universal input will be sent to the robots (forward, backward, left right), but it will be up to the user to determine how those inputs are used to actually control robot itself.

The embedded software will also emit a video stream to the robot's connected clients using web sockets.

→ **Output**

Robot Usage Flowchart

Authentication

From marketing page user can choose to sign-up or sign-in to the application.

↓

User can either **sign-up** locally, which requires email verification or using OAuth2.

↓

User can either **sign-in** using saved JWT, locally using email and passowrd, or using OAuth2.

Connection

User either selects their own robot or searches for a robot based on robot name, owner name, or filter.

↓

User requests to control robot and view video stream or only view video stream.

↓

Server establishes connection between user and robot using web sockets for control and/or streaming.

Control & Stream

Users connected to the robot can send controls via keyboard input to the robot.

↓

The embedded software on the robot handles the input from the user and translate the input into robot movement

↓

The robot also transmits video output to the server which emits the stream to connected users via websockets.

User Stories - Marketing Page

- As a User, I want to be able to sign up and sign in to the application from a marketing site so that I can take part in Botsyn.
- As a User, I want to be able to view legal documents such as terms of use so that I can come to understand the legal scope under which Botsyn operates.
- As a User, I want to be able to view pricing information for Botsyn so that I can understand its cost relative to my status.
- As a User, I want to be able to view general information and instructions for how to use Botsyn so that I can confidently utilize the application.

User Stories - Main Application

- As a User, I want to be able to add robots to the application so that I can sync my robot to the application itself.
- As a User, I want to be able to connect my robot(s) to the application so that I can relay information between both the site and my robot.
- As a User, I want to be able to search for robots by name so that I can find my own robot or one of my friends'.
- As a User, I want to be able to control permissions for the robot so that I can determine who can view streams of or control the robot.
- As a User, I want to be able to control my robot through the application so that I can gain experience and utilize the application.
- As a User, I want to be able to stream video from my robot to the site so that I can show my friends what my robot it doing and so that I can control the bot remotely.
- As a User, I want to be able to view a gallery of available streams for robots so that I can quickly find which robots are available or being utilized.
- As a User, I want to be able to participate in a live chat so that I can communicate with others watching the stream of a particular robot.

User Stories - Admin
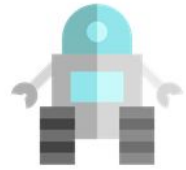
- As an Admin, I want to be able to view and respond to users' email queries
- As an Admin, I want to be able to view real-time user information in an efficient dashboard
- As an Admin, I want to be able to manage user accounts (block, delete, edit, create)
- As an Admin, I want to be able to view and manage robot connections
- As an Admin, I want to be able to view the e-store's purchase history

User Stories - E-Store

- As a User, I want to be able to purchase robotic kits with instructions so that I can sync a robotic system which I created to the application.
- As a User, I want to be able to purchase individual parts for the robots so that if some part of my robot malfunctions or is damaged, I will be able to repair it easily.
- As a User, I want to be able to checkout as a guest so that I can purchase kits without being an official member of the site.
- As a User, I want to be able to checkout with my Botsyn account so that I can easily complete the checkout process and keep track of my order history.
- As a User, I want to be able to view my order history so that I can reorder kits if one is damaged or broken.
- As a User, I want to be able to search available products by name so that I can easily find the product that I am hoping to purchase.
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- As a User, I would like to be able to review products which I have purchased so that I can inform other potential customers of the quailty of the product.

Project Status - Completed Objectives

- Design / Outreach
  - Created project abstract and description
  - Wrote user stories and tiered diagrams
  - Created project task list and timeline
  - Devised budgeting and financial plan
  - Contacted prospective schools
- Technical
  - Completed application skeleton
  - Finalized user account system
  - Determined project stack
  - Established development environments

Project Status - Remaining Objectives

- Develop a robust e-store
- Develop application chat room functionality
- Develop core user/robot connection and control functionality
- Develop intuitive open-source embedded software for robot connection
- Develop a comprehensive admin site
- Develop a marketing site

Division of Work - Joe Kollin

- Task 1 - Develop a secure payment system.
- Task 2 - Create a catalog of available inventory.
- Task 3 - Develop a search system to allow users to search for catalog items and filter the results.
- Task 4 - Store and link purchase history to users' accounts.
- Task 5 - Develop a live chat client for each connected robot.

Division of Work - Dane Isburgh
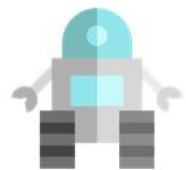
- Task 6 - Develop a robust user accounts system.
- Task 7 - Develop a system to add, search-for, and connect robots.
- Task 8 - Develop an interface which will allow users to manage their robots (permissions, connections, etc.).
- Task 9 - Develop a robot control interface that will display video output from the robot and allow the user to send control input.

