Robotic Navigation Distance Control Platform

Project Design Proposal

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Objective

The objective of the Robotic Navigation Distance Control Platform is to design and build a robotic platform that will be able to maintain a fixed safety distance behind another moving object. If time permits, steering and variable distance controls will be incorporated. The steering control will allow the robotic platform to change direction to follow the moving object. The variable distance control will allow the robotic platform to maintain a specified safety time distance behind the moving object. The robotic platform will also contain an EMAC 80515 microcontroller that will interface the distance sensors and the motor and steering controls.

Hardware

The hardware subsystems consist of a left navigation sensor, a distance control sensor, a right navigation sensor, a electric motor and a servomotor. The robotic platform chosen for this project is a radio controlled (R/C) car . The sensors will be mounted on the (R/C) car and the current R/C car's electric motor and servomotor will be used for navigation control. This system has five modes of operation: Fixed Navigation Mode, Time Navigation Mode, User Out of Range Mode, Auto Out of Range Mode, and Stop/Start Mode. Each subsystem and mode of operation will be discussed in full detail. See figure 7.1 for hardware subsystem block diagram.

Sensor Subsystems

Photoelectric or Ultrasonic Pulse Sensors:
All sensors will transmit either a light or an ultrasonic pulse. If an object is in front of the sensor, the transmitted wave will reflect off the object, and the same sensor will receive the reflected wave.

Sensor Output Signal:
The output signal from the sensor is related to the distance between the sensor and the object in front of the sensor. The possible outputs from the sensor are an analog, digital or PWM signal since the exact sensor for the project is still undetermined.

Robotic Platform Motor Subsystem

Input Signal to Motor:
The input signal to run the motor will consist of a pulse width modulation (PWM) signal provided from the microprocessor, which will control revolutions per minute (RPM) of the motor. The PWM signal will consist of a 50Hz signal with the positive pulse width varying from 0.85ms to 1.85ms.

Motor Speed Output:
The motor shaft will drive a gearbox that will be connected to the wheels of the robotic platform. Depending on the input pulse width of the PWM signal, the motor's shaft speed will vary, providing the different ground speeds for the robotic platform.

Robotic Platform Steering Subsystem

Input Signal:
The input signal will consist of a PWM signal from the microcontroller and the variations in the input PWM signal will control a servomotor. The PWM signal will consist of a 50Hz signal with the positive pulse width varying from 0.9ms to 2.1ms with 1.5ms as the servo's centering position.

Output Steering Rod:
The steering rod will be connected to the servo horn, which is a plastic lever arm attached to the servomotor. The rotational movement of the servo horn will produce a translation movement. The other end of the steering rod connects to the wheel linkage that controls the robotic platform's direction.

Software

The software programmed on the EMAC 80515 microcontroller will process the incoming distance and the left and right navigation signals. The EMAC microcontroller software will provide appropriate PWM signals to the motor subsystem and steering subsystem allowing the robotic platform to follow another object placed in front of it. The different modes of operation are: Fixed Navigation Mode, Time Navigation Mode, User Out of Range Mode, Auto Out of Range Mode and Stop/Start Mode.

Fixed Navigation Mode:
All systems are powered, and the robotic platform waits for the user to enter a fixed safety distance in feet to follow the object. First, the user will be asked to enter the "User" or "Auto" Out of Range Mode. Secondly, the user will enter the desired distance, and then press the activation button on the keypad to activate the robotic platform navigation controls. The robotic platform will then proceed to navigate behind a moving object.

Time Navigation Mode:
Similar to fixed navigation mode except the robotic platform waits for the user to enter a time in seconds to safely follow the object.

