Project Checkpoint 2 Report

Team 305

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EGR 314 - Embedded Sys Design Project II

Dr. Kevin Nichols

Team Organization:

After our first team meeting, we discussed and ultimately agreed on this charter: Within the framework of our collaborative endeavor, our shared objective revolves around fulfilling the baseline prerequisites and transcending them through a synergistic amalgamation of concerted efforts. This concerted effort is predicated on a dual commitment: first, to harness the collective expertise inherent in our collaboration, and second, to consistently strive for the peak of our capabilities. In pursuing this collective aspiration, we shall adopt a multifaceted approach represented by a strategic allocation of roles and a commitment to perpetual self-improvement.

Outlining specialized proficiencies shall be a fundamental cornerstone to attain this ambitious yet attainable goal. Each member of our cohesive unit shall be entrusted with tasks that align with their individual areas of expertise. This strategic deployment ensures the optimal utilization of the unique skills possessed by each team member, thus enabling us to extract maximum value from our collaborative engagement. This, however, is not to be misconstrued as an isolated endeavor; instead, it sets the stage for a collective orchestration where the harmonious interplay of our diverse talents culminates in a symphony of accomplishments.

Nevertheless, our pursuit extends beyond the confines of our respective comfort zones. We must cultivate an environment wherein each member is not merely a spectator but an active participant in a broad spectrum of project facets. Moreover, it facilitates an organic cross-pollination of skills and knowledge, nurturing collaborative growth. Areas that may not inherently coincide with our core competencies become enrichment opportunities, thereby obviating any potential disparities in contribution. In

effect, we substantiate the principle that the output of our collective exertion is intrinsically tied to the sum of our individual inputs. By embracing these principles, we navigate the trajectory toward surpassing the minimal requisites, forging a balanced equilibrium where each member's strengths are optimally used and each member's potential is maximally realized. Through this orchestrated interplay, we elevate the outcome of our collaborative venture and the collective prowess of the entire team.

User Needs, Benchmarking, and Requirements:

To come up with a baseline, we utilized the internet by searching for similar products through typing specific keywords related to the product we had in mind. We then would find a promising product with a decent amount of reviews. These reviews are incredibly important since we are able to read through all the good reviews and bad reviews, which would give us a summary of all the strengths and weaknesses of the product and most importantly what functions are desired by the users.

Product 1: Emporia Vue: Gen 2 with 16 sensors

Link: emporiaenergy.com

Price: $164.99
Vendor: Emporia
Description: Home Energy Monitor

Positive reviews:

1. Easy to use - Latent
2. Simple to install - Latent
3. Does what it says it does - Explicit

Negative reviews:

1. Cyber Safety concerns due to wifi connection with low security - Explicit
2. Doesn't give much functionality info - Latent
3. Only works for specific setups (Isn't universal) - Explicit
4. Interface isn't great - Latent
5. Poor wifi connection - Latent

Product 2: SwitchBot Curtain Smart Electric Motor

Link: Amazon.com

Price: $84.99
Vendor: Amazon
Description: Curtain motor

Positive reviews:

1. Easy physical setup - Latent
2. Easy digital setup/ programming - Latent
3. Works exactly as advertised - Explicit
4. Isn't in line of sight (non-invasive) - Explicit
5. Works for any size curtains - Latent

Negative reviews:

1. A little too noisy for comfort - Explicit
2. Doesn't work well on non-smooth curtain beams - Explicit
3. Requires occasional calibration, sometimes is often needed - Latent
4. Too expensive for what you get - Latent
5. Short battery life - Explicit

Product 3: Rechargeable Wireless Tubular Roller Shade Motor Kit

Link: Amazon.com

Price: $92.99
Vendor: Amazon
Description: Curtain motor

Positive reviews:

1. Very good price for what it is (cost effective) - Latent
2. Good setup/use instructions - Latent
3. Works well - Explicit
4. Great adaptability in the sense of works with pretty much any shade curtain - Explicit
5. Great customer support - Latent

Negative reviews:

1. Requires some DIY experience - Explicit
2. Bad battery life (requires upgrades) - Explicit
3. Requires some programming experience to unlock full functionality - Latent

Product 4: SwitchBot Smart Motorized Blinds Kit

Link: Amazon.com

Price: $189.99
Vendor: Amazon
Description: Motorized Blinds.