Division of Work - John Mikolay
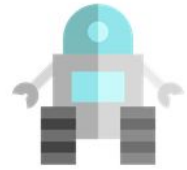
- Task 10 - Develop an admin messaging system to display and allow responses by email to users' queries.
- Task 11 - Develop an admin site which will convey real time user information in an efficient dashboard.
- Task 12 - Develop an admin site which will allow an admin to manage user accounts (block, delete, etc.).
- Task 13 - Develop an admin console which will allow an admin to view and manage robot connections.
- Task 14 - Create an admin site which will allow an admin to view the e-store's purchase history.

Division of Work - Stephen Enochian
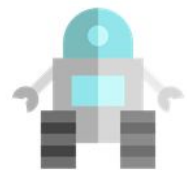
- Task 15 - Develop a single page marketing component to allow users to sign up and sign in to the application.
- Task 16 - Compile and link to relevant legal information (privacy policy, terms of service, etc.).
- Task 17 - Develop a contact component / form to allow users to notify admins of issues, questions, etc.
- Task 18 - Develop a general information / instructions component accessible from the main application and the marketing site to educate users.

Division of Work - Hours

Effort Matrix

Legend: ■ Dane Effort ■ Stephen Effort ■ John Effort ■ Joe Effort

X-axis: Task ID (1–18)
Y-axis: Amount of Work (Hours)
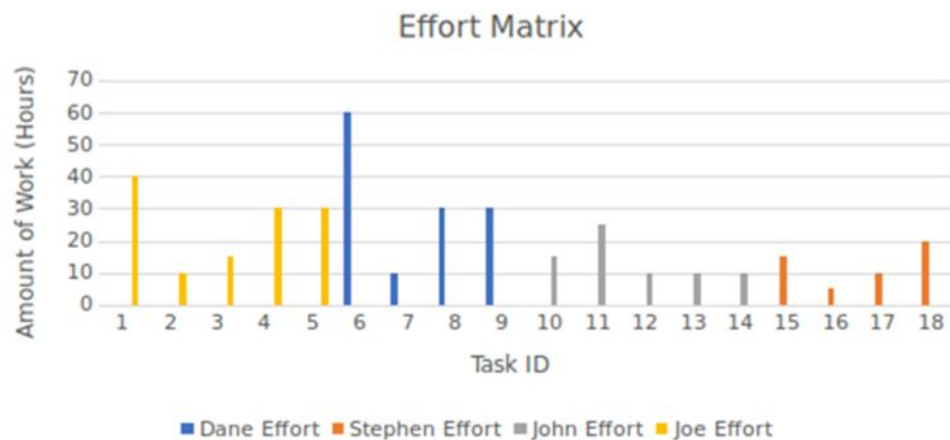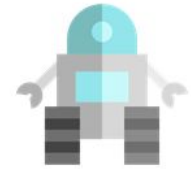
Division of Work - Milestones
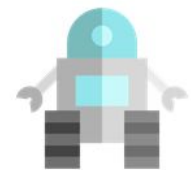
Task Id	Duration (Hours)	Start	Finish	Predessor's
1	40	11/1/17	12/1/17	N/A
2	10	12/1/17	12/8/17	N/A
3	15	12/8/17	12/15/17	2
4	30	12/15/17	12/29/17	1,6
5	30	12/15/17	12/29/17	N/A
6	60	9/1/17	11/1/17	N/A
7	10	11/1/17	11/11/17	6
8	30	11/11/17	12/11/17	7
9	30	11/11/17	12/11/17	7
10	15	12/10	12/24/17	11
11	25	10/29/17	11/18	N/A
12	10	11/18/17	11/25/17	11
13	10	11/25	12/10	7, 11
14	10	1/1	1/8/2017	4,11
15	15	11/7/17	11/22/17	N/A
16	5	11/1/17	11/6/17	N/A
17	10	11/27/17	12/6/17	N/A
18	20	11/7/17	12/29/17	15, 16, 17

Self-Assessment Essays

Dane Isburgh Self-Assessment Essay

Botsyn is designed to be an intuitive web and mobile application that will allow robotics and embedded systems enthusiasts to network and share their creations. For our senior design project, we plan to focus on introducing the application and its services to STEM/robotics programs at local secondary schools with the hope that they will use our app to network with one another. The application will use real-time communication and video streaming over network sockets to allow individuals to connect to one another's robots with minimal latency. The project itself will incorporate the technical knowledge and skills that we've gained over our cumulative co-op experiences and last four years of college education.

The academic knowledge I've gained at UC has helped me to better understand some of the more complicated concepts and constructs used in industry. A few specific courses which made me a more productive developer and helped me learn more while on co-op include:

- CS 2071 – Discrete Structures
- CS 4071 – Design & Analysis of Algorithms
- CS 4092 – Database Design and Development

While my education at UC has played an important role in developing my academic knowledge, my co-op experiences have played a significant role in increasing my practical knowledge as well as developing my technical skills and interests.

During my my first two co-op rotations as a Research and Development intern at the AFRL I was able to apply what I learned in my introductory Computer Science courses while also learning more about mobile and embedded systems development.