Fixed/Time Navigation Flowchart Description:
The Fixed/Time Navigation Mode software flowchart is seen in figure 8.1. The software will initialize the EMAC, LCD, and keypad. The display prompt will ask the user to enter either Fixed or Time Navigation Mode. The EMAC will wait until the user enters one of the two modes through the keypad. The display prompt will ask the user to enter

either “User” or “Auto” Out of Range Mode. The EMAC waits until the user enters one of the two modes through the keypad. After the mode is selected, an activation button be pressed to start the navigation controls. Once the activation button is pressed, either the Fixed or Time Navigation Modes flow chart will be followed as seen in figure 7.1. Either Navigation Mode will use the Steering Control function, which will sample the left and right navigation sensors and determine if the robotic platform should move, left or right to follow the moving object. The two signals of the navigation sensors will be compared and if there is a variation in the output signals the robotic platform will turn to match the two sensor signals.

The Fixed Navigation Mode will use the fixed navigation control function to keep the distance between the robotic platform and the followed object constant. This is accomplished by calculating the distance between the robotic platform and the followed object from the distance sensor signal. The calculated distance will be compared to the user specified distance and the motor subsystem will adjust to achieve the user specified distance.

The Time Navigation Mode will use the Safety Time Control as seen in Figure 6.1. The Safety Time Control will calculate the time between the robotic platform and the followed object. The motor subsystem will be adjusted to keep the user specified safety time between the robotic platform and the followed object. If the distance sensor does not detect an object or no signal is received in either the Fixed or Time Navigation Modes, the Out of Range Mode will be entered.

User Out of Range Mode:
If the object being followed is out of range or there is no signal from sensors, the robotic platform will enter an “Out of Range Mode,” in which the robotic platform will stop. The EMAC microcontroller will display “Out of Range” on the LCD. The robotic platform will wait for the user to reactivate the navigation controls, which will also clear the “Out of Range” message on the LCD screen.

Auto Out of Range Mode:
Similar to user out of range mode except the robotic platform will continue navigation once an object is placed back within range of the sensors. The EMAC microcontroller will clear the “Out of Range” message on LCD screen.

User/Auto Flowchart Description:
If the User or Auto Out of Range Mode is entered, the LCD will display the user entered Out of Range Mode. The Stop Electric Motor function will pause the motor subsystem, which will stop the electric motor. If the user entered the User Out of Range Mode the Wait function is called until the user presses the navigation controls button, at which time the LCD is cleared and the previous navigation mode is called. If the user selected the Auto Out of Range Mode, the robotic platform will use the Auto function and will wait until the distance sensor detects an object. Once an object is detected, the LCD display will be cleared and the previous navigation mode is called. See Figure 4.1 for User/Auto Out of Range Software Flowchart.

