Preliminary Budget Proposal

PREPARED FOR

ECE Department

Lafayette College

PREPARED BY

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AuBi Team

Oct 13, 2021

ECE Department
Lafayette College

Dear ECE Department,

Re: Enclosed Preliminary Budget Proposal

Please find enclosed our preliminary budget proposal for your kind consideration.

The AuBi Robotics team is aware that the creation of an automated service robot assistant takes a mixture of technical excellence and clear communication and our team will ensure you receive both. We strive to deliver an innovative and affordable deliverable that will be both on time and within budget.

Our team has been in this field of studies for 3 years. Our mission is to provide assistance to healthcare professionals everywhere by automating providing the automated services of a robotic assistant. You may also wish to review our website at https://sites.lafayette.edu/badrobot/ to see our portfolio and learn more about our team.

Finally, we realize that you are very busy and wanted to thank you in advance for your time spent reviewing our proposal.

Yours Truly,

The AuBi Team

Project Summary

1. Project Overview

Mission Statement: We aim to provide assistance to healthcare professionals everywhere by providing the automated services of a robotic assistant. Designed to assist in long term care facilities, AuBi provides services including food delivery, patient tracking, basic entertainment, and locational assistance. AuBi also takes workload off of understaffed nursing teams, allowing them to focus on the most important tasks for their patients' care.

Smart Goals:

- Go to a location
    - Localize present pose and current location in environment
    - Calculate path to new location
    - Translate path to motor commands
    - Move to designated location without collision
    - Verify it arrived at said location
- Go to a tag
    - Determine where tag is
    - Listen for and respond to call from tag
    - Determine path to designated tag
    - Translate path to motor commands
    - Move to designated tag without collision
    - Verify it arrived at the designated tag
- Intake / Release Cargo
    - Contains physical location for storing cargo
    - Physical location must be secure
    - Ability to lock and unlock to designated user via fingerprint verification
    - Must be easily obtainable from exterior of robot
- Move in a pattern
    - Store a preset route
    - Navigate the preset route without collision

- Convey information
    - Obtain information from external sources
    - Display set information with visual output
    - Project sound related to data
- Recognize users
    - Obtain a database of current known users
    - Input new users to database
    - Determine users through visual input
    - Determine users that aren't in database
- Interaction Logs
    - Obtain database for storing data
    - Use algorithm for storing data in database
    - Connect to external sources so data can be viewed
- Charge itself wirelessly
    - Must be able to sustain charge
    - Must have rechargeable batteries
    - Must be able to efficiently charge itself
    - Must have charging station
    - Must navigate to charging station
- Safety Requirements
    - Reset switches easily reachable
    - Main power switch
    - Main operation light
    - Emergency stop button
    - Collision avoidance
    - Hidden but accessible hardware
    - No sharp edges
    - No working on robot while energized

2. Systems & Hardware

Physical Design (Mechanical): The mechanical physical design is envisioned to be both a lightweight and smooth surfaced robot that can move efficiently through a nursing home like setting. The mechanical system for the robot will consist of gearboxes and wheels allowing the robot to effectively operate.

Physical Design (Electrical): The electrical physical design will allow the AuBi robot to operate its physical design effectively and efficiently. This will consist of motors, motor controllers, and a cooling system.

Power: The AuBi robot will be battery powered, and will sustain a minimum of 3 hours worth of charge. These batteries will be rechargeable using a wireless charging station, and will not require more than 8 hours to charge. The ability of custom ordering batteries to fit our power draw needs is available and will be looked into.

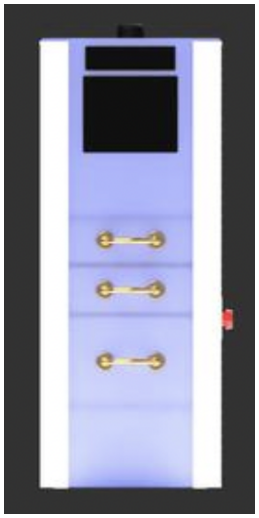
UI: The AuBi robot will have a user interface that will be designed for primarily older users. A large touchscreen will be implemented and positioned for easy use. This interface will be programmed via a microcontroller, either Raspberry Pi or Jetson Nano. An audio system will also be implemented within the user interface to assist with easy accessible communication.

Navigation: The AuBi robot will implement an advanced navigation system powered by a Jetson Nano. This system will consist of an RPLidar used to determine current location and plan paths to new locations. It will also contain additional sensors which will assist in collision avoidance and obstacle detection.

Communication: AuBi will have multiple communication systems. The robot will have access to Wifi via a Wifi Module working with the Jetson Nano to allow for communication with an external webpage and centralized system. The external website will be used to call the robot to specific locations, report interactions, and alert obstacles or problems with the robot.