My primary project at the AFRL, and my initial motivation for Botsyn, was the development of a robot named Rosie (https://daneisburgh.com/#projects > Rosie). Rosie was a real-time telepresence robot we developed to be controlled over the Internet via a native Android application, and could be used in combination with the Google Cardboard. I had intended for Rosie to also be controlled through some sort of web application but I did not have enough web development experience at the time. The next semester I began work as a full-stack developer at Lampros/Viaggi, which lasted for my final three co-op rotations. As a full-stack developer, I learned how to design and build scalable, real-time web applications using back-end frameworks and services such

as Node, Express, Phalcon, Symfony, and MySQL as well as front-end frameworks such as Vue and Angular, all in combination with Amazon Web Services.

At the AFRL and Lampros/Viaggi, I learned how to work in project groups with those in my field as well as communicate with individuals who may not have the same level of technical knowledge or experience. I primarily learned how to develop applications as a member of a team and how to plan and organize our individual tasks to be more productive as a whole. At Lampros/Viaggi I worked directly with clients to develop project plans and pricing quotes, and I learned how to better gauge how much time certain project tasks would take to effectively complete.

Though my initial motivation for the Botsyn project arose while working on Rosie at the AFRL, my current web/mobile interests have developed while working with Lampros/Viaggi over the last few months. Our goal is to primarily focus on the web/mobile application and the service that it will provide to students and robotics enthusiasts alike. I believe that, with our combined knowledge and expertise, we will be able to develop an application that will will be straightforward and allow users to easily create an account and connect their robots to the app. I'm excited to work on this project because I am very much interested in web and embedded development, and I've planned to work on a project which incorporated the two since my work at the AFRL. Also, I believe that we can provide a valuable service to a growing community of tinkerers, hobbyists, and local schools which are taking advantage of using increasingly more affordable robotics technology to learn and have fun.

Our preliminary approach to designing a complete solution is to work with schools in the area to determine the overall usability and validity of our application. Ultimately, we expect to be to create a fully functional, full-scale, dynamic web and mobile application that will allow users to network and connect to each other's robots. Timer permitting, we would like to integrate a e-commerce portion in the site to allow users to purchase kits and parts which are compatible with our application. I believe that myself and my team members will be able to work well with one another and that we will be able to evaluate each of our individual contributions to the app's development (through GitHub commits) and the production of its underlying services.

John Mikolay Self-Assessment Essay

My team's project, Botsyn, strives to excite young minds to learn about STEM. Our vision for Botsyn is to create web, iOS, and Android social media like application that will allow users to connect and share access to their robots. It will also include an

E-store that will allow users to buy parts necessary to get up and running if they do not already own them. The connection between the robots and our application should be simple, but also provide a learning experience that is rewarding. We will be utilizing VueJS for our front-end framework and the robots will use the open source Johnny-Five platform. Creating a platform for learning and expression of different robot features that can be shared with others will provide an avenue for new and interesting ideas.

I have gained experience through the college curriculum that will allow me to reach back and apply the knowledge I have gained. The courses CS1 (1021) and Software Engineering (3093C) provided me with a solid foundation of programming that I have been able to build off to broaden my development skills. This foundation will be helpful when I go to learn new technologies that may be required to build our project. I also feel that my Technical Writing (4092) course will help me to convey instructions and tutorials that we write for the application clearly and concisely. This will be critical for helping younger users learn new technologies that they may have never been previously exposed to. These three courses to me, will have the largest contribution to my success in this project.

Alongside my college courses, I have also gained relevant experience for this project from my past co-ops. I worked at GE Aviation for all five of my rotations as a software engineering intern. In these roles, I was exposed to front-end and back-end development, which really allowed me to round out my programming knowledge and skills. In my last role, I gained some exposure to VueJS which will be directly applicable to building the front-end for our project. I also served as a member on the Agile Council and gained tremendous experience and understanding on using the Agile framework and road mapping features for products. These experiences will help me both develop and stay on target with meeting our project goals.

Botsyn will allow me to demonstrate the skills I have gained across my college career. It will also allow me to apply those skills to a new area for me, which is robotics. I am excited about our finished product and the capability of controlling and sharing the robot control via the application. To accomplish this my plan is to start simple and nail down the basic functionality of the application. Once we have accomplished that we can then start branching out and incorporating various features to bolster the application experience. We should be able to divvy up parts of the application to each member and allow them to grow as a subject matter expert of what they are working on. This will allow us to work fast while not running into too many roadblocks waiting on other team members to finish a feature.

I hope that our application at the end of this project timeline is complete and available for the public to use. I would like for our E-store to be functional as well as a meaningful place for someone to get their robotics equipment. I also would like to see our application demoed at a school to excite students about the application, but also STEM. I plan to evaluate my contributions by meeting with peers and doing retrospectives. This will also us to gauge agreement on the completed work and offer insight on whether further refinement is needed. I also hope to get feedback as we develop the project from a school so that we can incorporate their ideas in the app. Primarily though, the feedback of the users will be the final judge on whether we did good or not.

Stephen Enochian Self-Assessment Essay

The goal of this project is to allow users to remotely control and receive feedback/content from robots which may or may not be physically / geographically co-located. The system will provide users the opportunity to network and grow their skills. Further, integration within STEM education is paramount to our development path. This project we hope will be an impetus for growth within a budding industry.

