FAMU/FSU College of Engineering

Department of Electrical and Computer Engineering

# Concept Generation

Team 315

Control Module/Interface for Service Robots

Team Members: Brendan Laney, Diego Guedez, Jerry Jean-Pierre, Ivan Arzeta, Kyle Crawford

Date: 10/20/21

# 100 Concepts

### Morphological Chart

| User Interface | Display | Connectivity | Cameras/Sensors | Power Source |
|---|---|---|---|---|
| Touchscreen | LCD | Bluetooth | Lidar | Lithium battery |
| Voice | LED | WIFI | Digital Camera | AC power |
| Mobile Application | Smartphone display | Wired Ethernet | Radar | Solar power |
| Push Buttons | Tablet display | USB | Acoustic sensors | Fuel cell |
| Keyboard | Computer monitor | Wireless Ethernet | WIFI sensing | DC power |
| | LEDs | | Laser based sensors | Nuclear power |
| | HUD | GPS | Ultrasonic sensors | |
| | | Line follower | Photoelectric sensors | |

### Lateral Thinking

## Robot

- Dual cameras front and back of robot
- Dual lidar tracking front and back
- Dual sonar tracking front and back
- Multiple channels for output to each motor
- Blackbox recording of all actions taken by the robot
- Regenerative breaking for the motors
- Automatic calibration for speeds and breaking distances for different operating platforms
- Kid cart foam around sides
- Omnidirectional wheels
- Bat-like sonar
- Roller skate wheels
- LCD screen on cart
- LED screen
- Tablet display
- Computer monitor
- Color LEDs
- HUD
- Pushbuttons
- Grocery cart size
- Rideable for kids
- Broom bristles under cart

- Plasma screen control module
- Uses one of previous Senior Design projects as a motorized cart
- Use a shopping cart and put an electric motor on it
- Bluetooth and WIFI for external devices
- Allows usage with other carts - dynamic
- Use microprocessor to connect to motors
- Use pre-existing system
- Require USB type c input and output

## Control Logic

- Combine camera and lidar feed for tracking
- Combine camera and sonar feed for tracking
- Combine lidar and sonar feed for tracking
- Collect GPS data from user's phone to aid tracking around corners
- Robot returns to charging station automatically after use
- Artificial intelligence for path finding and motor control
- Emergency break when obstacle appears in front of the robot
- Ignore unsafe commands entered into the robot by users in manual mode
- Robot makes an alert sound through a speaker when stopping or ignoring unsafe commands
- Follows a black line on the floor
- WIFI sensing data collected by module and plans route to follow user
- Radar observes environment for objects and uses camera recognition to find user and determine path to follow
- Navigation capabilities using AI – able to find unknown locations (solving a maze)
- Use distance from multiple strategically placed routers for robot positioning
- Lead mode – robot knows locations of items in the store that user can follow it to
- Hazard communication between modules
- Premapped area known by robot
- Save paths traveled by robot to create map of area
- Auto path, after saving path, reuse to move robot without direct user input
- Cart knows geographical location of other carts
- Bots in vicinity to each other connect to avoid collision with one another
- Multiple robots can follow a single user with all following the same route as the lead robot in a single file line
- Cart semiautonomous mode only within premapped area
- Cart scans person to know who to focus on
- Deciphers between people, objects, structures
- Determines whether it is safe to proceed
- Will stop if unsafe to proceed
- Response time?

- Control module has maximum dimensions of 8”x4”x4”
- Follow user outside of predefined area?
- Follow user unless physically uncapable
- User has joystick that detaches from cart and can move robot around manually
- Payment processes once cart leaves store, recognizes what items are in cart
- If a user likes a specific item, the cart will show them multiple items they may like in relation
    - Related items
    - On-sale, BOGOs
- If person is in path, robot asks person to move and get out the way in a kind and polite, yet firm manner
- Uses machine learning to learn the store it’s in

