



**Management &
Engineering for
Manufacturing**

HomeBody - Fall Detection

Group 13

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UConn
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SECTION 1: EXECUTIVE SUMMARY

Many Americans are hospitalized or killed each year due to falls within the home. There are many devices on the market that detect falls, but most of them require the user to wear the device on their body. Our device uses an InfraRed sensor to detect when falls occur, and can be placed anywhere in the home. Our product does not require any wearable parts, and operates 24/7. It also has the ability to send out an alert message to a desired recipient upon the detection of a fall. This ensures that assistance will be requested, even if the user does not have the ability to ask for it themselves.

With the elderly population growing and the increasing desire amongst older Americans for independent living, there should be a large demand for our device, assuming it functions well. The device can be sold both online and in stores. It will come with a user manual that helps the user decide where to place the device, depending on the layout of the home. It may be recommended to purchase more than one device for optimal coverage, but this decision is ultimately up to the user. This should not be too much of an issue because our device will be relatively inexpensive with a goal retail price of no more than \$100.

SECTION 2: PROJECT INTRODUCTION

Home Body's mission is to ensure the safety of people in their home by providing them emergency support for trips, slips, and falls. The company was started in the sponsor's home in Rhode Island. It is made up of the owner Rick and Michael Bartosewicz who is a semi-retired systems and electro-optics engineer. Rick started the company several years ago, Mr. Davids' mother lived at a nursing home for dementia patients. She fell in the middle of the night and remained wedged between the door and wall. No one knew she was stuck. Another time she climbed out of a crib, fell to the floor, and laid there for several hours before someone rescued her. Mr. Davids' aunt Helen fell in a doorway at her home and was unable to get up for 3 days until relatives arrived to check up on her. These accidents are not uncommon in homes and managed care facilities. Due to the events that happened in Rick's life he decided to start this project in order to provide safety to others so the events that happened to him won't happen to anyone else. Home Body has the capability to become a commercial brand with the new IR sensor that detects fallen bodies and sends an alert to a designated emergency contact. This product can become available in multiple stores across the country and provide safety and comfort to homes everywhere. The customers of this company would be those who are seeking to provide safety for loved ones who live alone and are prone to falling or for themselves for the same reasons.

The main goal of the project is to create an infrared sensor combined with a raspberry pi microprocessor to detect a fallen body and simultaneously send an email to the emergency contact. Along with the hardware we have to design a 3D printed enclosure to contain it, providing drop protection and the optimized field of view. Each sensor will come with a user's

manual that describes how to set up the sensor and gives suggestions on where to locate the sensors based on the design of the house.

TECHNICAL REVIEW

SECTION 3: PROBLEM DEFINITION

(Project Description)

A. Stake Holders

- Richard Davis -> Project Sponsor and Stake Holder
- Michael Bartosewicz -> Project Sponsor, InfraRed Reference, and Stake Holder
- Grant Moxham -> Team Member
- John Gallagher -> Project Manager
- Alex Clonan -> Team Member
- Stephen Duncanson -> Team Member
- Tao Liu -> Team Member
- Isabelle Bunosso -> Project Intern
- Professor Calvert -> UConn Advisor
- Professor Cunha -> UConn Advisor
- Ahmed El-Mouwfi -> Project Mentor
- Brian Lassy -> Project Mentor

B. Scope

- Create a device that can detect a fallen body and send out an email to an emergency contact
 - Utilizing InfraRed and/or sound sensors
- Prepare Users Manual and Set-Up Instructions along with suggestions of where to place the sensors based on where slips, trips, and falls occur the most

C. Service Environment

- HomeBody does not have a set facility or factory for our team to visit. It is a company started by our Sponsors Rick, located in Rhode Island, and Bart who is currently in Kentucky. Due to the inability to visit them in person, all of our meetings have been over zoom. Despite the lack of physical interaction the zoom calls have been extremely productive and interactive between us and our sponsors, allowing us to form great relationships with them. At the end of each meeting we have an agenda that the sponsors assign us to complete by the next meeting which has allowed us to stay on track.

