

Functional Description for Autonomous Vehicle

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Objectives

The objective of this project is to create an EMAC based system that will autonomously navigate a vehicle through the Jobst-Baker quad to the destinations entered by the user. This vehicle operates under the following conditions:

- The sidewalks in the quad are clear of debris.
- The vehicle starts from the same position at the Northeast door of Jobst and is oriented in the same direction pointing South.

The vehicle navigates from point to point using an internal map of the quad stored in the EMAC memory. Large obstacles, such as people, are detected and the vehicle motion is halted until the obstacle is cleared.

Modes of Operation

This system has three modes of operation: query mode, maneuver mode, and obstacle mode. They are described in detail below.

- Query Mode:
The vehicle is stationary, and the user has the opportunity to enter the destination or destinations of the vehicle. First, the user enters the number of destinations, and then the user enters the destinations in sequential order.
- Maneuver Mode:
Straight:
The vehicle uses the signals from the sensors to stay on the sidewalk with motion parallel to the edge of the sidewalk. In this mode, no turns are expected and no intersections are detected.
Intersection /Lost Edge:
The sensors do not detect the edge of the sidewalk, so the vehicle first stops and then determines from the internal map and the distance input if it is at an intersection. If it is at an intersection, it then enters Turn Mode or re-enters Straight Mode depending on the desired destination. If it is not at an intersection, it searches for the sidewalk edge and re-enters the Straight Mode.
Turn:
If upon entering an intersection, the vehicle needs to turn to reach the destination entered by the user, it then enters the Turn Mode from the Intersection /Lost Edge mode. During this mode, the sensors are used to detect when the vehicle has turned onto the new sidewalk. Once the vehicle is on the intersecting sidewalk, the system steers the vehicle into a straight path parallel to the edge of the sidewalk and enters the Straight Mode. Since the turn radius on the vehicle is large, the vehicle might have to briefly leave the sidewalk while turning.
- Obstacle Mode:
The vehicle stops when the obstacle detection sensor detects an object within a specified range. The vehicle waits until the object is no longer detected and then continues in its previous mode of operation. Obviously, if the obstacle is stationary, the vehicle will remain stopped, and an information signal will be displayed.