Positive reviews:

1. Cost effective smart blinds - Latent
2. Nice user-friendly Interface - Latent
3. Easily programmable - Explicit
4. Aesthetically pleasing (is visible) - Latent
5. Easy Installation - Explicit
6. Compatible with Apple products - Explicit

Negative reviews:

1. Calibration can be a bit tricky - Latent
2. Short lifespan due to mostly being made of plastic - Explicit
3. Bad customer service - Latent
4. Isn’t always reliable and sometimes glitches or fails a little - Latent

Product 5: Dusk to Dawn A19 Outdoor LED Light Bulbs

Link: Amazon.com

Price: $15.99
Vendor: Amazon
Description: Sunlight sensor bulbs

Positive reviews:

1. “Efficient solution” to making sure lights are on at night and off during day - Explicit
2. Extremely easy installation (is the same as a regular light bulb) - Explicit
3. Shines bright - Explicit
4. Works as advertised - Latent
5. Works reliably and doesn't fail - Explicit

Negative reviews:

1. Relatively short lifespan - Explicit
2. Low wattage (incompatible with some home systems) - Explicit
3. Doesn’t works outside because it isn't waterproof - Explicit
4. They come in bad packaging and often get damaged during shipping - Explicit

Develop Requirements:

After analyzing all the data we acquired from our product search on the internet, we are now able to organize the important user-needs. These user needs are now used to set up our development requirements for our product to ensure we make a product that targets our specific audience.

Introduction:
Pretty much every house or apartment has windows and other home appliances that can be redundant in moving, changing, or turning off and on. This problem leaves room for technological solutions to automate and facilitate all those redundant activities. That being said, there is a market for products that have light-sensing capabilities which can in turn help users utilize these devices to adapt their systems to different times of the day and certain conditions when the appliances should be on or off. We have a solution that can utilize different sensors and motors to fully automate redundant household functions that will elevate the quality of life for the users .

Objectives:
Our main objective is to design and develop a simple yet efficient home automation system. It must include at least one motor that is activated through a sensor as well as another sensor and a reliable power supply, all while the design and functionality satisfies the user and stakeholder needs gathered in earlier research.

Use case #1
Uriah lives in a large house in the middle of the Arizona desert and he needs to close the blinds in his house when he leaves or else the whole house heats up too much. It takes him way too long to constantly go around the whole house individually, closing and opening all the blinds. He decides to invest in a home automation system that can sense the temperature and brightness to open or close all the blinds for him. He can now save a lot of effort and time by not having to worry about whether his house will be too dark or too hot due to the outside temperature and brightness.

Use case #2
Jack lives in a small apartment with a couple of windows. However, he is always extremely busy and can’t afford to waste time with simple things such as opening or closing the blinds for sunlight into his apartment, which also doubles as his office. He decides to get a home automation system to automate and control the amount of sunlight he receives without having to stop working. Jack can now live in a more efficient manner.

Aspects

1. Product Design

1.1. Design must be efficient and easy to understand/use
1.2. Has to be aesthetically pleasing
1.3. Needs to be durable and built for longevity after constant use
1.4. Needs to be heat and solar deterioration resistant

2. Software/ Functionality

2.1. System will utilize a variety of sensors to monitor environmental conditions
2.2. Has Wi-Fi functionality
2.3. Must have customizable programming

3. Interactivity/ User experience

3.1. Installation must be simple without much modification needed
3.2. Maintenance should be quick and easy or non-existent
3.3. User interface needs to be straightforward

4. Customization

4.1. The user should be able to adjust the sensitivity and timing of the sensors
4.2. The user should be able to monitor the status of the devices
4.3. The user should be able to modify the components as needed

5. Manufacturing

5.1. Materials should be good quality while also being cost efficient
5.2. Material will be durable and have longevity

6. Safety

6.1. Shouldn’t have any sharp features to prevent unnecessary injury
6.2. Shouldn’t run on abnormally high power
6.3. Needs instructions on how to operate safely
6.4. Shouldn’t be made of materials that are potentially hazardous

