Fantom

Team 1: FANtastique Inc

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Outline

- Meet the FANtastique team
- Motivation and description of FANTOM
- Background
- Technical case
- Business case
- Benefits and risks
- Risk remediations
- Adhered standards
- Current situation
- Demo
- Questions
- Conclusion
- References

Our Team

Our Team

Jehaan Jacob Joseph

Chief Communication Officer

Assists with company-wide communication, research, and development

Karina Khartanovich

Chief Executive Officer

Accountable for administrative, financial, and risk management operations

Ziyi Zhao

Chief Information Officer

Assists the company's IT development, and integration with other part of the project

Shafin Rehman

Chief Technology Officer

Responsible for the technical writing aspect and electrical aspect of the project

Ardavan Mohseni-Javid

Chief Financial Officer

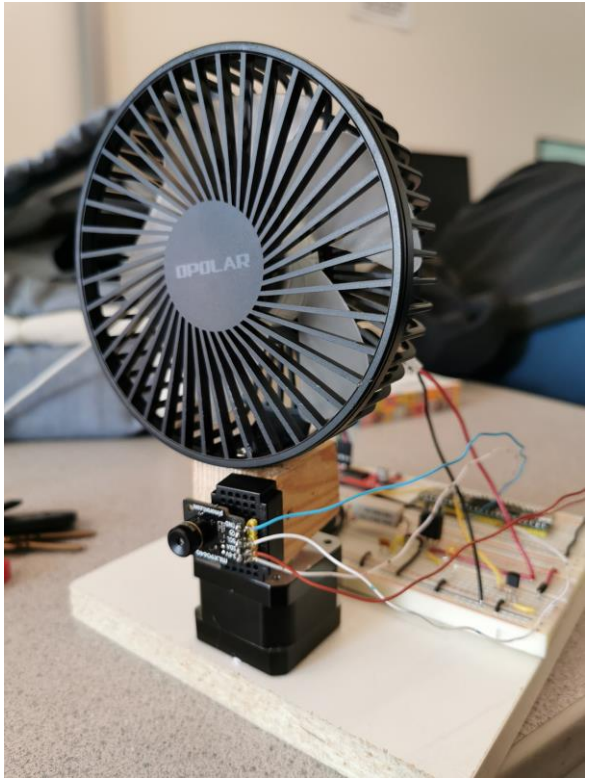
Safeguards the accounts, manages finances, expenditures, and revenues of the business

Motivation

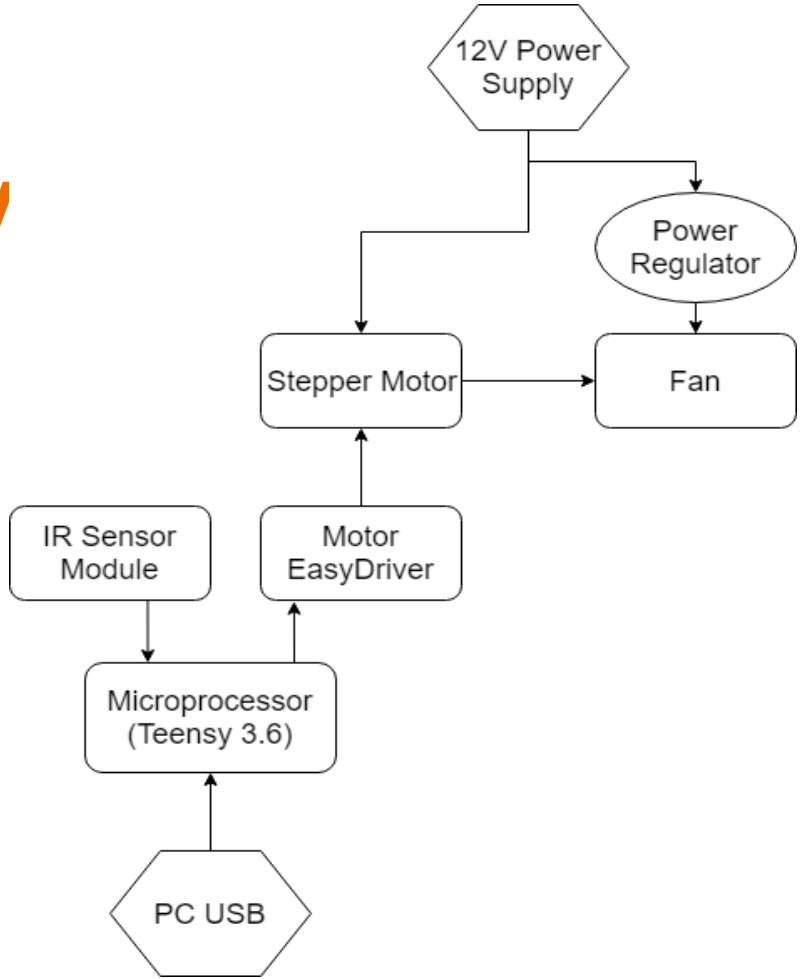
- Energy wasted from allowing home cooling solutions to run for longer than needed or from covering a wider range than necessary
- Air Conditioners consume a high amount of power by default
- Commercially available desk fans consume much less power but tend to be left on when not needed
- They also circulate air (when oscillating) in a fixed range of motion which may or may not cool the room as needed
- No products currently exist on the market that circulate air based on user location and room layout
- More advanced cooling solutions that have more than just the basic fan features are often in a price range of > $300