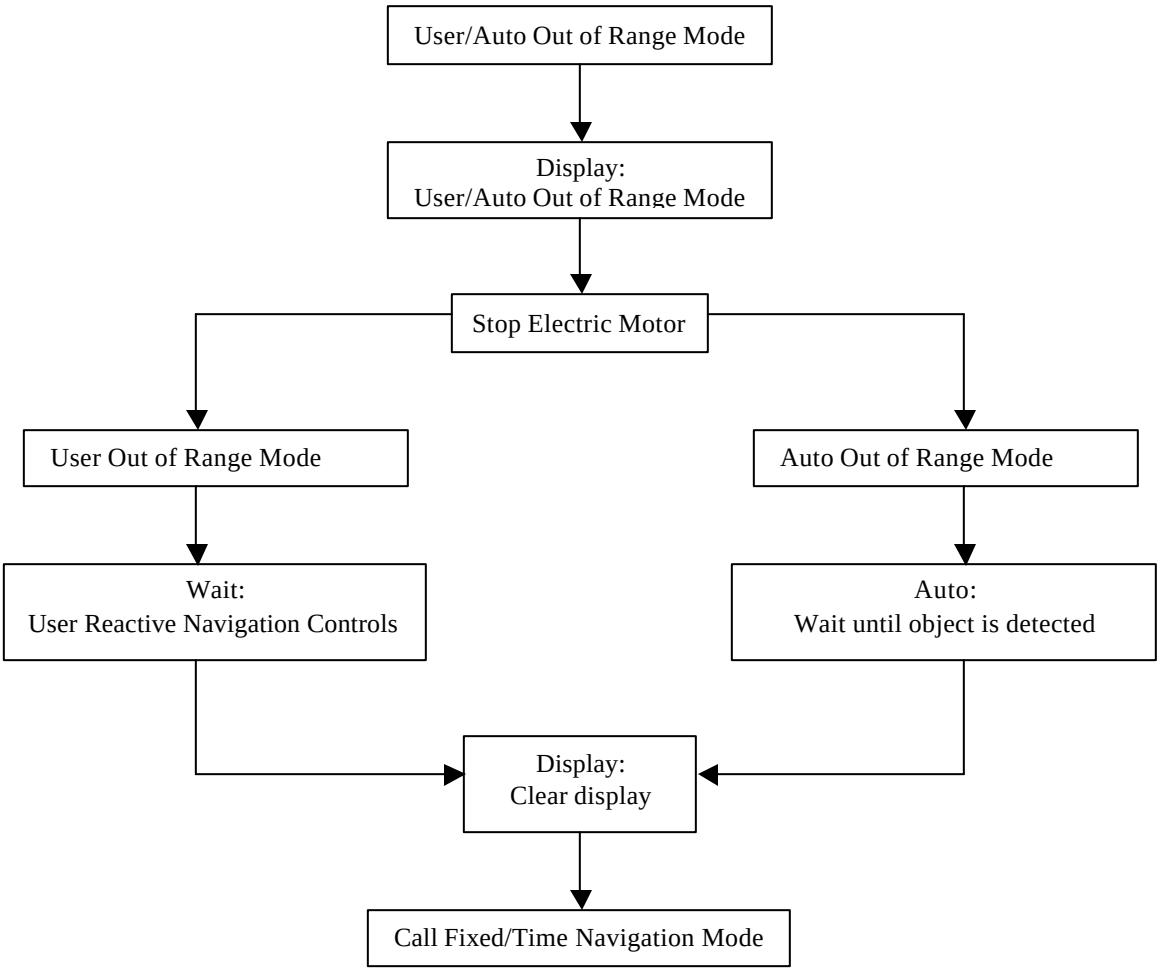

Figure 4.1
User/Auto Out of Range Software Flowchart

Stop/Start Mode:
The user is able to stop and start the current navigation mode using keypad input.

Stop/Start Flowchart Description:
When the user presses the stop button on the keypad, the Stop Electric Motor function is called. The Stop Electric Motor function will pause the motor subsystem. When the Start button is pressed on the keypad, the previous Fixed or Time Navigation Mode is called . See Figure 4.2 for Stop/Start Mode Software Flowchart

Figure 4.2
Stop/Start Mode Software Flowchart

Schedule

Due to the knowledge of the detailed design, a schedule of tasks in figure 5.1 must be completed by the specified dates.

Date:	Completed tasks
12/22 - 1/27	Determine sensors
1/28 - 2/03	Motor and servo subsystems coding, debugging and testing
2/04 - 2/10	Stop/Start Mode software coding, debugging and testing
2/11 - 2/17	User input software code, debugging and testing
2/18 - 2/24	
2/25 - 3/02	
3/03 - 3/09	Sensor characteristic and output signals
3/10 - 3/16	Hardware interfacing and installation
3/17 - 3/23	Fixed navigation mode software code, debugging and testing
3/24 - 3/30	
3/31 - 4/06	
4/07 - 4/13	
4/14 - 4/20	User/Auto Out of Range mode software code, debugging and testing
4/21 - 4/27	
4/28 - 5/04	Finish project, presentation, project report

Figure (5.1)
Schedule of task to complete by specified date during spring 2004 semester