D. Previous Work

(Short Literature Search) REQUIRED

Research done:

- Slips, trips, and falls: The locations that these occur the most
- InfraRed Sensors: FoV, IFoV, Frame Rate, population, and what an infrared sensor does
- Home Safety Industry: Other products in the industry
- 3D printing material: looking for a material that is strong and heat conductive
- Systems Engineering: What is it and what makes a good systems engineer

E. Deliverable Requirements

(Remember to include objectives, metrics, constraints, and criteria that make one design better than another) REQUIRED

- A Spec including specifications that the sensor needs to incorporate such as:
 - size, weight, volume, field of view, instantaneous field of view, frame rate, population, human temperature, material of 3D case
- Functional Block Diagram of the IR and Raspberry Pi code (ECE)
- Project Charter
- Initial Business Plan
- 3D Case Design (solidworks)

SECTION 4: DESIGN DESCRIPTION

Describe Your Design Process. This should be an iterative process. Explain the overarching approach and then start describing the iterations that were worked on. This is where you would include your evaluation of the different components of your project including your unit problem. (Design Matrix and Design of Experiments.) REQUIRED

Designer's Description	Design Process	Product	Functions	Issues
Define the type of sensor and how to incorporate it	Sensor selection, cost assessment, performance assessment	InfraRed Sensor	Detects when there is a thermal presence in front of it	It needs to only alert when there is a human in front of it, not just any heat source
Define the material in order to assess cost and thermal conductivity	Material selection, cost assessment, thermal conductivity assessment	PLA	Contains the hardware of the sensor, fall protection	Needs to look aesthetically pleasing and not break if knocked over
Define the type of code going to be used to make the sensor work	Code selection, performance assessment,	Python	Will allow the ECE members to utilize the raspberry pi	Raspberry Pi processor may not be powerful enough

	efficiency assessment		processor when coding	
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SECTION 5: DESIGN EVALUATION

This is the analysis section. The metrics/criteria defined in your project definition should be used to describe how the design(s) so far is/are compared. REQUIRED

- The selection of the infrared sensor was done by our ECE members after we provided them with several options that they then choose the best selection.
- The 3D material of PLA is the only material that is accepted by the 3D printers at UConn so it is the only option for the prototype enclosure.
- Python was selected because the raspberry pi was already owned by a member of our team so it saved a good amount of money, allowing us to have more money to spend in our budget for other materials.

SECTION 6: DESIGN RECOMMENDATIONS

A. Currently Recommended Design

This is your conclusion section. Based on your design evaluation what do you recommend the sponsor to do? REQUIRED

Based on the designs above, it is recommended that the sponsor proceeds with using python and the raspberry pi for the infrared sensor for the prototype. This is because it would save them money testing the sensor and making sure it works before they invest more money in higher quality materials. For the same reason they should use the PLA material for the 3D enclosure of the hardware. It is more cost effective than the higher quality materials and for a prototype it would be too costly to purchase higher quality materials with the chance of the system not working properly. Once it has been established that the prototype is working, higher quality materials that would make the product better can be purchased and utilized in the commercialized sensor.

B. Future Design Requirements

Because this is a mid-year report, you can include your next steps here as well. REQUIRED

- The future designs we have to create are the 3D enclosure that is not only going to encapsulate the hardware of the sensor but provide drop protection in case the device is knocked over.
- Designing where the sensors need to be placed around the house depending on the houses set up and the recurring sites of slips, trips, and falls.

BUSINESS PLAN

SECTION 7: COMPANY OVERVIEW

A. Company Introduction

Our sponsor Rick Davids created HomeBody out of his home in Rhode island after having several family members fall and not be able to get up for several hours, or even days in one instance. Rick knows that these events happen all over the world, every day. After Rick's mom and aunt both suffered from falls, Rick came up with the idea to create a fall detection system that is affordable and easy to set up, but can also reliably detect falls and send out an alert to the user's desired recipient.

B. Technology

Our device uses an Adafruit MLX90640 InfraRed sensor which collects data and presents it as a 32 x 24 array of pixels. This data will then be sent to a Raspberry Pi 4 Model B microprocessor, where the data will be run through a code written by the team's ECE members. The code should be able to determine when a fall has occurred and will send out an alert message.