As a student, I'll be applying the principles attained and focused in the following courses. These courses helped learn some of the fundamentals required for practical application of computer science concepts.

- Database Design & Development - CS4092
- Data Structures - CS2028
- Parallel Computing - CS5168

From Database & Data Structures, my primary takeaways are building the proper infrastructure to support a frontend environment. And as I grow in my understanding of Parallel, I anticipate greater potential to grow efficiency in design and implementation of our project.

Similarly, my co-op experiences have played an even greater role in providing project management, personal management, and real-world scenario development. Within the Air Force Research Labs, I've been given the opportunity to develop on multiple platforms & languages with a variety of hands-on/-off scenarios which actively contribute to the wellbeing of the workplace and the readiness of our national defense. Within Intelligrated as a software engineering intern, I've contributed to internal

productivity and as a result provided a better development environment for the department as a whole. Finally, as a systems development engineering intern at The Walt Disney Studios, I worked in a mentor-mentee environment directly with a systems development engineer to build internal productivity with a new emphasis on properly securing and controlling the code as it's distributed. These skills collectively have molded me into the developer I am today and have better prepared me for this capstone.

This project intrigues me for multiple reasons. Predominantly as a backend developer, I'm curious to apply greater emphasis to frontend and explore that interactivity component. Further, I have a growing interest in pursuing a clean UI and UX throughout and the opportunity to explore this in a real-world & live-feedback environment feeds this. Finally, as a youth who rapidly consumed any and all STEM education available, this route to giving into the system going forward is fulfilling insomuch as it continues the growth cycle for future computer scientists.

From a preliminary standpoint, we're aiming to create an initial release of this product and get it into the hands of consumers/educators/students. As developers, we recognize the project will likely evolve based on the desires & wants of both users & market/technology changes. Our ability to adapt will be our greatest sign of progress and engagement in creating the end result. Personally, I aim to place emphasis on areas in which I am already knowledgeable and am readily taught. This may be measured via commited code, fixes, or documentation produced - though likely not with any hard-and-fast ruling. At the end of the day, the goal is to collectively produce a final product and contribute as much as possible from everyone while focusing on their personal skillsets and their effective applications.

Joseph Kollin Self-Assessment Essay

The goal of this project is to develop a web and mobile (Android and iOS) platform to allow users to remotely control and stream video from mobile robots. The applications which my team and I will be developing will allow users to connect their personal robots to a network by means of custom embedded software, navigate their robots remotely, and stream a video feed from their robot to the rest of the application's user base. In addition, the application will include an E-store which will allow enthusiasts to purchase assembled robotic systems and parts at a reasonable price. The majority of the project will be coded in JavaScript. Specifically, the web application will employ the use of a modern Node.js server framework, Express.js, and will also utilize a progressive,

front-end web framework, Vue.js. In order to properly communicate with the robots themselves, a progressive, robotics programming framework, Johnny-Five, will be used. This framework is an open-sourced, JavaScript-based API which will allow my team and I to swiftly communicate with a variety of different mainstream microcontrollers.

The academic curriculum which I have followed over the course of the past 4 years at the University of Cincinnati will, in part, ensure my success in this final academic endeavor. Taking into consideration all the courses that I have enrolled in while in college, I believe that my experience in Software Engineering (3093C) will help me the most in the success of this project. During lectures and through the course's semester long assignment, Software Engineering familiarized me with the Agile Methodology and several other programming paradigms and best practices. This will certainly be useful because my team and I have decided to operate as an Agile team and to have weekly scrum meetings. In addition, at the beginning of Software Engineering, I was totally unfamiliar with Android development. I was required to learn a bit of Java and the Android SDK as I developed. This experience taught me the importance and the effectiveness of need-based learning. Prior to this course, I had no understanding of or experience with pragmatic application development. I would learn everything there was to know about a language, and then proceed to write a program solution. However, when doing full-stack development, one is required to learn as they go. Since I will be working with the full stack on this upcoming project, I will be able to apply my understanding of continued learning from this course. In addition to Software Engineering, I will be able to apply the skills which I acquired from Technical Writing (4092). Technical Writing taught me the importance of brevity and the proper way to convey highly technical information. When my team and I formally document this project, this knowledge will be applied. Finally, in the interest of application performance, I will be able to apply what I learned in D and A of Algorithms (4071) and Data Structures (2028). There two courses taught me how to efficiently design algorithms and test their execution. Logic and algorithms are a large part of any project and I will be sure to apply the knowledge I gained from these courses to Botsyn.

In addition to my coursework, I believe that my cooperative education experiences will play a large role in the development of this project. I spent all my co-op rotations with General Electric Aviation here in Cincinnati, Ohio doing a combination of system administration and application development. During my first two rotations, I worked as a system administrator (Infrastructure and Systems Administrator) primarily with applications hosted in AWS. These experiences introduced me to cloud computing and application servers in general. Considering the scope of this project, this experience will allow me to create and maintain a cost effective and efficient architecture for the

application. My third and final rotation was spent as a full-stack application developer (Software Engineering Co-op). During this rotation, I built an application from scratch, configured the application server, developed a CICD pipeline to increase developer productivity, and presented my application to the CIO of GE Aviation. This rotation introduced me to a plethora of useful development practices and tools which I will easily be able to apply to this upcoming project. It also taught me how to properly describe and demonstrate an application to an unfamiliar user-base. This experience will be easily applied at the Tech Expo.