Biometrics: The AuBi robot will be able to identify users via facial recognition. This will be accomplished through a high definition camera working in pair with a microcontroller. The AuBi robot will also have a fingerprint sensor to guarantee a secure cargo delivery system.

3. Design & Calculations



Mass of Robot Calculation					
Unit	**Subsystem**	**Position**	**Qty**	**Unit Weight (kg)**	**Total Weight (kg)**
Omni Wheels	Drive System	NA	4	0.51	0.00
Ball Castor	Drive System	NA	2		0.00
Acrylic (0.5 x 0.6 x 0.002)	Physical Design	Body	1	0.69	0.69
Acrylic (1.5 x 0.6 x 0.002)	Physical Design	Body	2	1.72	3.45
Acrylic (1.5 x 0.5 x 0.002)	Physical Design	Body	2	1.44	2.87
80/20 (25mm x 25mm)	Physical Design	Body	1	12.30	12.30
Aluminum Sheet	Physical Design	Baseplate	1	11.28	11.28
NEO Brushless Motor	Drive System	Baseplate	2	0.43	0.85
Arduino Nano	Drive System	Baseplate	2	0.01	0.01
12V DC Fan	Physical Design	Baseplate	4	0.60	2.39
Motor Driver	Drive System	Baseplate	1	0.01	0.01
ICM-20948, imu	Navigation	Baseplate	1	0.01	0.01
E4T OEM Miniature Optical Encoder	Drive System	Baseplate	2	0.01	0.01
ABENIC DC12V Battery	Power	Baseplate	1	0.57	0.57
13.3" 1920x1080 LCD Screen	UI	Body	1	1.00	1.00
Ladieshow F1 Plus Wireless Soundbar	UI	Baseplate	1	0.66	0.66
Raspberry Pi 4 Model B 4GB Kit	UI	Baseplate	1	0.07	0.07
NVIDIA Jetson Nano-BO1-4GB	Navigation	Baseplate	1	0.25	0.25
RPLIDAR A2M8 360 Laser Range Scanner	Navigation	Body	1	0.19	0.19
Ultrasonic Sensor	Navigation	Baseplate	2	0.01	0.02
Raspberry Pi High Quality Camera	Biometrics	Body	1	0.02	0.02
Rugged Panel mount FingerPrint Scanner	Biometrics	Body	1	0.04	0.04
Wide angle lens	Biometrics	Body	1	0.05	0.05
Wires / Electrical Components (Body)	Physical Design	Body	1	0.25	0.25
Wires / Electircal Components (Baseplate)	Physical Design	Baseplate	1	0.25	0.25

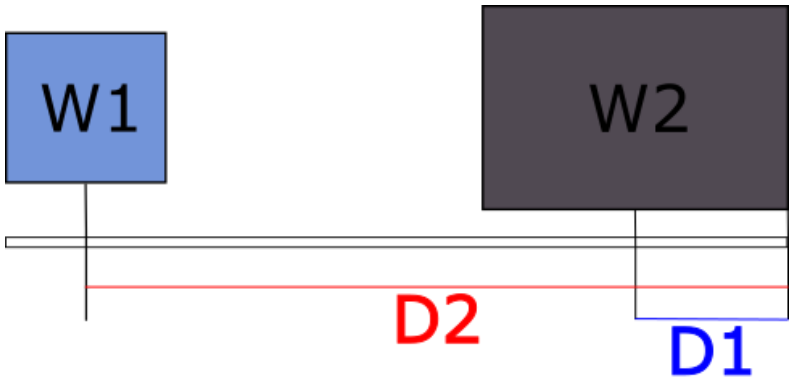
Screws / Mechanical Components (Body)	Physical Design	Body	1	0.25	0.25
Screws / Mechanical Components (Baseplate)	Physical Design	Baseplate	1	0.25	0.25

Mass of Robot	
Body Mass (kg)	21.11
Baseplate Mass (kg)	16.62
Total Mass (kg)	37.73

Dimensions of Robot	
Height (m)	1.25
Width (m)	0.5
Length (m)	0.6

Center of Mass Calculations

Center of Mass Calculation	
Mass of Body (kg)	21.110
Mass of Body (lbs)	46.540
Mass of Base (kg)	16.621
Mass of Base (lbs)	36.644
Length to Base's Center (m)	0.003
Length to Base's Center (ft)	0.010
Length to Body's Center (m)	0.625
Length to Body's Center (ft)	2.051
Center of Mass Calculation (ft)	1.152
Center of Mass Calculation (m)	0.351