C. Product/Service

The product we will be producing is the fall detection device composed of the IR sensor and microprocessor, enclosed in a 3D printed case. It will come packaged, with a user manual. Our product does not come with a service, but will send out an alert message to whoever the user chooses as the recipient. It is up to the user who they wish to be alerted if a fall occurs. Most users will likely have their alert message sent to a neighbor or friend or family member who lives nearby.

D. Intellectual Property Status

This project might qualify as unique intellectual property. Most fall detection devices work through the use of an accelerometer device that is worn by the user. Our project is different from most because it uses an InfraRed sensor. Through a quick google search, it can be found that others have had this idea in the past, but it is unclear whether or not this idea has been patented or successfully taken to the market.

E. Commercialization Strategy

This product can be advertised to the elderly demographic using online advertisements. If someone wants to purchase after seeing an ad, they can go to our website and buy it, having it shipped directly from the manufacturer. However, they should also be sold in stores to increase the amount of exposure this product has to the general public. This also benefits people with disabilities or medical conditions who are harder to target through online advertisements.

SECTION 8: INDUSTRY OVERVIEW

A. Industry Definition and Description

The industry is medical alert systems which include any product that reports a medical emergency to the authorities or an emergency contact. This includes wearable alert systems or in-home sensors that report when a human is in need of help.

B. Regulations and Policies Driving the Industry

Medical alert devices are constantly becoming increasingly affordable and accessible due to improvements in technology and increased investments to the Research & Development of these devices and systems. Due to this, the Global Medical Alert Systems market is expected to have a compounded annual growth rate of 8.3% and reach 10.9 Billion dollars by 2026 (PRNewswire). Home-based users are a large part of the market.

Other factors driving the industry include:

- Increase in elderly population and health literacy
- Elders desire for independent living
- Healthcare reforms and government financial assistance in favor of senior citizens

SECTION 9: CUSTOMERS

A. Customers & End-user

The end user will typically be elderly individuals who live alone. These are the people who are most at risk of falls in the home and create the demand for our product. However, the need is not limited to just the elderly. Our product would also be of much use to people who are disabled and people who have medical conditions which may require emergency assistance.

B. Buying Behavior

This product will be bought by people who live alone or by the family members or care-takers of someone who lives alone. It could also be bought by nursing homes or senior living facilities. The purchase decision will usually be made by the user of the device, however the decision may be influenced by family members or caregivers as well.

SECTION 10: MARKET

A. Market Definition

- *Primary market*

The primary market for our product is elderly people who live alone. This is the demographic that is most prone to falls within the home that are likely to require some sort of medical assistance.

- *Secondary markets*

The secondary market for our product is people with disabilities or medical conditions that could leave them incapacitated, whether or not a fall has occurred. For example, our device could be very beneficial to someone who is prone to seizures or has had a history of strokes or heart attacks.

B. Primary Market

- *Size and trends*

In 2019, 21% of men and 34% of women aged 65 and older lived alone (Statista.com). These percentages tend to increase with age, as people die and their spouses stay unmarried.

- *Current total and served-available markets*

Add text here INCLUDE INFO CONSIDERED TO DATE

- *Predicted annual growth rate*

People aged 65 plus represented 16% of the American population in 2019, and this number is expected to reach 21.6% by 2040 (Administration of Aging). This is a slow but steady compounded annual growth rate of about 1.44%.

SECTION 11: COMPETITORS

A. Indirect Competitors

Indirect competitors include elderly living facilities and nursing homes. These are places that an elderly individual may go to if they have any doubts about the risks involved with living alone. Using our fall detection device and alert system should give these people the peace of mind that they will be taken care of in case of an accident. This will hopefully allow people who have the desire to live alone to do so for a few extra years before they begin to rely on elderly living facilities to look after them.

B. Direct Competitors

Direct competitors include any company within the medical alert industry that makes fall detection devices. Some examples of direct competitors include Bay Alarm medical, Medical Guardian, and Lively.