My course work and co-op experiences has taught me a lot over the course of the past four years, but perhaps the most important result is that I discovered a love for application development. During the past year, while at GE and while in school, I developed three applications in my free time. Application development, for me, serves as fun and creative outlet and I am excited to be able to build something from the ground up for school. I do not have an interest in embedded systems, but I am willing to learn and excited for the challenge. Up to this point, the solution which my team and I have designed is rudimentary. A shell application has been created and we have begun to reach out to schools all throughout Ohio to gauge interest in the application. The feedback which we receive from these schools will determine how the app is constructed. In addition, an application architecture has been conceptualized. As we move forward, we have decided to build the application first as an MVP and then incrementally build out the functionality. We will begin development by focusing on the web application and then utilize a mobile application framework to allow the app to be used cross-platform.

For this project, by the end of the second semester of Senior Design, I expect to have a complete web, iOS, and Android application which allows users to interact with robotic systems and purchase new ones through a native e-store. I also expect that we will be able to introduce the platform to at least one school in the local Cincinnati area. I will evaluate my own contributions to this project by taking into consideration the amount of code which I contributed, the number of features which I completed, and the number of bugs that I fixed. I will not diligently and precisely keep track of each of these criteria, but I will hold myself accountable to the proportion to which I contribute. In application development, an application is never truly complete. Due to deprecations, browser changes, user-asks, and several other constraints, it is impossible to push an application and be done with it. If, however, my team and I can meet each of the goals outlined in our project description and have created a functional asset, I will be happy with the result.

Professional Biographies

Dane Isburgh Biography

Contact Info
- Phone: (513) 535 - 3654
- Email: isburgdk@mail.uc.edu

Work Experience
- Full Stack Developer -- Viaggi, Covington, KY -- April '17 to Present
  - Member of development team working on web application to allow users to manage wireless internet services and control connected devices.
  - Currently develop using PHP, JavaScript, and MySQL with the Symfony and Angular frameworks.
- Full Stack Developer -- Lampros Labs, Covington, KY -- May '16 to April '17
  - Led development of social networking web app for coaches, hosted on AWS LAMP server.
  - Developed Android puzzle game incorporating in-app purchasing and auto puzzle generation.
  - Worked directly with clients, created budget quotes, managed individual project tasks.
- R&D Intern -- AFRL Discovery Lab, Dayton, OH -- Jan to Dec '16
  - Developed augmented reality Android app for Google Cardboard and Samsung VR.
  - Led development of telepresence robot, incorporated image processing and 3D printing.

Skills

1. Proficient in full-stack web development using JavaScript (Node, Express, Vue, Angular), PHP (Symfony, Phalcon), CSS/SASS, and SQL/NoSQL (MySQL, PostgreSQL, MongoDB, DynamoDB) in combination with AWS services.
2. Proficient in object-oriented software development using C++, Java, and Python.
3. Proficient in Android development with experience using NDK and external SDKs.
4. Experience in robotics and embedded development using microcontrollers/microprocessors.

5. Experience in 3D printing and 3D modeling using CAD software (FreeCAD and OpenSCAD).

Project Sought

I'd like to develop a multi-platform, real-time web/mobile application using a MEAN stack (SQL or NoSQL) hosted on AWS.

I am also interested in integrating some sort of IoT device or embedded robotics that would communicate with the app's back-end and could be managed/controlled on the app's front-end.

Joseph Kollin Biography

Contact information

- Joseph Ryan Kollin
- kollinjr@mail.uc.edu / (440)-241-2039
- 347 Warner Street
- Cincinnati, Ohio, 45220

Co-op Work Experience

Software Engineering Coop, *General Electric Aviation*, May 2017 - August 2017
- Developed a multi-tenant interactive office map for GE's BEBC office location
- Utilized a progressive stack including Polymer, Go, Node, and DynamoDB
- Designed and implemented the UI and an encoded SVG image representation of the office floorplan
- Formally presented the application to managers at GE

Infrastructure Engineering Co-op, *General Electric Aviation*, January 2017 - May 2017
- Aided in migration of GE's low risk application infrastructure to a new VPC
- Condensed Jenkins servers to prevent corporate billing
- Worked closely with application owners to notify them about the possibility of outages during app migrations
- Received a corporate award for my dedication and contributions to the migration effort

Infrastructure Business/Operations Intern, *General Electric Aviation*, January 2016 - May 2016
- Aided in the collection and aggregation of data for the Pace Initiative
- Developed VBA macros to save the valuable time of other employees and myself
- Received a corporate award for my dedication and contributions to the Pace Initiative

Project Sought

I am seeking a project which will allow me to apply a combination of the practical and theoretical skills which I have collected over the course of my past four years here at UC. Most of my skill lies in web development, so I would like to take part in a web based project and use a stack with which I am not too familiar. I have experience with Polymer, Golang, DynamoDB, ReactJS, and RethinkDB. Additionally, I would like to work on a marketable project which will allow for creativity and a future beyond the course itself. I have a strong background in math, so something which is mathematically or algorithmically involved would also be preferred.