What is Fantom?

- Revolutionary smart cooling system that will efficiently track and direct airflow to individuals in a room
- Will utilize an IR sensor module to perform the tracking as well as controlling the intensity of the airflow
- Will be able to incorporate multiple fans to track multiple people
- Software application on a smartphone will allow the user to customize the operation of the device as well as set up automated profiles
- Device will only operate if a person is detected within its vicinity, otherwise will not be on thus saving on energy costs and reduce our carbon footprint



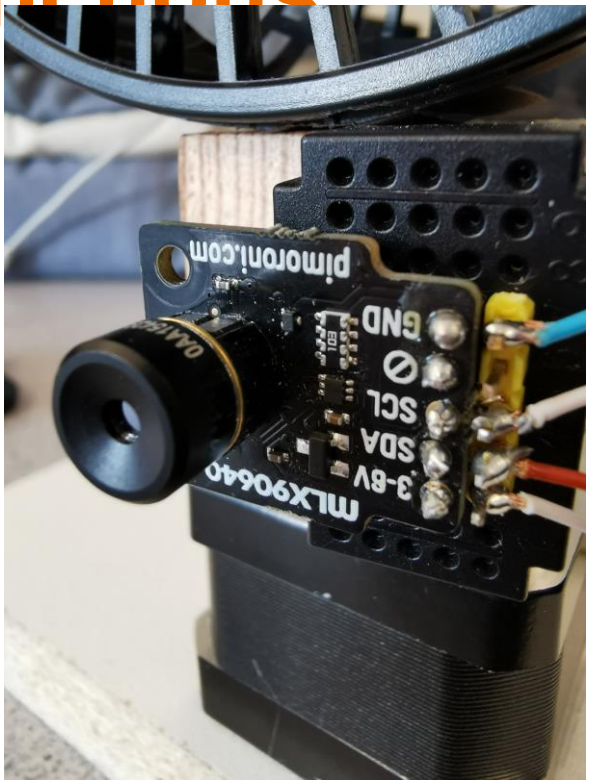
Technical Case: High Level Overv



Technical Case: Main Functions

Individual Tracking:

- IR/thermal camera will be able to track an individual
- Done by locating the center of the hotspot given the range of average human body temperatures



Technical Case: Main Functions

Rotation and Oscillation:

- To facilitate the tracking function, the fan will have to rotate and oscillate to ensure the airflow is directed towards the individual
- Stepper motor will be used to control the angle of rotation
- MCU will send signal to a stepper motor driver, which in turn will power and drive the motor appropriately