C. SWOT Analysis

<p><u>Strengths</u></p> <ul style="list-style-type: none"> ● Our device does not require wearable parts ● Easy to set up and stays on 24/7 ● Automated alert message 	<p><u>Weaknesses</u></p> <ul style="list-style-type: none"> ● Our budget is very low compared to these established companies ● 32 x 24 is relatively low resolution
<p><u>Opportunities</u></p> <ul style="list-style-type: none"> ● High sales potential as our product 	<p><u>Threats</u></p> <ul style="list-style-type: none"> ● Device not being accurate enough

uses IR compared to most that use accelerometers	
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SECTION 12: MARKETING AND SALES PLAN

A. Opportunity Statement

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

B. Marketing & Sales Objectives

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

C. Current Customers

(if appropriate) COMPLETE IF APPROPRIATE FOR PROJECT

D. Potential Customers

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

E. Pricing

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

F. Sales Plan

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

G. Advertising

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

H. Sales/Marketing Budget

Add text here COMPLETE IF APPROPRIATE FOR PROJECT

SECTION 13: RESEARCH AND DEVELOPMENT (R&D) PLAN

A. R&D Objectives

Add text here COMPLETE FOR FINAL REPORT

B. Milestones and current status

Add text here COMPLETE FOR FINAL REPORT

C. Technical Risks

Add text here COMPLETE FOR FINAL REPORT

D. Staffing

Add text here COMPLETE FOR FINAL REPORT

E. R&D Budget

Add text here COMPLETE FOR FINAL REPORT

SECTION 14: MANUFACTURING AND ENGINEERING (M&E) PLAN

A business-focused version of the M&E plan. That is... Interpret the M&E plan into business-speak. Business people may only read this section of the report.

A. Objectives

Add text here COMPLETE FOR FINAL REPORT

B. Staffing

Add text here COMPLETE FOR FINAL REPORT

C. Manufacturing/Engineering Budget

Add text here COMPLETE FOR FINAL REPORT

D. Quality Control

Add text here COMPLETE FOR FINAL REPORT

SECTION 15: HUMAN RESOURCE PLAN

A. Staffing Objectives

Add text here COMPLETE FOR FINAL REPORT

B. Organizational Structure

3-5 year plan COMPLETE FOR FINAL REPORT

C. Human Resource Budget

Add text here COMPLETE FOR FINAL REPORT

SECTION 16: RISK MANAGEMENT PLAN

A. Potential Risks

Add text here INCLUDE INFO CONSIDERED TO DATE

- If the sensor plugs into the wall there is a risk of the owner of tripping and falling over the wire.
- If the sensor is battery powered there is potential for it to run out of power and not be able to detect the falling body.
- The sensor is placed in poor locations around the house making it ineffective.
- The sensor could mistake a pet such as a cat or dog as a fallen body and report it to the emergency contact causing a false alarm.
- The cost of the sensor being too expensive causing customers not to purchase it as they see the product as not worth the money.
- The raspberry pi processor may not be powerful enough to utilize the full power of the infrared sensor
- The 3D enclosure of the hardware being too large, not protective enough
- The amount of pixels recorded by the IR sensor is not enough for the device to be accurate

SECTION 17: FINANCIALS

May not have all this data, but provide what makes sense to support your project. Discuss this section with your faculty advisor.

A. Financial Objectives

- Do not exceed budget of \$500 for the project
- Retail cost for the device of <\$100 is the goal

B. Plans for obtaining investors or strategic alliance

Add text here INCLUDE INFO CONSIDERED TO DATE

C. Pro Forma Profit & Loss statements

Add text here INCLUDE INFO CONSIDERED TO DATE

D. Pro Forma Cash Flow projections

Add text here INCLUDE INFO CONSIDERED TO DATE

E. Pro Forma Balance Sheet

Add text here INCLUDE INFO CONSIDERED TO DATE

F. Alternative return scenarios

Add text here INCLUDE INFO CONSIDERED TO DATE

SECTION 18: APPENDICES

Insert if/as needed

A. Appendix Title

Add text or visual

B. Appendix Title

Add text or visual

C. Appendix Title

Add text or visual

D. Appendix Title

Add text or visual

E. Appendix Title

Add text or visual

SECTION 19: REFERENCES

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