TEAM B1: IR Man

AI smart home IoT Hub

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Use Cases

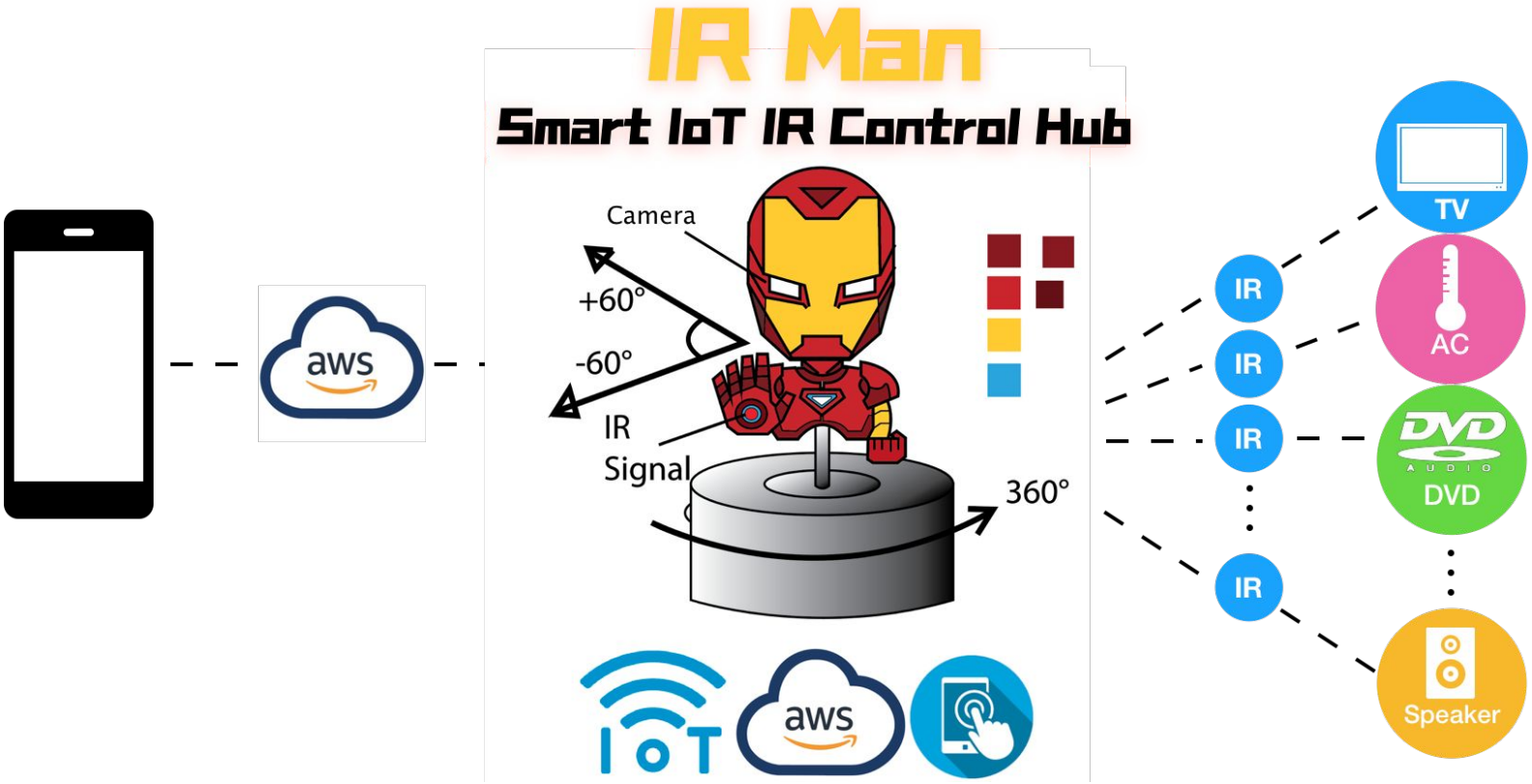
- What can we do to eliminate those remote controls?

- Proposal: A smart IoT IR Control Hub that allows you to use your smartphone to remotely control all the traditionally dumb or non-internet-enabled IR household appliances.
- CV, ML, AI, NLP and More to Come!