Activities

Syntonic LLC, Co-owner
- Actively work as a developer for a variety of companies with two of my college friends
- Participated in and won the OSU Hack OHI/O hackathon as a representative of the company
- Diligently handle accounting and tax matters for the company

Engineering Models Teaching Assistant / Tutor
- Effectively assist students who are learning the MATLAB programming language
- Work in the tutoring center providing help to first year engineering students
- Consistently work 10 hours per week while also working as a full-time student

John Mikolay Biography

Contact Information

Phone: 513-509-8809
Email: Mikolajd@mail.uc.edu

Co-op Work Experience

DTLP Intern - GE Aviation

May 2017 – August 2017

- Improved the employee exit report webpage by implementing a service to populate the report dynamically with data in a database. Utilized JavaScript, Bootstrap, and CSS styling to modernize the page layout.
- Worked as an analyst to review employee exit reports for suspicious activity.
- Performed analysis on the effectiveness of the exit report's risk scoring algorithm to allow the team to determine confidence in newly proposed scoring thresholds.

DTLP Intern - GE Aviation

January 2017 - April 2017

- Created a customizable pod metrics dashboard application that allowed users to monitor pod metrics based on data in Rally, GitHub, and SonarQube. Implemented with AngularJS and Spring Boot.
- Automated the granting of default access to projects for all users in the organization's Rally workspace, by creating and deploying a scheduled Ruby script on a Jenkins server.
- Served as a member on the Agile Council, contributing solutions to product owners and scrum masters for better managing teams via the creation of custom Rally apps and scripts using HTML, JavaScript, and Ruby.

Software Engineering Intern - GE Aviation

May 2016 - December 2016

- Enhanced communication flow of the Aviation U.S. Co-op Department to assignment leaders and co-ops by creating new internal and external websites, which utilized AngularJS to deliver a modern web experience.
- Greatly improved data record management by migrating all co-op records to a new database and training the Co-op department on new features that would improve productivity.
- Shadowed members of the Co-op Department to identify and implement VBA macros for large excel reports to automate and drastically reduce time spent on tasks.

Software Engineering Intern - GE Aviation

August 2015 - December 2015

- Designed and implemented a load testing application that would boot and run on 20 connected PCs to evaluate the performance and reliability of the department's aircraft simulation software.
- Improved and created unit tests to verify simulation software requirements were being satisfied for newly supported aircraft (C++).

Software Engineering Intern - GE Aviation
January 2015 - April 2015
- Effectively improved the identification of invalid data by creating the UI and Back-End functionality for the team's data validation tool utilizing C# and WPF.
- Conducted QA testing on software to ensure requirements were satisfied and changes were bug free.

Stephen Enochian Biography

Contact information

- (937) 269-7195
- enochisg@mail.uc.edu

Co-op Work Experience

- The Walt Disney Studios, Systems Development Engineering Intern, 2017
  - Secured data between on-premises and cloud resources via universal client
  - Integrated with Amazon Web Services via python SDK and S3, IAM, STS, & KMS versioned via Git
  - Grew cloud storage capabilities and flexibility through new toolset development
  - Built proof-of-concept product for supporting studios-wide and third party data transfers
  - Produced product via cross-company collaboration and feedback
- Air Force Research Labs, IT/Infrastructure Support/Software Engineering Intern, 2015-2017
  - Developed augmented reality resource visualization app for Microsoft HoloLens (Unity, C#)
  - Maintained 11 Ubuntu-Linux servers to include: initial configuration, Python automation, network diagraming, providing updates, software installs, managing logs, and troubleshooting

- ○ Provisioned wireless network environment for 20+ devices across 5 access points
- ○ Performed MySQL installs/backups/restorations & system beta testing prior to company rollout
- ● Intelligrated, Software Engineering Co-Op, 2015-2016
  - ○ Reinforced stability and feature availability of department resource-acquisition software via C#
  - ○ Directed isolation testing to ascertain identit(ies) of subpar hardware performers
  - ○ Conducted routine and as-needed maintenance on development conveyor & sortation systems
  - ○ Actively developed within a Git and Subversion file management environment

Budget

The budget for the project will be used to pay for the hosting services provided by AWS and MongoDB. The initial environment that was set-up for developing the primary client and admin sites (staging environment) is hosted on an AWS EC2 T2-micro instance (1 core, 1 GB RAM) with local versions of all services (MongoDB, Redis, NodeJs, etc.) The micro instance is being used free-of-charge under the AWS free-tier usage.