Technical Case: Main Functions

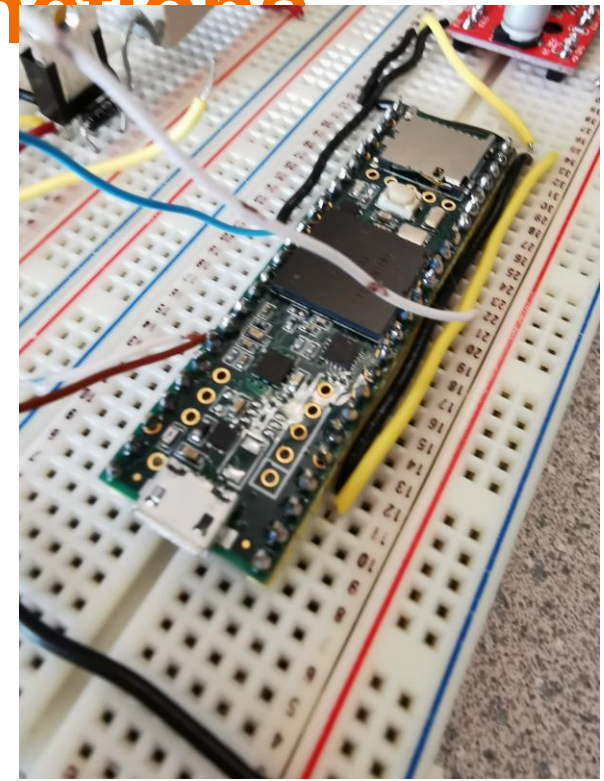
Articulating Airflow:

- IR/thermal camera will be used to approximate the distance between the fan and an individual and adjust the intensity of the airflow accordingly
- Done by considering all the pixels on the camera that that are within range of human skin surface temperature at a given moment
- More pixels in range will be interpreted as the person standing closer
- This feature is to be implemented with a PWM circuit

Technical Case: Main Functions

Power Savings:

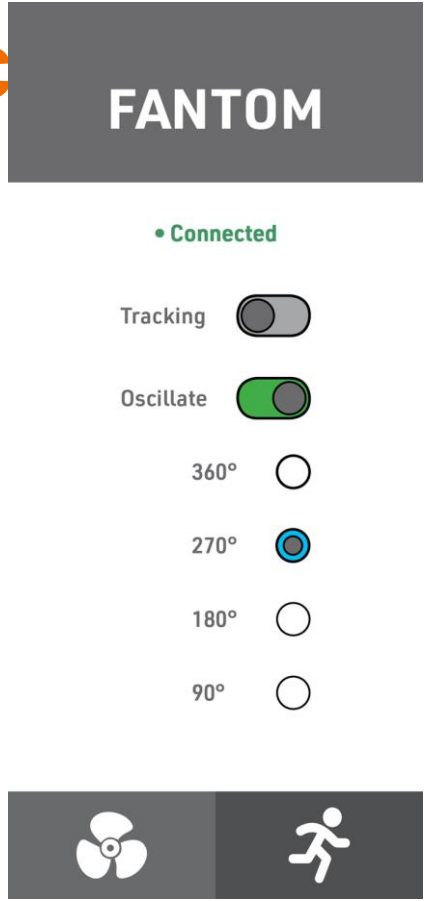
- Fan will only operate when it detects a presence within its vicinity
- If no one is in the area, the fan will perform a full 360 degree sweep twice, once in the clockwise and another in the counterclockwise directions to confirm
- After this, if nobody is detected, device will transition into a sleep state until the senor sees someone



Technical Case: Main Func

Smartphone Application:

- Software application will allow a user to customize the operation of the fan to their personal preference
- Set to either be autonomous or manual control
- In manual mode, user can select a desired fan speed and whether it should oscillate between various specified angles