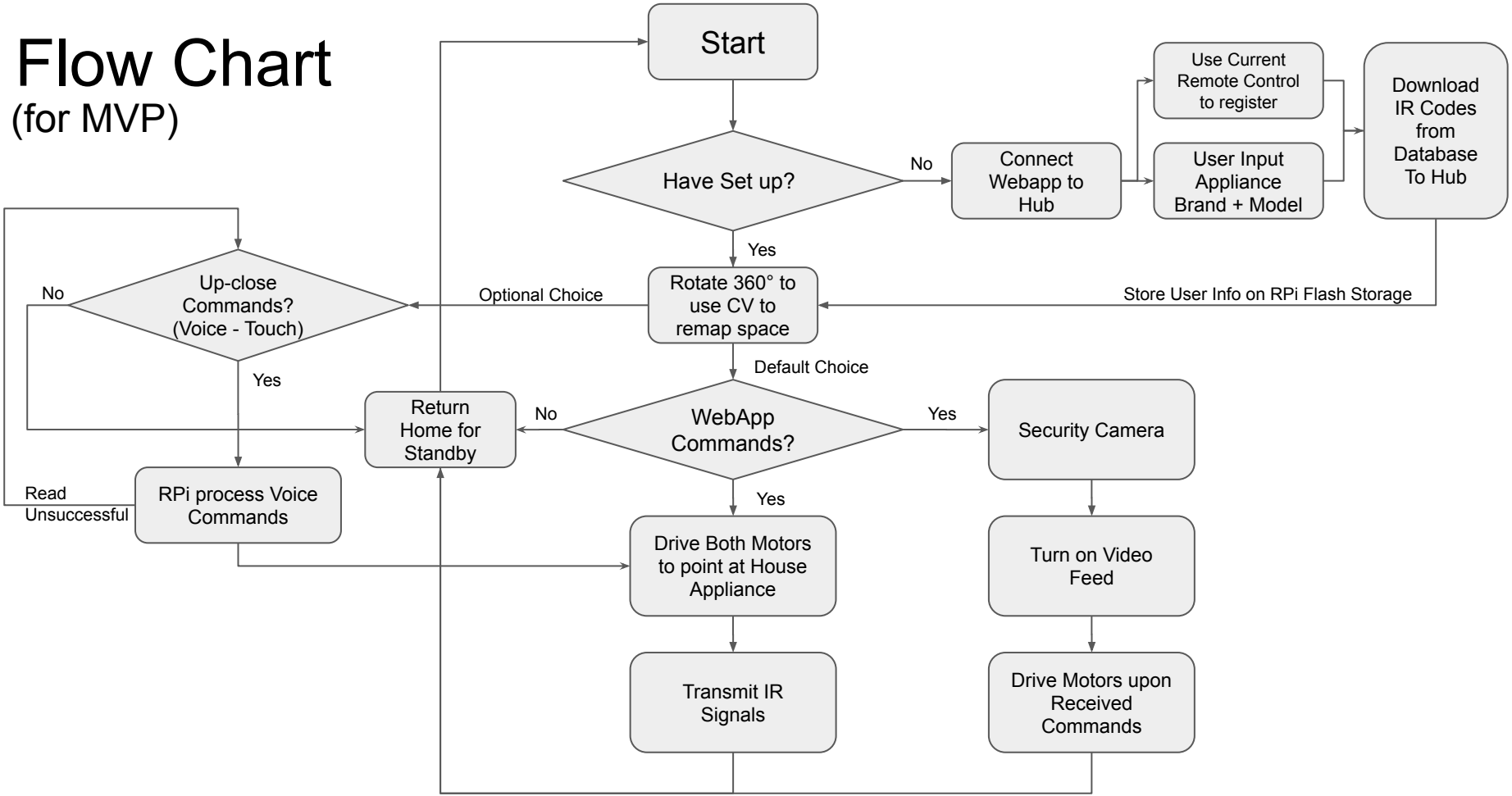
- INNOVATIVE, INTERACTIVE AND FUN!

IR MAN

Introducing… IR MAN!



Flow Chart
(for MVP)



Requirements I

Computer Engineering

- Enabling Wireless Communication Module on RPi
- Defining necessary I/O and data buses
- Security and Privacy

Software Engineering

- Front End User Interface (Webapp)
- Defining Programming interface and framework
- Deploy on AWS Cloud service
- IR database management for scalability
- Machine Learning and NLP applications

Requirements II

Signal Processing

- IR data processing and means to register new IR device
- Designing Signal Processing Pipeline
- Noise cancelling filters and robustness/reliability improvements

Analog & Circuits

- Designing Circuits for IR transmitter and Receiver
- Integrating Circuits for H-Bridge and Step Motors
- Specifying Power Consumption and Heat
- Designing necessary PCB layouts upon requirements