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Equipment list

- HP 8011A Pulse Generator

Appendix

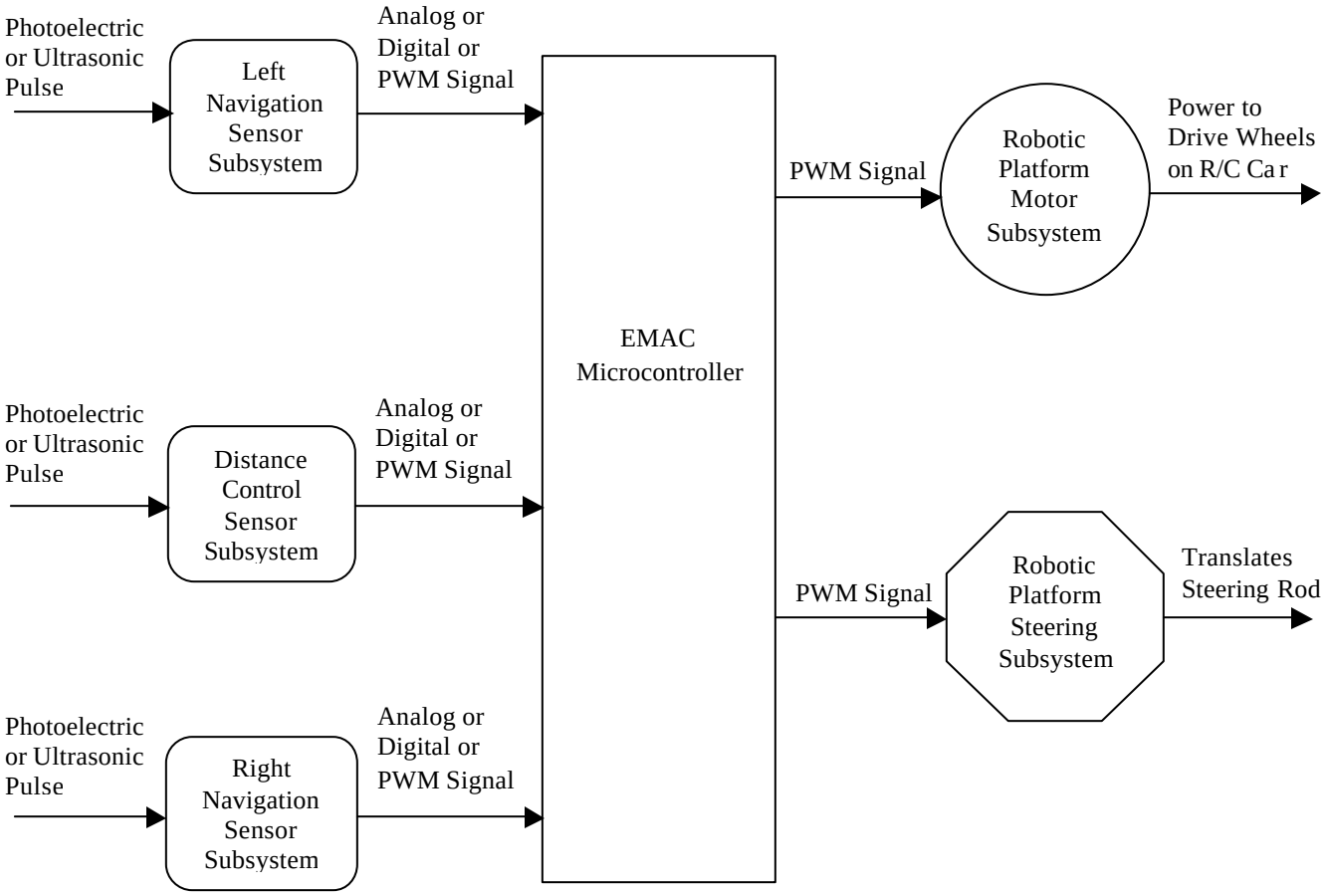