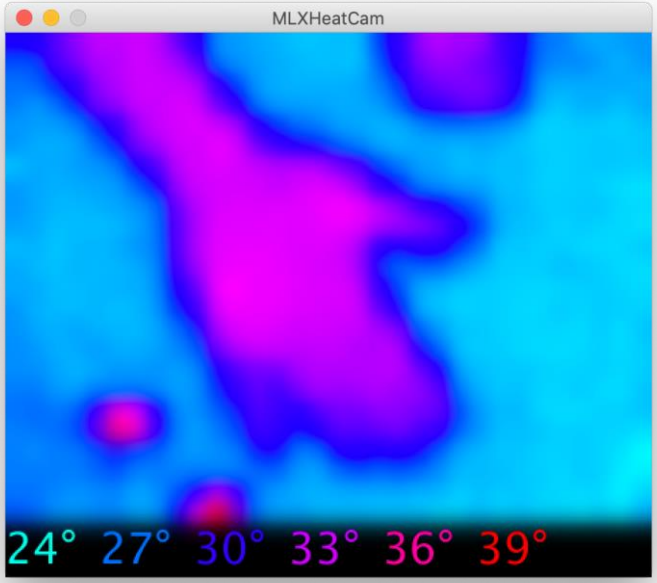


Technical Case: Materials, Hardware and Design

- Small USB powered desk fan assembly was used for the Proof of Concept
- Internal electronics were taken out
- Teensy Board 3.5 used as the microcontroller
- Stepper motor used to control the rotation of the fan
- Power supply will connect directly to the breadboard and provide 12 Volts DC and 1 Amp current to the motor and 5 Volts DC to the microcontroller
- Power regulator will be used step down power from 12 Volts DC to 5 Volts DC for the fan motor

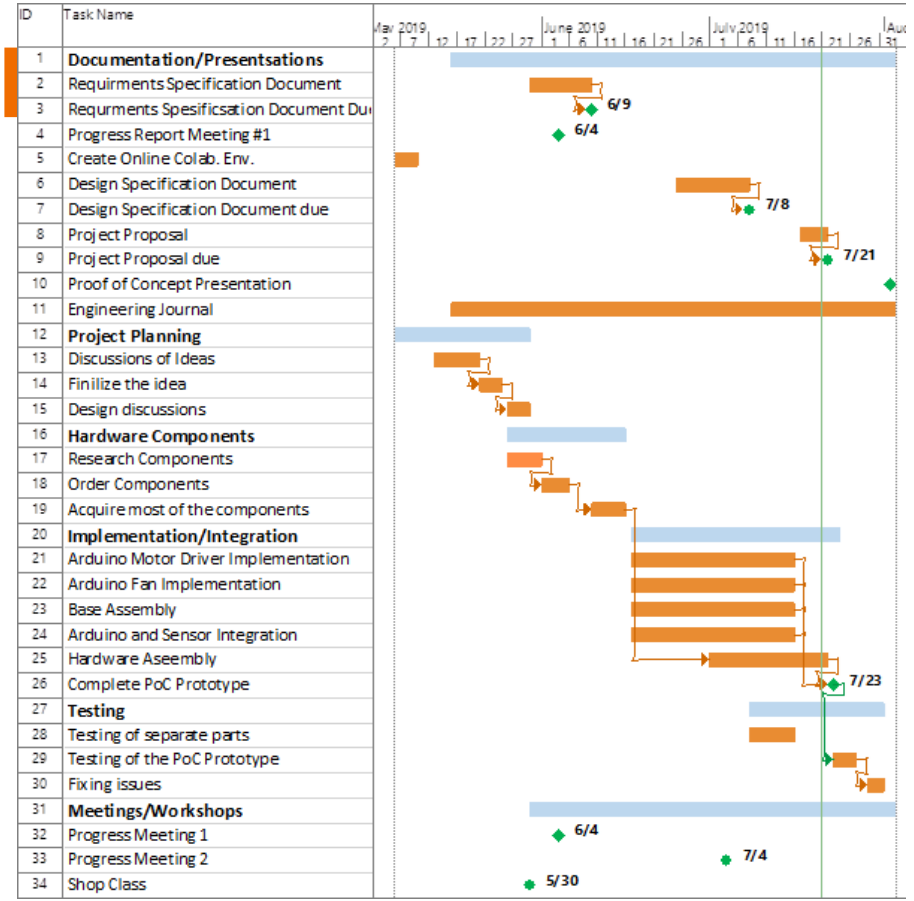
Technical Case: Software Algorithm

- The sensor module used for this application has a resolution of 32x24
- Algorithm will detect number of pixels in each column of the pixel array of the sensor that are within the human skin temperature range from 28 to 34 °C
- If there is a person in view, it will determine the column in which the person's temperature is most concentrated
- If this column is on either the left or right of the center most-columns, the MCU will give the appropriate command to the stepper motor to turn so that the heat source will be centered on the center-most column