## Cameras/Sensors

- Temporary facial recognition to keep track of current user
- Simple motor control based on camera feed (no AI)
- Multiple cameras?
- Support for minimum of one camera up to n number of cameras
- What kind of cameras?
- User gestures towards camera for robot to follow
- Camera mounted on electric swivel so can turn on its own
- 360 degree camera for monitoring most of environment at once
- WIFI sensing to detect changes in environment
- Acoustic sensors
- Laser based sensors
- Ultrasonic sensors
- Photoelectric sensors
- Line follower
- Lidar

## User Interface

- Bluetooth ping user’s phone for location data
- Voice activated commands in manual mode or to switch between modes
- Assisted power steering when users push the cart
- Manual instructions for motors sent through an app connected through Bluetooth
- Switch between modes using an app connected to the module
- Push notification if trouble occurs
- Push notification to support employee
- Admin app login in allows for monitoring of all robot locations
- Admin app login allows for overriding of user control
- Mode switch button on cart

- Cart LED lights up if in stop mode
- Follow user
    - Via App
        - User inputs commands for robot to switch to autonomous or manual
        - User can control robot moving around via commands
    - User can voice commands
    - Robot will disobey commands if unsafe
    - Walk in front of user (“repelling magnet”)
    - Follows user to car
        - Follows route back inside store navigating safe zones in parking lot
        - Goes in cart section and charges itself
- Touchscreen HUD on cart for the user to interact with
- Provides user bags to put items in
- Can take items of shelf (particularly high shelves for shorter people) and places in cart
- Keyboard input to select modes and configure robot
- Pushbutton selections to change modes
- Voice commands on mobile application to operate robot
- Cart goes home with user and takes items to front door of apartment, navigates back to store via flight
    - Removes process of lugging groceries upstairs or elevator

## Power Source

- Solar powered robot
- Nuclear - Fusion
- Battery
- AC/DC
- Fuel cell

## Multi-Use Applications

- Golf caddy
    - Keeps track of score for user
    - Makes slight noises when competitors are teeing off to get them to shank
- Construction cart
    - Carries equipment
    - Heavy load capacity
    - Moves through rough terrain
    - Can scale walls

# High Fidelity Concepts

1. HUD on Cart for User Interface. User can interact with cart to switch between manual and autonomous mode. Keeps track of items in cart, displaying a list to the user and cost of each along with total cost. Recommends items to user based on items they put in cart (ie. If the user likes BOGO items, it will suggest other BOGO items. If the user likes a brand people like, it will recommend similar brands other people like).
2. Camera will be mounted on an electric turning swivel. This will tie into user tracking for when they turn down an area or walk past obstruction causing the robot to lose visual contact. The robot will travel to their last known location and turn the camera towards the potential area the user could be. Once spotted the robot will resume normal following operation. If the user is not spotted, the robot will rely on alternative user location tracking until user is seen on camera view
3. There would be an additional button on the app to end the current session for the robot and having it stop tracking the user. When this button is pressed the module directs the robot back to a central hub or charging station where all the robots are stored automatically. This would allow the battery to be charged between uses without anyone having to manually go and plug them in. The charging stations would have a router or Bluetooth module sending the general location for the robot to move towards, so the stations wouldn't have to be in designated locations. When the robot is within view of the station the camera feed and AI will be able to guide the robot into the charging station automatically.

# Medium Fidelity Concepts

1. Single User can connect to multiple robots at once: Through the phone app a user can connect to multiple robots at once. While moving around the use area the lead robot will follow and track the user while the other robot simply follow the robot Infront of them.
2. User gestures robot to follow. Utilizes cameras to recognize if user is motioning a hand wave towards them to follow.
3. User says voice commands to robot to select which mode to run. Through the mobile application on their smartphone, they can change the mode and move the robot. The user is detected through three cameras that also detect objects in proximity. The robot is powered through a Lithium battery.
4. Regenerative breaking on the motors when the robot is breaking to recharge the battery. This allows the robot to be used longer between recharging sessions.
5. Utilizes machine learning to learn store it is in. Remembers aisles, corners based on following users in past. Users can then ask robot where an item is and it will lead the user to it.