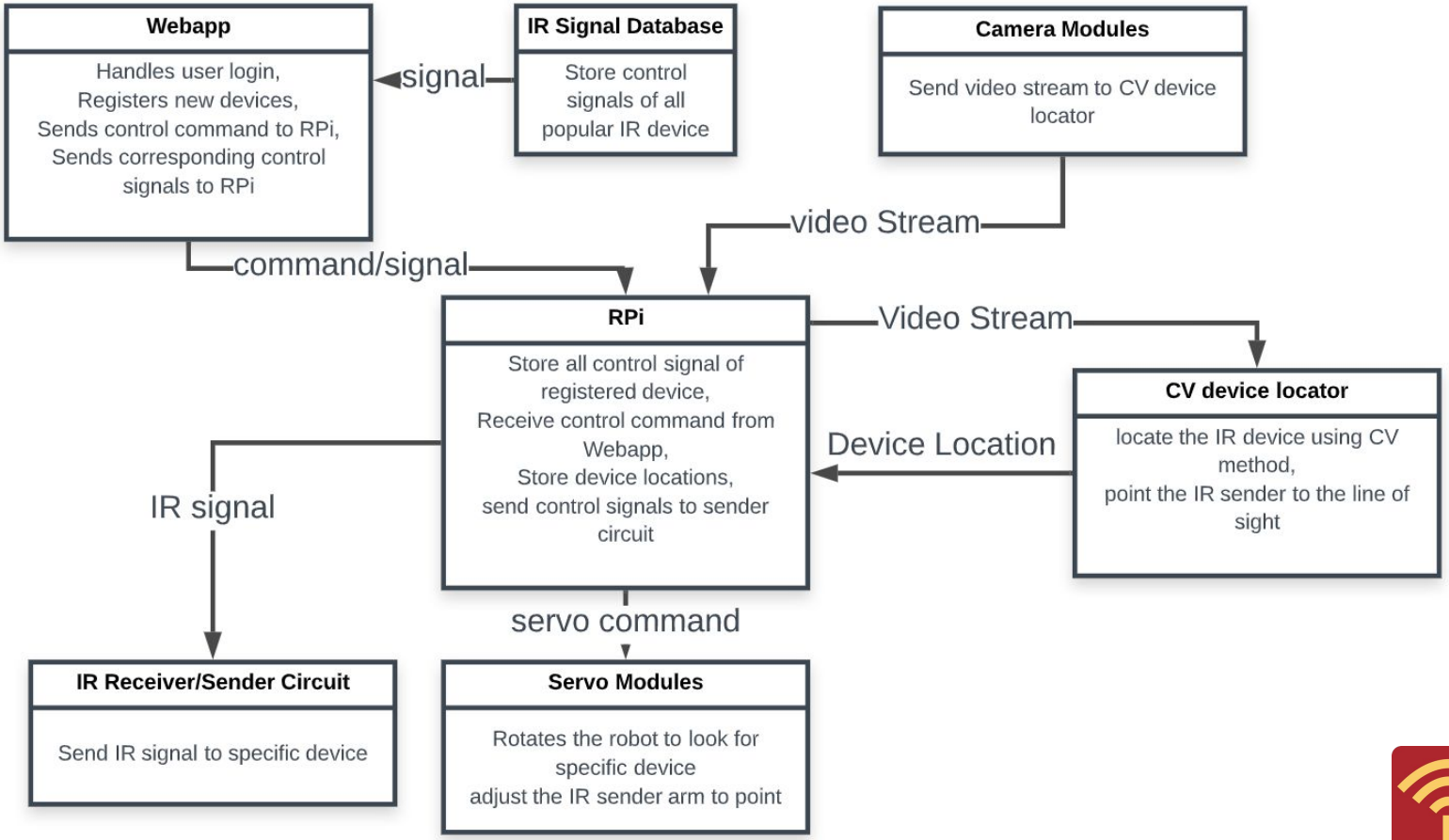
Robotics

- Computer Vision Object Recognition and Mapping
- 2 DOF Motion Planning and Path Planning
- Human Computer/Robot Interaction (ML + NLP)
- Industrial Design for the appearance

Technical Challenges

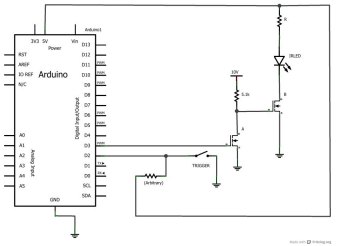
- Possible signal noises and cross interference
- Line of Sight + Signal Strength
- CV driven Robotic kinematics and dynamics
- Communication across different platforms (mobile devices, AWS, RPi)
- Latency of transmission among cloud, phones, and IR devices (~500ms)
- Various signal definitions across different brands