Technical Case: Sch

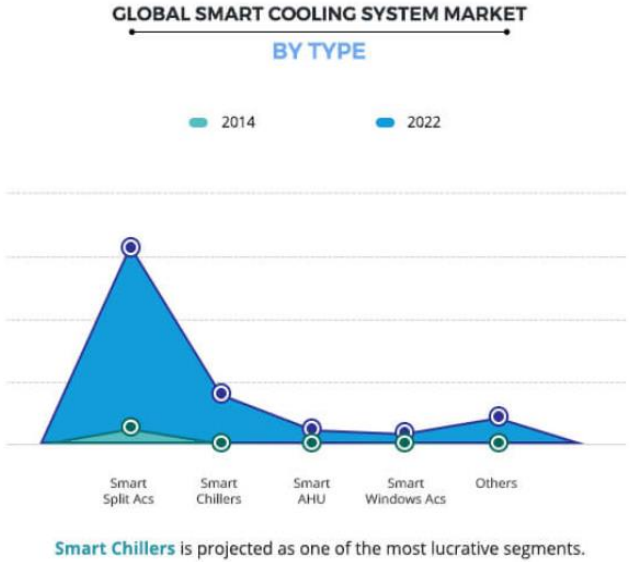
	Estimated	Progress-to-Date
Proof-of-Concept	August 2, 2019	Major features implemented
Final Prototype	Late November	Planning for Beta phase



Gantt Chart

Who Would be Interested?

- Smart cooling systems are set to see a dramatic increase in both demand and revenue between 2019 - 2022
- Projected revenue to be $137.548 trillion with a Compound Annual Growth Rate (CAGR) of 52.4%
- Asia-Pacific region will dominate the market with its own projected CAGR of 59.1%
- FANTOM would be targeted at those who want more than a simple cooling solution but also want a more cost friendly alternative to expensive air conditioning units
- Smart features such as tracking and energy saving would facilitate environmental conscious buyers



Business Case: Funding

- Wighton Engineering Development Fund
- The Engineering Science Student Endowment Fund (ESSEF)
- Each member of the team will also contribute within their means if funding from these two sources isn’t enough

Business Case: Cost Considerations

- Want to market our product as an alternative to both simple cooling solutions but also more expensive and bigger air conditioning units with retail cost of ~$200

Part Description (PoC)	Cost
Fan Assembly	$20.99
Power Supply	$15.99
Stepper Motor	$30.57
IR/Thermal Camera Sensor	$101.23
Circuit Components	$10.00
Teensy 3.5 Board	$55.30
Bluetooth Module	TBD

Potential Risks and Benefits

Benefits:

- Will cost less than the next comparable cooling solution
- Energy savings by being smart about when it turns on and off thus saving money and reduces the user's carbon footprint
- Easily programmable to suit the desire of the user through the use of a smartphone application
- Fully automated; no need for manual user input to operate

Risks:

- Might be undesirable in large, open space environments where the airflow may be insignificant
- Tracking the movement of multiple individuals might not be sufficient with just one fan
- Having multiple fans operating together and communicating data might require a complex software algorithm
- IR/thermal camera could cause security concerns

Risk Mitigations

Outlined Risk:

Might be undesirable in large, open space environments where the airflow may be insignificant

Remediation:

User will be made aware that the device is intended for use in a small room size, or as a personal device such as on the user’s desk.

Risk Mitigations

Outlined Risk:

Tracking the movement of multiple individuals might not be sufficient with just one fan

Remediation:

Having multiple fans that can communicate work in tandem is a feature we are considering for the next stage.