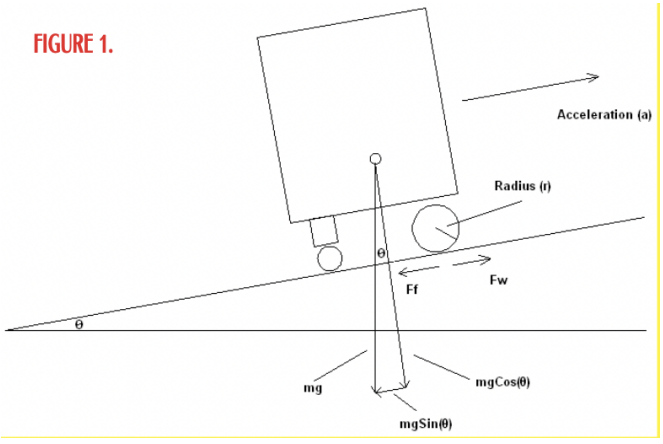


$$D\_COM = (W1D2 + W2D1)/(W1+W2)$$

Motor Sizing Calculation

Motor Sizing Calculation	
Mass of Robot (kg)	37.732
Maximum Speed (m/s)	0.833
Gravity (m/s^2)	9.800
Max Incline (degree)	0.000
A for Max Speed in 3s (m/s^2)	0.556
Wheel Radius (m)	0.076
Torque (N*m)	0.799
RPM (Rev/Min)	104.432
Angular Velocity (Rad/s)	10.936
Power (W)	8.734
Gear Box Ratio	5.950
Proposed Motor RPM	1780.000
Proposed Motor Stall Torque (Nm)	0.228
Ratioed Motor RPM	299.160
Ratioed Motor Stall Torque (Nm)	1.357

FIGURE 1.



4. Budget

Subsystem	Description	Budget Request
Physical Design (Mechanical) = $1000		
Wheels	Two 6” Double Aluminium Omni Wheels as well as two ball bearing castors will be used as wheels in the drive system	$200
Gear Box Ratio	Two 5.95:1 gearbox’s is required for the motors to meet the desired Torque.	$200
Acrylic Panels	One (0.5m x 0.6m x 0.002m), two (1.5m x 0.6m x 0.002m), and two (1.5m x 0.5m x 0.002m) acrylic sheets will be used as paneling for the physical structure.	$200
80/20 Framing	16.2 meters of 80/20 is required to build the baseframe of AuBi	$200
Aluminum Baseplate	A (0.5m x 0.6m x 0.00635m) aluminum plate will be used as the baseplate for the physical structure.	$200
Physical Design (Electrical) = $325		
Drive System	Two motors, arduino unos for motor controllers, two motor drivers, two encoders, and two IMU’ will be implemented in both the AuBi robot and the navigation testing robot.	$250
Cooling System	Four 12v DC fans as well as temperature sensors and a microcontroller will use PWM control signals to produce an efficient cooling system.	$75
Power = $600		
Battery	Lithium 12V 30Ah Battery will be used to power the AuBi system	$275
Wireless Charging	A Wireless charger will be built and implemented to allow the robot to be charged wirelessly and with no external assistance required.	$175
Circuit Breakers, Converters, and Cabling	Circuit breakers, power converters, and cabling will be purchased to be used in powering the AuBi robot.	$150
UI = $370		
Visual Display	A 13.3” LCD touchscreen will be used as the main display for user interference.	$200
Audio	The UI will require an audio system to make the robot more interactable.	$45
Raspberry PI Kit	A Raspberry Pi kitl will be purchased for development and controlling the User Interface.	$125

Navigation = $500		
Jetson-Nano	The Jetson-Nano computer will be used to drive the navigational processing.	$125
RPLidar	The RPLidar will give the AuBi robot the ability to have collision avoidance and quickly figure out the most efficient path.	$350
Sensors	Ultrasonic sensors and other proximity sensors will also be used to assist the navigation system.	$25
Communication = $360		
Jetson-Nano Kit	The Jetson Nano kit will be purchased to help develop both the communications and biometrics of the AuBi robot	$200
Wifi Card and Antenna	A WiFi card will be needed to allow the microcontroller to connect to Wifi.	$25
Wireless Router	A Wireless router will be purchased to achieve external communications with the robot.	$100
Wireless Keyboard and Mouse	Wireless keyboard and mouse will be purchased for ease of development of subsystems.	$35
Biometrics = $175		
High Quality Camera and Lens	A high quality camera will be needed to further enhance the facial recognition system.	$75
Fingerprint Scanning	High quality fingerprint scanners are needed for the fingerprint verification system.	$100
Estimated Tools / Cables / Screws, Bolts, Nuts = $500		
Estimated Shipping & Extra Fees (15%) = $800		
Total Cost = $4,630		