Figure 7.1
Hardware Subsystem Block Diagram

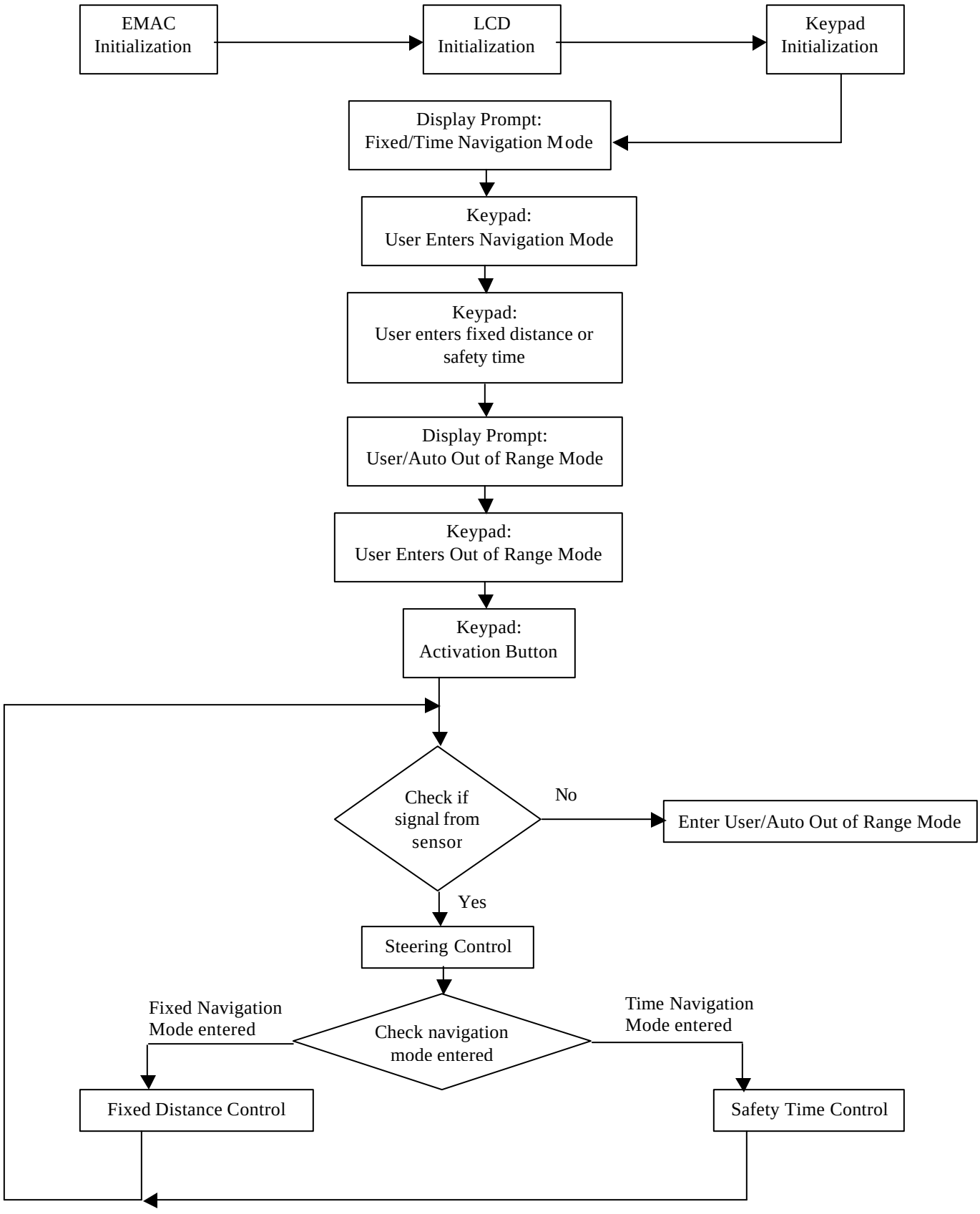

Figure 8.1
Fixed/Time Navigation Mode Software Flowchart