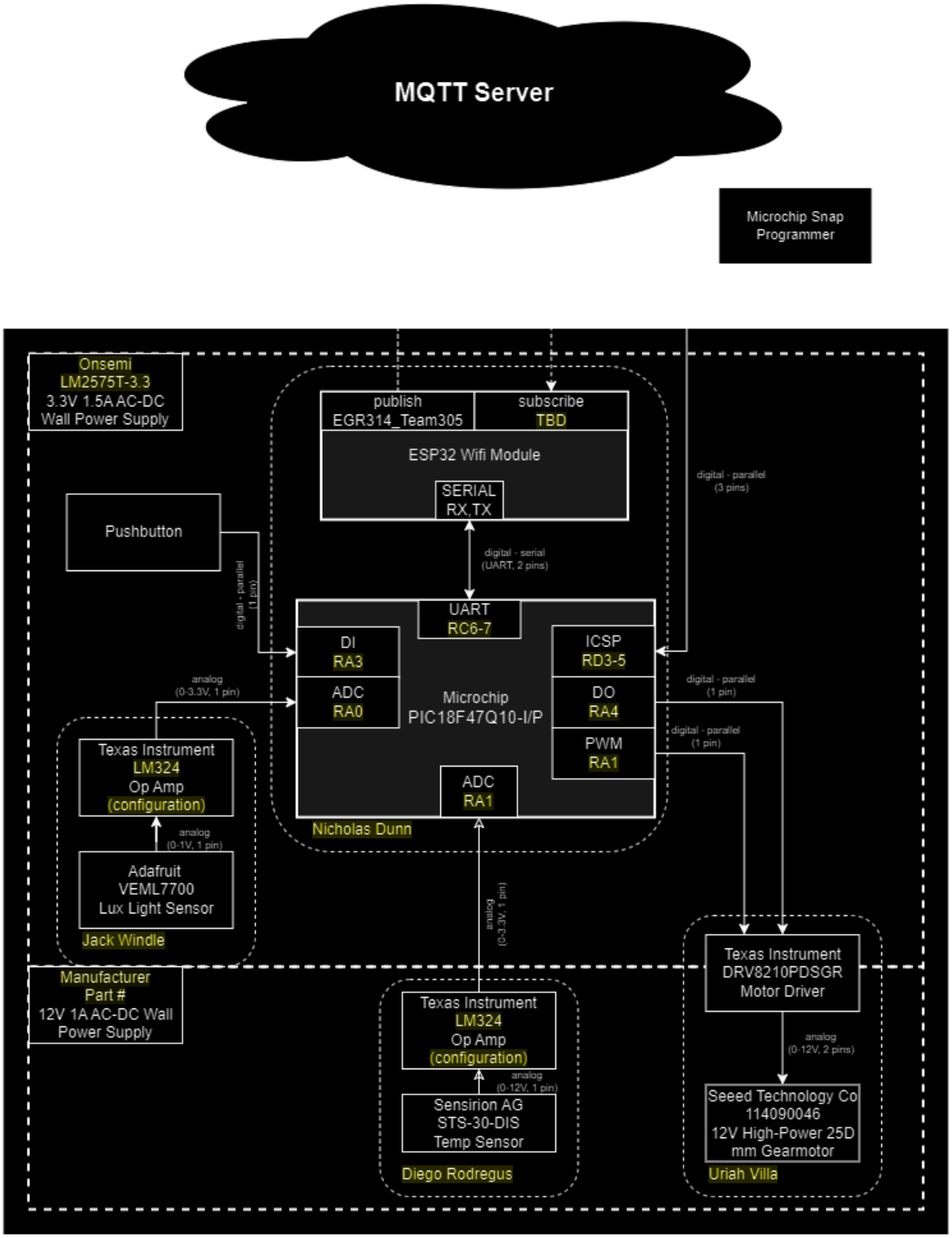
Design Ideation:

To come up with the product that we are now working on, we went through a brainstorming phase. Our brainstorming for this project was very brief since we unanimously agreed on the result. Essentially, we began trying to come up with ideas and Jack off the bat said we should do a home automation system that would utilize sensors to control house appliances and features. We as a group were instantly on board with this idea.

Home automation is a very broad subject so we came up with three ideas that would fit the topic. The first was a system that would use sensors to open or close blinds.(Fig.1) The second was a system that would use sensors to turn on a fan/ motor.(Fig.2) Lastly, the third idea was an automatic door that would use sensors to open or close.(Fig.3) After making mock CAD models and discussing all the ideas, we unanimously agreed that making the blind opening system would be the best for our project due to it being the most useful and efficient in everyday life. (Fig.4)

We then discussed the details to decide on which specific sensors would make the most sense as well as taking our past experience into consideration. After a brief discussion we decided on this system functioning on the subsystems of a motor/ motor-controller, light sensor, and a digital thermal sensor.

Block Diagram:



EGR 314 Team 305 Verification Table (Jack, Diego, Uriah, Nicholas)

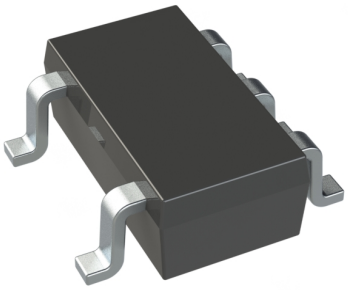
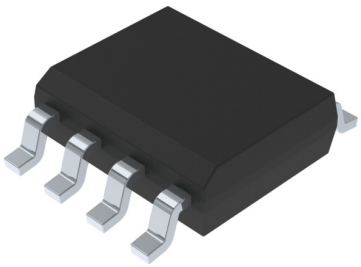
Power Supply - 3.3V	PIC	ESP32	Motor Driver	Motor	Temp Sensor	Lux sensor	Bluetooth Device
x	u	u	u	nc	u	u	nc
	x	RA6-7	RA1/4	nc	RA0	RA1	nc
		x	nc	nc	nc	nc	u
			x	u	nc	nc	nc
				x	nc	nc	nc
					x	nc	nc
						x	nc
							x