System Block Diagram

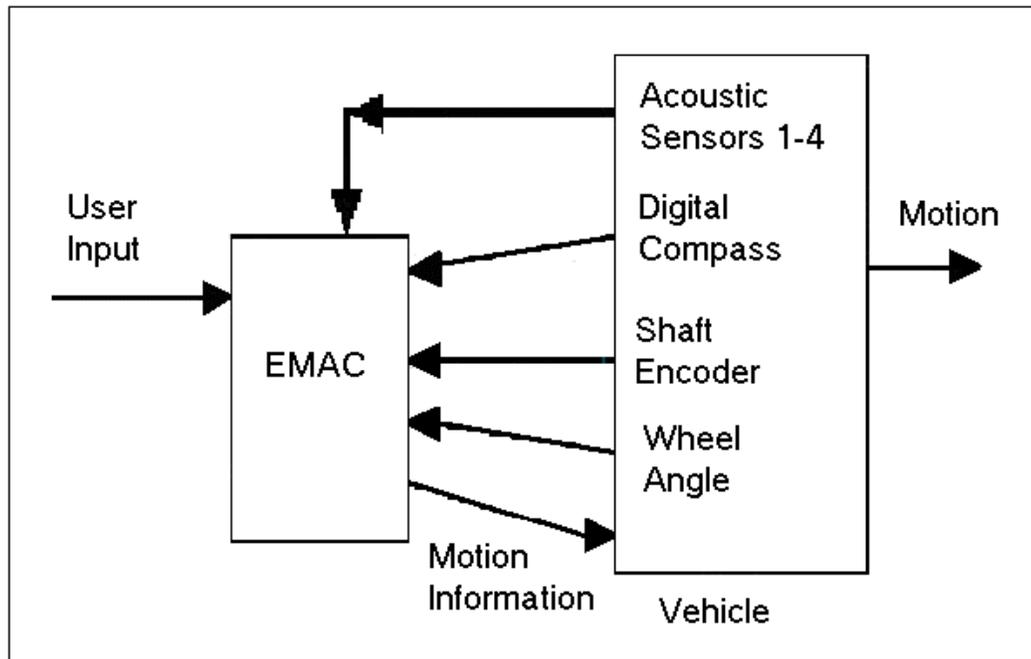


Figure 1 – Block Diagram

Inputs to EMAC based system:

- User Input:
The user picks the final destination and enters the waypoints the vehicle should take. Intersections are identified by number. The user specifies if the trip should be one-way or round trip. This information is entered on the EMAC keypad.
- Acoustic sensors 1-4 Inputs:
Sensors 1, 2, and 3 (see Fig. 2) are mounted on the vehicle pointing towards the ground for sidewalk detection inputs. Sensor 4 points straight forward (parallel to the ground) for an obstacle detection input. Sensors 1, 2, and 3 send signals to the EMAC regarding the surface texture and density. The acoustic sensors 1-3 may also be able to send speed information via Doppler shift. Sensor 4 sends a signal to the EMAC if an object is detected within a specified range in front of the vehicle.

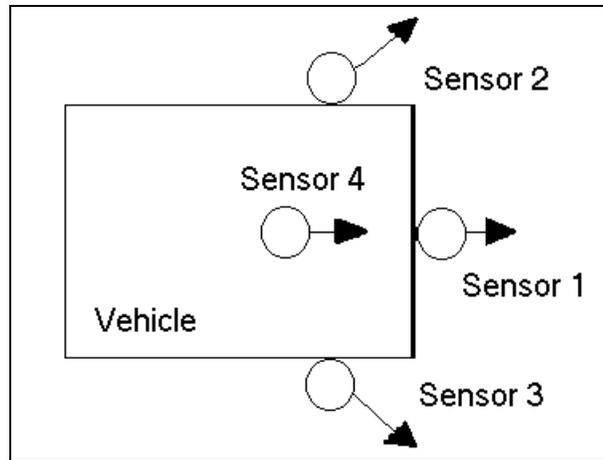


Figure 2 – Sensor Diagram on vehicle

- **Shaft encoder:**
This input is a pulse wave proportional to speed and is used by the system to determine where the vehicle is located on the internal map.
- **Linear Actuator:**
This input sends varying signals according to wheel direction and is used by the EMAC based system to know whether the vehicle is going straight, turning right, or turning left. This information also aids the EMAC based system in determining the vehicle’s location on the internal map of the quad.
- **Digital Electronic Compass:**
This input sends a signal to the EMAC based system indicating which direction the vehicle is headed. This information helps the system determine where the vehicle is located on the internal map of the quad.

Output from EMAC based system:

- The output of the system is the movement of the vehicle. Either the vehicle is stopped, or it is moving toward the waypoint specified by the user. The vehicle’s motion towards the waypoint can be seen in three ways: turning right, turning left, or going straight. The motion output depends on the various inputs to the EMAC based system.

Input/Output	Mode		
	Query	Maneuver	Obstacle
Acoustic Sensors 1-3	N/A	signals vary in amplitude according to surface, Doppler shift for speed	N/A
Acoustic Sensor 4	N/A	N/A	varying amplitude signal if obstacle is detected in the designed range
Linear Actuator	N/A	varying signal determining wheel angle	N/A
Shaft Encoder	N/A	varying frequency square wave proportional to speed	N/A
Digital Electronic Compass	N/A	sends signal according to direction vehicle is facing	N/A
User Input	destinations and waypoints	N/A	N/A

Vehicle Movement	stopped	vehicle turns left, right, or continues forward	vehicle stops and waits for obstacle to move
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Table 1 - System Inputs and Outputs