Risk Mitigations

Outlined Risk:

Having multiple fans operating together and communicating data might require a complex software algorithm

Remediation:

This feature will be researched and tested thoroughly if it is chosen to be implemented

Risk Mitigations

Outlined Risk:

IR/thermal camera could cause security concerns

Remediation:

The resolution of the sensor is very low and is not enough to depict any facial features of an individual

Additionally, the device does not store any information locally

Adhered Standards

Electrical System Standards	General requirements - Canadian electrical code, part II (CAN/CSA-C22.2 NO. 0-10 (R2015))	Safety while working with electrical equipment
	Safety of transformers, reactors, power supply units and combinations thereof - Part 1: General requirements and tests (IEC 61558-1:2017)	Safety while working with power supply units
Mechanical Systems Standards	ISO/TR 12100-2:1992, Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications	Safety in mechanical design
	ISO 14120:2015, Safety of machinery — General requirements for the design and construction of guards (fixed, movable)	Safety in construction of mechanical devices
	ISO 13852:2008, Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs	Safety zones for moving mechanical devices

Major Milestones and Completions

- Successful in creating algorithm to track the location of an individual and rotate the fan according to their position in the room
- Designed and built efficient power regulation system that distributes power appropriately to all of the device elements
- Initially powered the device with the power supply found in Lab 1, but successfully transitioned to using the 12 Volt power supply purchased in the parts list
- Mounted components on a stable base that prevents the device from moving around due to its own momentum

Current Trouble Spots

- Dynamic airflow intensity system is not working as expected
  - A PWM circuit in conjunction with a MOSFET was used to implement this feature, however it does not receive a high enough voltage from the MCU to change states
  - A BJT is currently being considered as a replacement for the MOSFET
- Unable to implement an idle mode
  - This is also due to the above issue with the MOSFET, as we intended to turn the fan on or off by sending the appropriate signal from the MCU
- Difficulty achieving smoothness of rotation with our current tracking algorithm
  - Our tracking algorithm uses a custom library that allows ease of control in determining the motors final direction
  - However, it’s options for controlling the speed and step size of the motor were limited and are still being developed at the moment

Lookahead for ENSC 440

- Will be transitioning into the Prototype phase
- Software application for a smartphone will be developed
  - Will allow a user to customize their device in terms of how it operates (automatic or manual control, fan speed, oscillation, etc.)
- More smart features will be implemented including
  - Multiple person tracking
  - Multiple fan option
  - Refinement of the existing feature set
- A full solution into the 360 degree rotational aspect of the device will be re-engineered
- A more power efficient microcontroller will be considered to possibly increase efficiency

Key Takeaways

- Research is an important step that cannot be rushed
  - MCU has limited memory which we discovered was not enough to carry out the processing for our system
  - Had to purchase a different MCU late into the semester
- Software development on a resource limited platform like Arduino, it is important to take into account the power, memory, and IO of the hardware.
- Hardware debugging often takes the longest time during the building and testing process
  - It is worth seeking external help when designing electronics systems due to our limited experience
- Given that we will be scaling up our system for 440, while also adding new features, we will be spending the first months on research in order to ensure we don’t repeat the same mistakes

Proof of Concept Demo!

https://youtu.be/UD2IHubfziY

Questions?

Thank You!

References

[1] "Specifications | Bluetooth Technology Website", Bluetooth *Technology Website*, 2019. [Online]. Available: https://www.bluetooth.com/specifications/. [Accessed: 09- Jun- 2019]

[2] "CAN/CSA-C22.2 NO. 0-10 (R2015). General requirements - Canadian electrical code, part II", CSA Website, 2015. [Online]. Available: https://store.csagroup.org/ccrz__ProductDetails?viewState=DetailView&cartID=&sku=CAN/CSA-C22.2%20NO.%200-10 [Accessed: 09- Jun- 2019]

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[7] SparkFun Electronics ® (2018). *IR Camera Display*. [image] Available at: https://cdn.sparkfun.com//assets/parts/1/3/0/1/4/SparkFun_MLX90640_Thermal_Imaging_Camera-Demo.gif [Accessed 6 Jul. 2019].