Key	
u	unverified connection/subsystem
x	connection verified by you
v (XYZ, 1/23/45)	connection verified by instructors (INITIALS, date)
(xyz)	serial protocol
nc	No Connection

Component Selection:

Component: Temperature Sensor

Choices:

Name: TC74A4-3.3VCTTR  **Price:** $1.15 **Link:** Digikey	**Pros:** • Surface Mount • Cheap • Reliable seller • Datasheet included • Fast shipping • Included in class	**Cons:** • Small part
Name: STLM75M2F  **Price:** $1.24 **Link:** Digikey	**Pros:** • Surface Mount • Cheap • Reliable seller • Datasheet included	**Cons:** • Long shipping time • Very small part

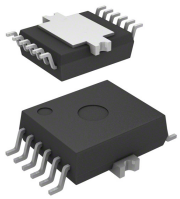
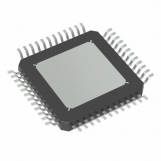
Name: STS21  **Price: $3.36** **Link:** [Digikey]	**Pros:** ● Surface Mount ● Reliable seller ● Datasheet included	**Cons:** ● Long shipping time ● Impossibly small part - Unable to work with ● Expensive

Choice: TC74A4-3.3VCTTR

Reason: Since it was the part given in class for an ICC, it will be easier to utilize than other components online. Given that it's used by the students and professor, there will be an abundance of help available with this part should we face any hardship with it. Also, given it's cheap and ships fairly quickly, we will have more than enough of them for our project.

Component: Motor Controller

Choices:

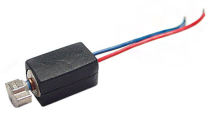
Name: IFX9201SGAUMA1  **Price:** $3.79 **Link:** Digikey	**Pros:** • Very good • Reliable seller • Used in class • Fast shipping	**Cons:** • Expensive
Name: TMC2160A-TA-T  **Price:** $6.21 **Link:** Digikey	**Pros:** • Will not be overloaded with its 20A max current draw • Will not be shorted out with its 50V max supply voltage	**Cons:** • More expensive • Long shipping time
Name: IMC101TT038XUMA1  **Price: $3.35** **Link:** Digikey	**Pros:** • Cheap • Very diverse use	**Cons:** • Way too many pins • Pins extremely small • Long shipping time

Choice: IFX9201SGAUMA1

Reason: Since it is the device we used in class, there is great support for this device. It also functions for what we desire.

Component: Motor

Choices:

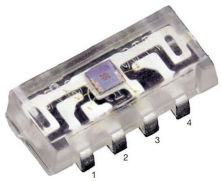
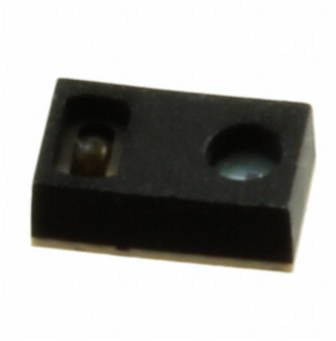
Name:12V DC Reversible  **Gearhead Motor** **Price: $2.25 Each** **Link: Jameco**	**Pros:** ● Small Gear Case ● Inexpensive	**Cons:** ● Lower RPM ● Short motor shaft
Name:DCM-1023  **Price: $85.00** **Link: Digikey**	**Pros:** ● Low RPM ● High Torque ● Fast shipping ● Durable	**Cons:** ● Large and bulky ● Expensive
Name: 1081000006  **Price: $2.50** **Link: Digikey**	**Pros:** ● Super cheap ● Very small	**Cons:** ● Very high RPM ● Long ship time

Choice: 12V DC Reversible Gearhead Motor

Reason: It is small, compact, and cheap. Perfect for our project where we need a small motor.

Component: Light Sensor

Choices:

Name:VEML7700-TT  **Price:** $1.88 **Link:** Digikey	**Pros:** • Very fast shipping • Cheap • I2C compatible	**Cons:** • Small part • Needs subsequent system for easier readings
Name: VEML7700-TR  **Price:** $1.88 **Link:** Digikey	**Pros:** • Very fast shipping • Cheap • I2C compatible	**Cons:** • Small part • Needs subsequent system for easier readings
Name: RPR-0521RS  **Price: $1.95** **Link: Digikey**	**Pros:** • I2C Compatible • Cheap	**Cons:** • Long shipping time • Pins are barely accessible.

Choice: VEML7700-TT/TR depending on tolerances for our project. Both have the same electrical works but the shape of the packaging and pin orientation differ a bit. Both are readily available and in stock at a low price. They do everything we need but can be made better with an additional subcircuit.