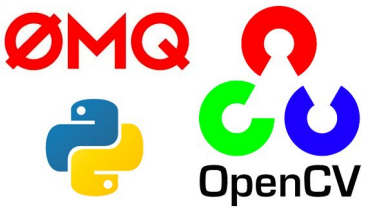
Solution Approach



Solution Approach

- Web App:
  - Develop with **MEAN** stack, deploy to **AWS EC2**
  - User Authentication + Information Security
- Robot:
  - Uses RPi Platform for data processing and peripherals control
  - 2 DOF robotics arm to improve IR's field of view
- IR Signal Processing
  - **AVR TCON** Chip Programming for **PWM** signal
  - IR + MOSFET circuit to send control signal
  - IR Code Database Parsing
- Computer Vision:
  - Use **OpenCV** and **ImageZMQ** to process video stream
  - Locate registered devices and send back (θ1 and θ2)





Testing, Verification, Metrics

- Success rate of control command
- Latency of control command
  - **T**_latency = **T**_webapp_to_ec2 + **T**_ec2_runtime + **T**_ec2_to_rpi + **T**_send_ir_runtime ≤ 1s
- Power consumption
  - **P**_total = **P**_RPi + **P**_Motors + **P**_Camera + **P**_IR
- Variety of devices supported
- Time to align IR sender to various device from random pose
- Accuracy of alignment with IR emitter to various device from random pose
- Video stream processing speed (Trade-off btw fps and speed)
  - **T**_total = **T**_extract_frame + **T**_normalization + **T**_resizing + **T**_forward ≤ 5s
- Validation for accuracy of object detection (TV, A/C, etc)

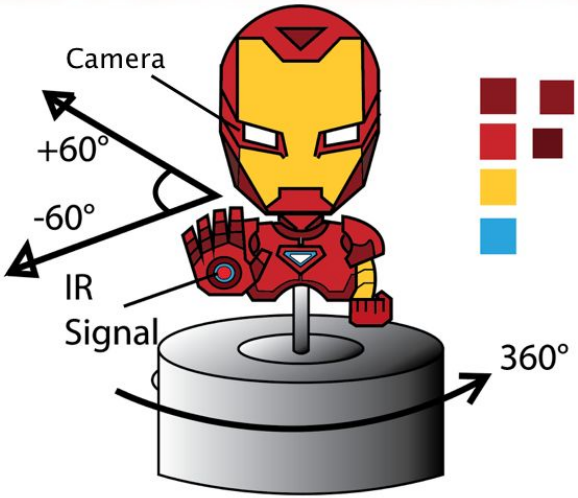
Schedule

	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MileStones					Proposal	Status1		Design Pre	Design Doc			Int. Demo				
Tasks		26-Aug	9/2	9/9	9/16	9/23	9/30	7-Oct	14-Oct	10/21	10/28	11/4	11/11	11/18	11/25	12/2
Phase I: Team Self-Education		Approx. 100 Hours														
Initial Research																
Drafting Proposal																
Conceiving Use cases for Product																
Evaluating solution approaches																
Inistial Prototypeing & Requirements																
Proposal Presentation																
Phase II: Design, Ideation and MVP Building					Approx. 200 Hours											
Identify Solution Requirements																
User Story (MVP, Final Story)																
Flow Chart																
System Architecture																
System Interaction Diagram																
Object Diagram (Webapp, database)																
Hardware & Electrical Architecture Schematic																
RPi Platform Interfacing and I/O																
Communication Protocol btw RPi and WebApp																
Computer Vision Pipeline Architecture																
Design Software Benchmark and Metrics																
Design Hardware Benchmark and Metrics																
Bill of Material																
Prepare for Design Presentation and Design Document																
Design Ideation																
Design Evaluation																
Design Presentation																
Refine Requirements																
CV Video Streaming POC & Object Detection																
Buidling the IR Circuit																
IR Software on RPi																
Path Planning Algorithm																
2 DOF Motor Driver																
Mechanical Structure (Motor to Arm KD)																
ID Design																
Web app development (Back end)																
IR Signal Database API																
Phase III: Integration and Testing									Approx. 150 Hours							
Prototyping (Think additional features)																
3D printing parts, Laser Cutting Parts, CNC cutting parts																
Hardware Limitations																
Software Integration																
Mechanical Integration																
Benchmark Testing and Metrics Reports																
Interim Demo (MVP DONE)																
Phase IV: Design Re-evaluation And Optimization													Approx. 100 Hours			
Improve ID Design																
Beautify UI/UX																
Reduce Latency																
Optimize for Universality																
CV Algorithm Accuracy + Speed																
Voice Control																
Machine Learning for Power Saving + User Habbits (if time permits)																
Phase V: Final Reporting and Validation																Approx. 100 Hours
Final Testing																
Produce Promo Video																
Final Report																
Final Presentation + Demo																

Key
Max Bai
Jiaqi Zou
Shirley Zhang
Slack Time
Max + Shirley
Jiaqi + Shirley
Jiaqi + Max
Whole Team

IR Man

Smart IoT IR Control Hub



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