The production version of the application will be designed to use independent AWS services (compute, memcaching, storage, etc.) and will use a load balancer (via AWS Elastic Beanstalk) to dynamically create/destroy computer instances as needed and route traffic. The application will also use MongoDB Atlas (database as a service). The table below details the total monthly cost to host the production-version of our application, all on demand:

Service	Cost
EC2 (8x t2.medium instances)	$271.76
Block store ● 2x 150 GB volumes ● 128 Mb/sec baseline throughput ● 10% change for daily snapshots ● 80 GB/month in ● 120 GB/month out	$68.64
Elastic load balancer (50 GB/week)	$20.02
Cloudfront (delivery network) ● HTTPS ● 300 GB/month ● 30 KB average object size	$35.99
Elasticache	$49.78
MongoDB Atlas ● 80 GB storage ● 8 GB RAM	$401.76
Total monthly cost	**$847.95**

Appendix

GitHub Repository

Contributions

Sep 10, 2017 – Nov 28, 2017

Contributions to master, excluding merge commits

Contributions: Commits ▾

isburgdk #1
389 commits / 296,476 ++ / 280,514 --

mikolajd #2
21 commits / 1,769 ++ / 241 --

kollinjr #3
10 commits / 80 ++ / 13 --

enochisg #4
2 commits / 10 ++ / 0 --
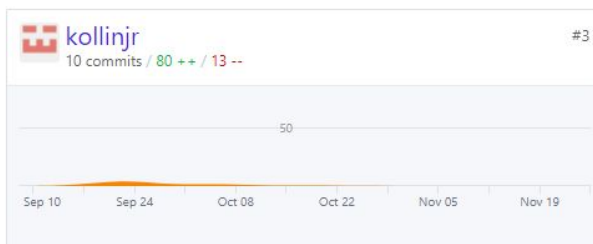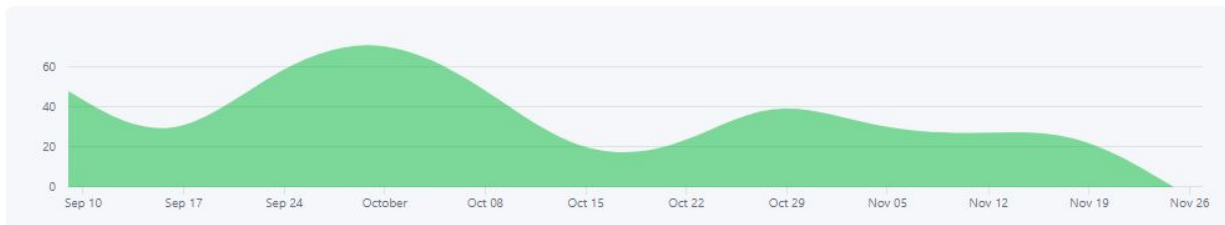
Outreach

Throughout the semester, we made several attempts to reach out to local schools to gauge interest in our project. A table which includes the institutions and individuals who were contacted has been included below.

School Name	Email	Contact Name	Phone Number	School Type
Hughes Stem	battled@cpsboe.k12.oh.us	Danielle Batte		High School
Akron Stem	dpopa@akron.k12.oh.us	Dina Popa	330-761-7965	High School
St. Xavier	enardini@stxavier.org	Edward Nardini	513-761-7815 x225	High School
Dayton Regional Stem	robin.fisher@daytonstemschool.org	Robin Fisher	937-256-3777	High School
Synnovation Lab (Sycamore High School)	warrena@sycamoreschools.org	Ashley Warren	(513) 686-1770 x3201	High School
Madeira	jjordan@madeiracityschools.org	Jennifer Jordan	513-891-8222	High School
Akron Stem	amorgan2@apslearns.org	Amanda Morgan	330.761.3195	Middle School
Walnut Hills	fiscjen@cps-k12.org	Jenna Fischesser	513-363-8402	High School
Milford	Baugh_K@MilfordSchools.org	Kathy Baugh		High School
Aiken	huffmaj@cps-k12.org	John Huffman	513-363-6765	High School
Greater Cincinnati STEM Collaborative	http://greatercincystem.org/contact/			Collaborative

The aim of this outreach is to assess interest in our project to determine whether or not it can be utilized in a classroom setting for pre-college students. Some of the questions which are being asked of the local instructors have been included below.

- Does your school place any special focus on robotics or other STEM related fields?
- What type of computer platform do you believe would aid you in your instruction?
- Do you see yourself as an educator using any sort of platform similar to this one in the next three years?
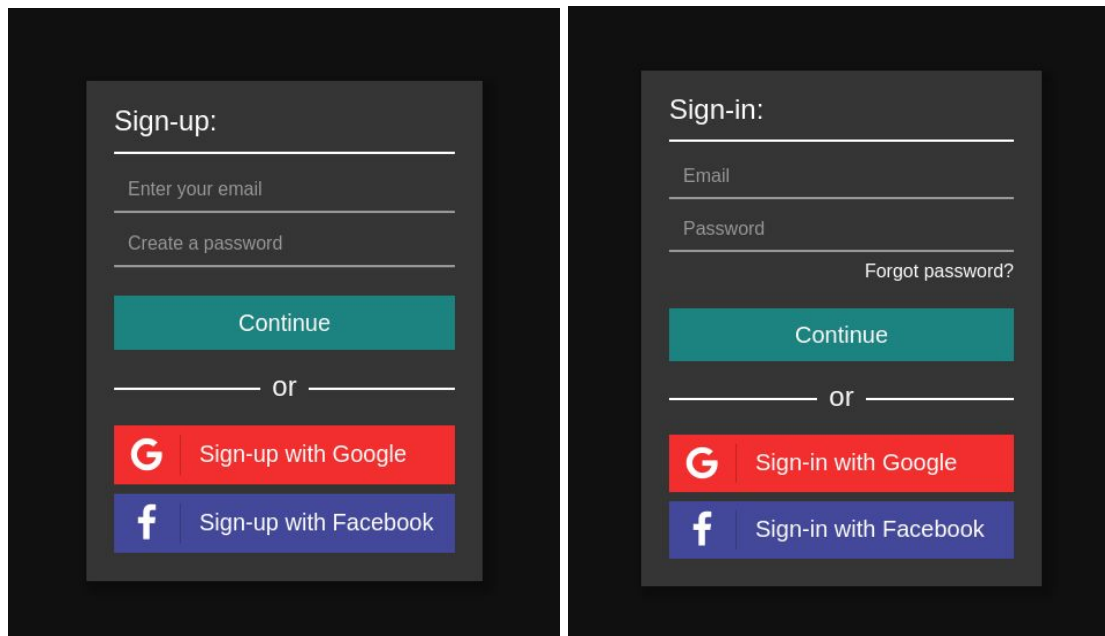
- Do you think the school would be willing to allocate funds for such a platform and, if so, how much?
- Do you think that our platform (after having explained Botsyn) could be utilized to educate students in its current form?
- What suggestions do you have for Botsyn that could allow for it to better interest / educate students?
- Would you be willing to allow us to perform a demonstration to one of your classes during the Spring?

Screenshots

Desktop homepage:
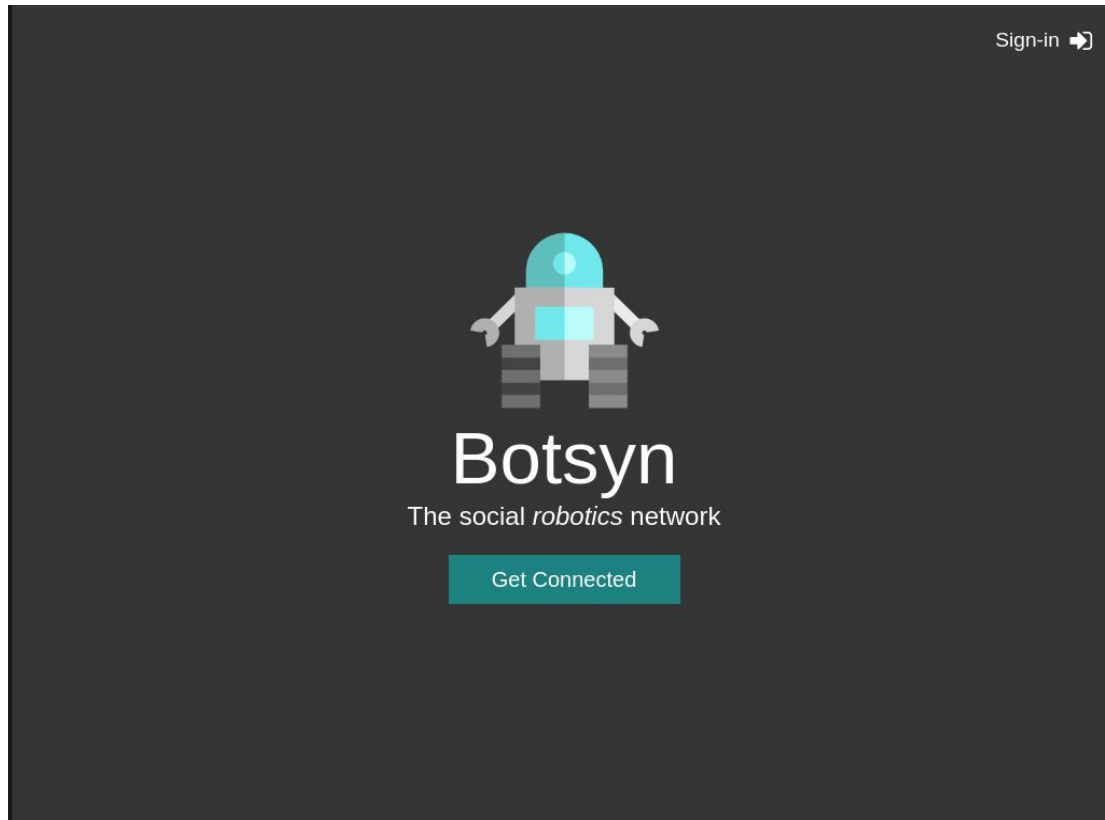
Desktop sign-up and sign-in modals, appear on homepage

Desktop client

Mobile homepage, sign-up, and sign-in

Mobile main client with profile page and and side navigation