Reason: We need to communicate with the professor about the potential use of a daughter board for this part. Choice 1 is the primary option though.

Component: Pic Microcontroller

Choice: Chosen in Microcontroller Selection Assignment.

Component: ESP32

Choice: Given

Power Budget:

	Peak Sustained Current (mA)	Nominal Voltage	Max watts
PIC18	50	3.3	0.165
ESP32	280	3.3	0.924
Motor	1000	12	12
Motor Driver	5	3.3	0.0165
Light Sensor	0.05	3.3	0.000165
Temp Sensor	0.2	3.3	0.00066
	Total:		**Total:**
12V 1.5A Fuse	1335.25		13.106325
3.3V 500mA Fuse			

The motor can use up to 1A of current at full speed so a 1.5A fuse will be sufficient to run it safely at full speed and still protect from shorts. The rest of the low voltage components draw less than 350mA with the current parts, so a 500mA fuse will be sufficient. This setup will allow us to use more low current devices in the future as well.

Microcontroller Selection:

Design Considerations	Team Project-Specific Requirements	PIC Option 1 PIC18F27J53-I/SO	PIC Option 2 PIC18F27Q10	PIC Option 3
GPIO Pin #	**6**	28	24	18
Built in Analog to Digital Converter. #	**2**	2	2	2
Built-in Hardware PWM. #	**2**	2	2	2
Built in I2C or SPI. #	**2**	2, 2	2, 2	2, 2
Built in UART. #	**2**	2	1	2

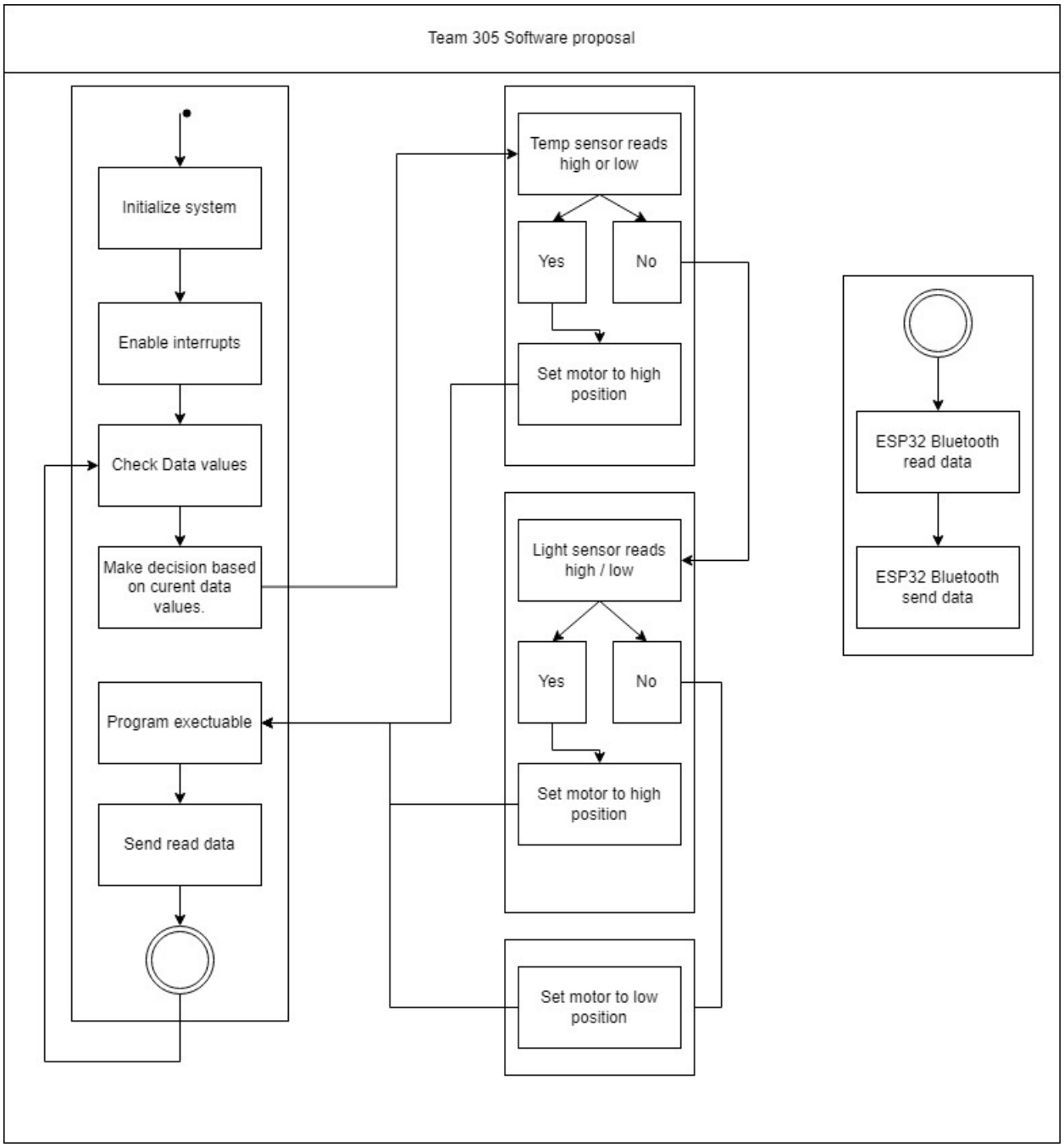
Microcontroller Considerations	PIC Option 1	PIC Option 2 PIC18F27Q10	PIC Option 3
Part Number	PIC18F27j53-I/SO	PIC18F27Q10	PIC18F14Q40-I/SS
Link to product page	Link	Product Link	Link
Link to Data Sheet	Data Sheet	Data Sheet	Data Sheet
Link to Application Notes	Notes	Application Notes	Application Notes

Link to Code Examples	Code Ex.	Code Ex.	Code Ex.
Link to External Resources	Resources	Resources	Resources
Production Unit Cost	$5.24	$1.62	$1.23
Supply Voltage Range	1.8 - 9 V	1.8 - 5.5 V	1.8 - 5.5 V
Absolute Max Current	350 mA	350 mA	350 mA
Max GPIO Pin Current	250 mA	250 mA	250 mA
8-bit or 16-bit	16-bit	16 bit	8bit
Footprints	Surface Mount	Surface Mount	Surface Mount
Supports External Interrupts	yes	Yes	yes
In-System Programming Capability and Type	yes	Yes	yes
Programming Hardware and Cost	$5.24	$1.62	$1.23
Works with MPLAB X IDE	yes	Yes	yes
Works with Microchip Code Configurator	yes	Yes	yes

Overall Pros	1. Exceeds all requirements 2. Powerful for what we need	1. Meets all the necessary requirements 2. Inexpensive	1. Meets all requirements 2. Is cheap
Overall Cons	1. Not cheap.	1. Doesn't have much room for adding potential extra components 2. There isn't much external info on it	1. Pins are somewhat small.
Ranking	1	3	2

Final Choice: We are choosing option 1 because it fits best for our project. Option 3 does not meet all our requirements, and 2 is an inadequate version of 1. Thus, option 1 is the preferable choice between these 3 options.

Software Proposal:



Hardware Proposal:

Appendix A: Table of Figures

Figure 1:

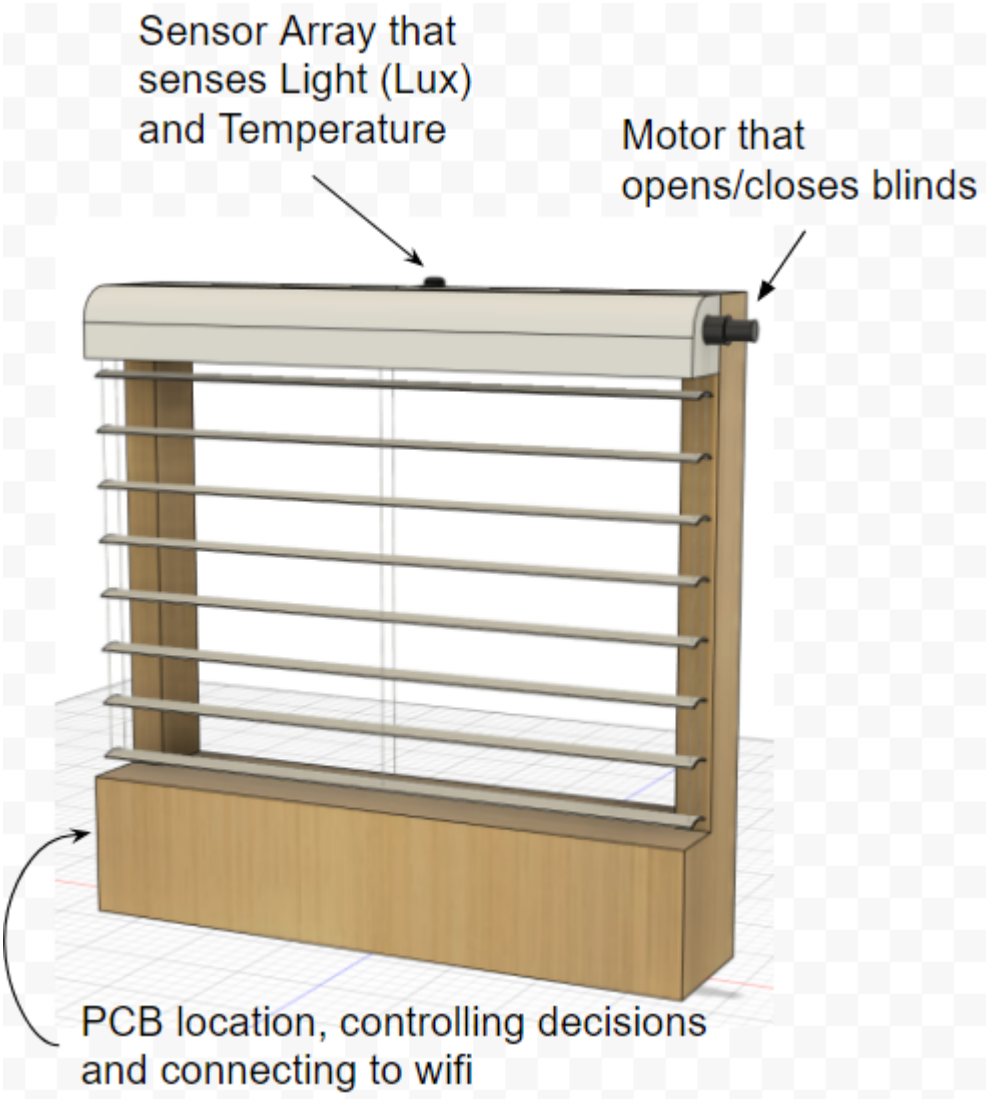


Figure 2:

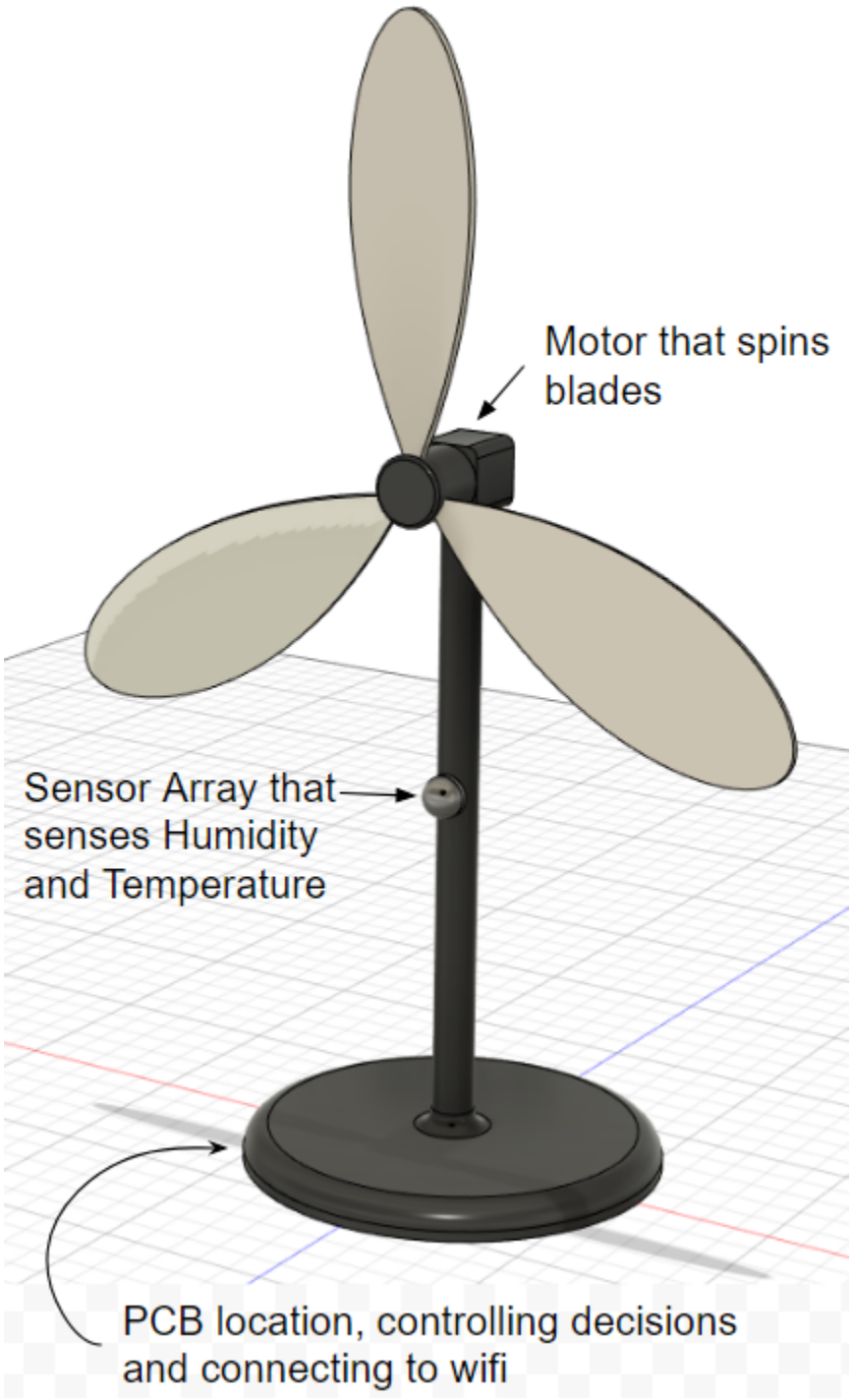

Motor that spins blades
Sensor Array that senses Humidity and Temperature
PCB location, controlling decisions and connecting to wifi

Figure 3:

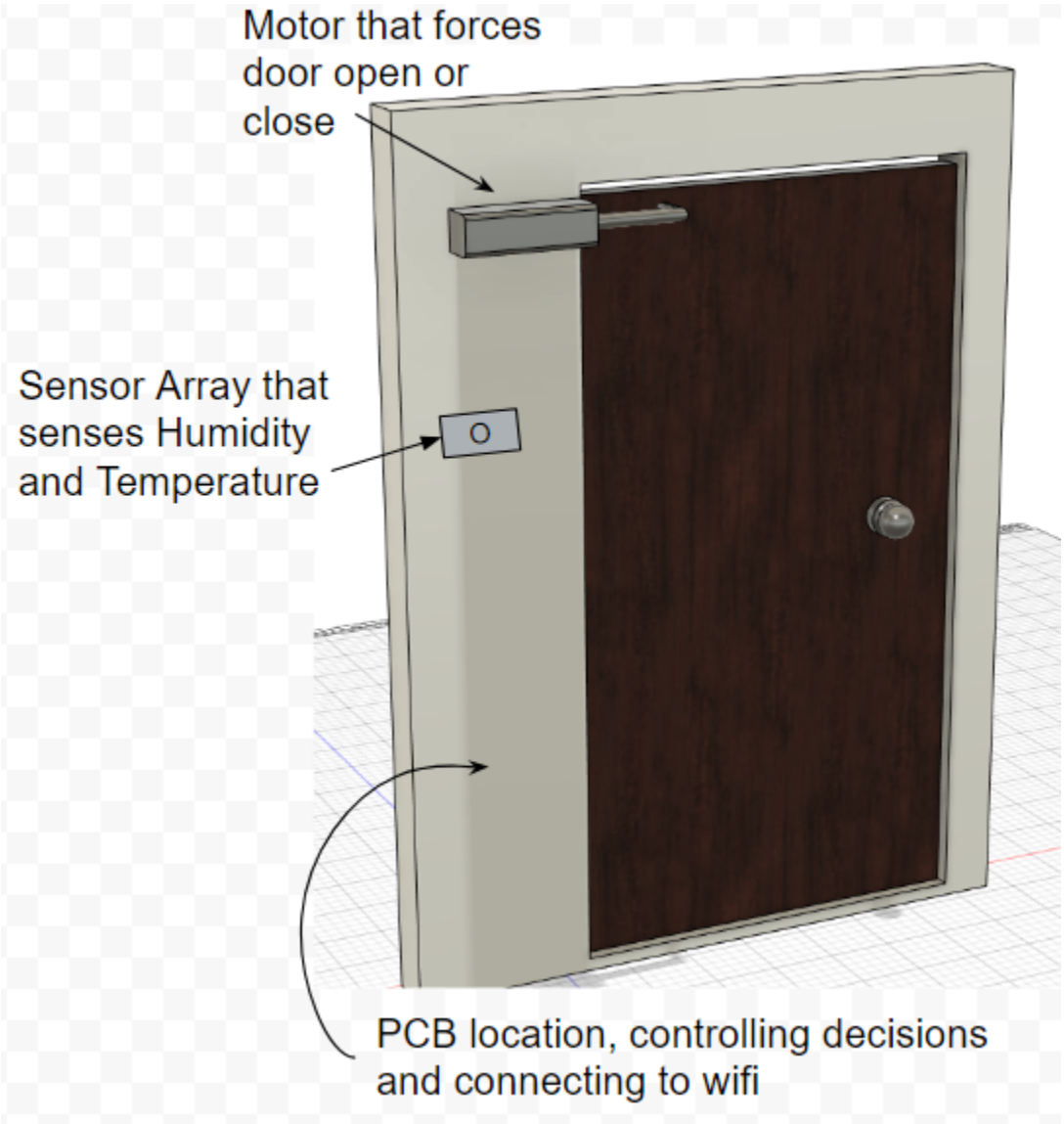

Motor that forces door open or close
Sensor Array that senses Humidity and Temperature
PCB location, controlling decisions and connecting to wifi

Figure 4: