Solium remote systems

Software Specification

Prepared for: CSE442

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November 3, 2008

Project Stage: 2

Assumptions / Limitations / Constraints

Technical Assumptions

We will be coding the project with Java for Windows operating system. Using this programming language, the program will be portable across many different systems. The code will be tested on a laptop before being put onto a remote controller such as iPhone or iPod touch. It should be easy to move from a laptop to a portable device.

Limitations/ Constraints

Safety Constraints

All the sensors must be fine tuned and very sensitive. Many of the handicapped people using the wheelchair will be unable to control themselves in the event of a crash or accident with the chair. Therefore, making sure the sensors are in proper working order at all times is a must.

In addition, the chair must be equipped with back up safety systems in case of an accident. This would be comparable to something like a motor vehicle safety system in the event of a crash.

The camera does not need to have the best picture quality, but it needs to be reliable and efficient. If the camera were to malfunction, the user of the chair would be in danger.

When the system is applied to the wheelchair extra caution must be taken to make sure that all wires and connections are safely secured away from not only moving parts such as the wheels, but from the user as well.

Technical Constraints

The product is supposed to be able to connect to all electric wheelchairs. We may find that the wheelchair hardware is very different, reducing the chance for the product to be adaptable to all types of wheelchairs. Making sure the product can be implemented for all types of wheelchairs may add a great amount of time to the schedule and also increase the budget.

Not only does the wheelchair have to connect to the motor, we need to make sure all wheelchairs have a place to mount a camera, the safety features, and other add-ons. When future planned add-ons are released, we must also make sure that these too can be used on any wheelchair.

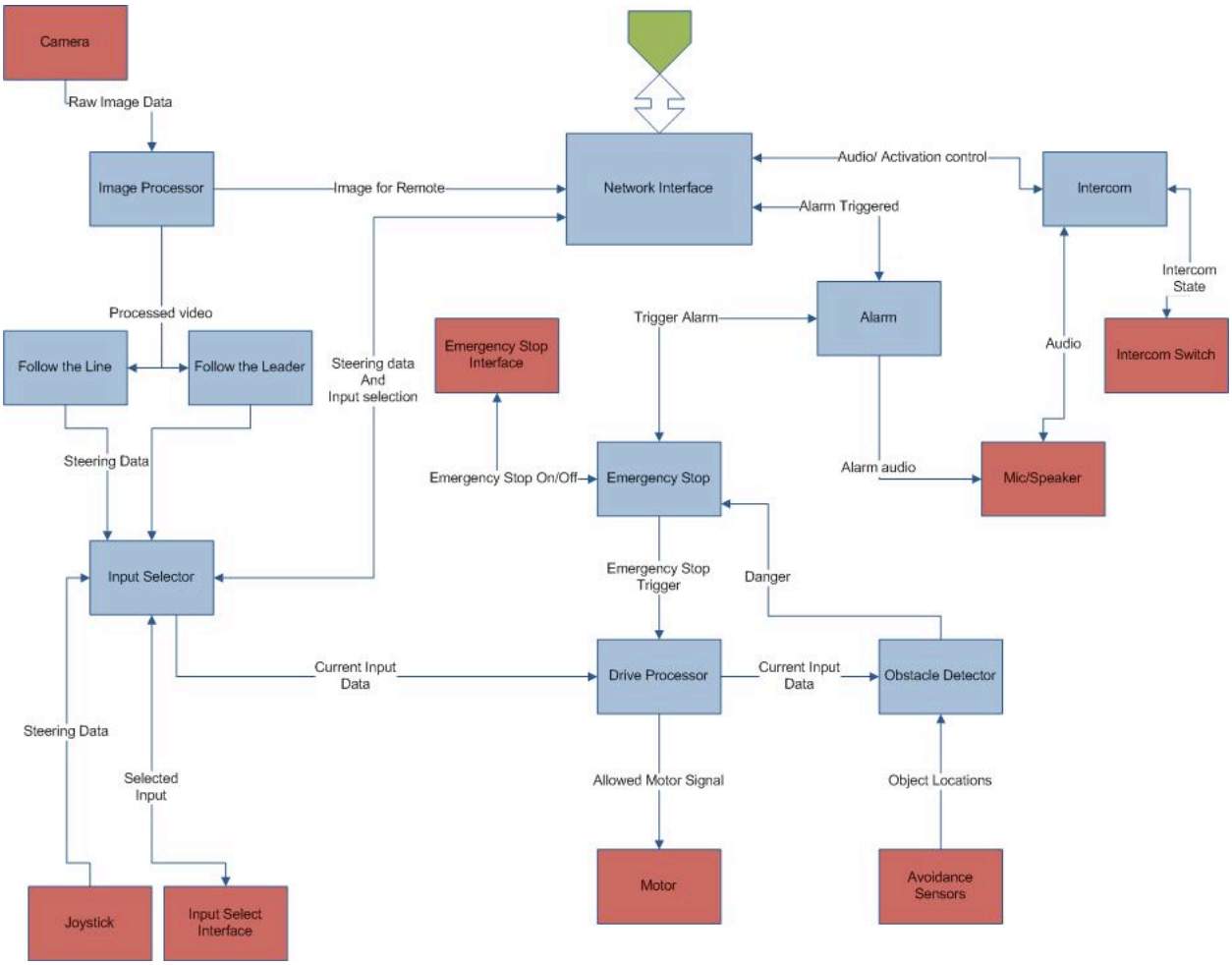
Financial Constraints

Financially, the remote system needs to be as inexpensive as possible. Insurance may not cover the chair for most families. Adding a great financial burden to a family that is already dealing with the high costs of caring for a handicapped child would make the chair very unappealing to them.

Facilities that rent out wheelchairs, such as hospitals, would also find a large price tag unattractive. They would probably consider if the add-on was nonessential, considering that people got along without it for many years. So, if the cost was too high, the hospital would not give a lot of revenue for nonessential products.

Software architecture diagram

Chair modules



Red is hardware / Blue is software

Camera

The chair is equipped with a camera, which feeds video to an image processor.

Image processor

The image processor takes input from the camera. The input from the camera is then formatted for more efficient transmission through the network to the remote device, and then sent to the network interface.

If activated, the video will also be sent to either the line follower or follow the leader modules to be processed to control the chair's movement.

Follow the line

The follow the line module will use image processing to follow a pre-determined path. The path will be a line drawn on the floor. The module will take video from the camera as input. The module will then output steering data to the input selector.

Follow the leader

This will function much like the follow the line, except the image processing will be different. Instead, this will key in on a predetermined image and direct the chair to follow the image. The image would be worn on something like a vest. The output is chair steering data to the input selector.

Joystick

This is a standard wheelchair joystick. The input from the joystick is sent to the input selector.

Input selector

This acts like a multiplexor for the steering data. It is connected to an input selection interface. The selected input is displayed on the selection interface on both the remote and the chair. This will also take chair control input from the joystick, line follower, follow the leader, and the remote controller over the network. Whichever input is selected will be passed to the drive processor.

Intercom switch

When the switch is pressed the intercom on the chair is activated. If the intercom is activated by the remote, it is displayed as active here.

Intercom

The intercom takes activation control from both the chair and the remote through the network. When active, it relays audio between the chair and remote to allow a conversation to take place.

Alarm

The alarm takes activation control from the chair, the remote through the network, and the emergency stop module. When active, it relays the activation between the chair and remote to alarm at both places. The alarm is sounded using the speaker.

Obstacle detector

This unit will take in as input the range data from the avoidance sensors and drive control output. Using the data, it will determine if the desired motion will be safe. If danger is encountered, the emergency stop will be activated. Then, if new drive control input is in a safe direction, that input is allowed.

Drive processor

This module takes in input from the input selector and the emergency stop module. If the emergency stop module is activated, the drive processor will not drive the motors, otherwise the module will translate the desired movement into motor signals to carry out the motion.

Emergency stop

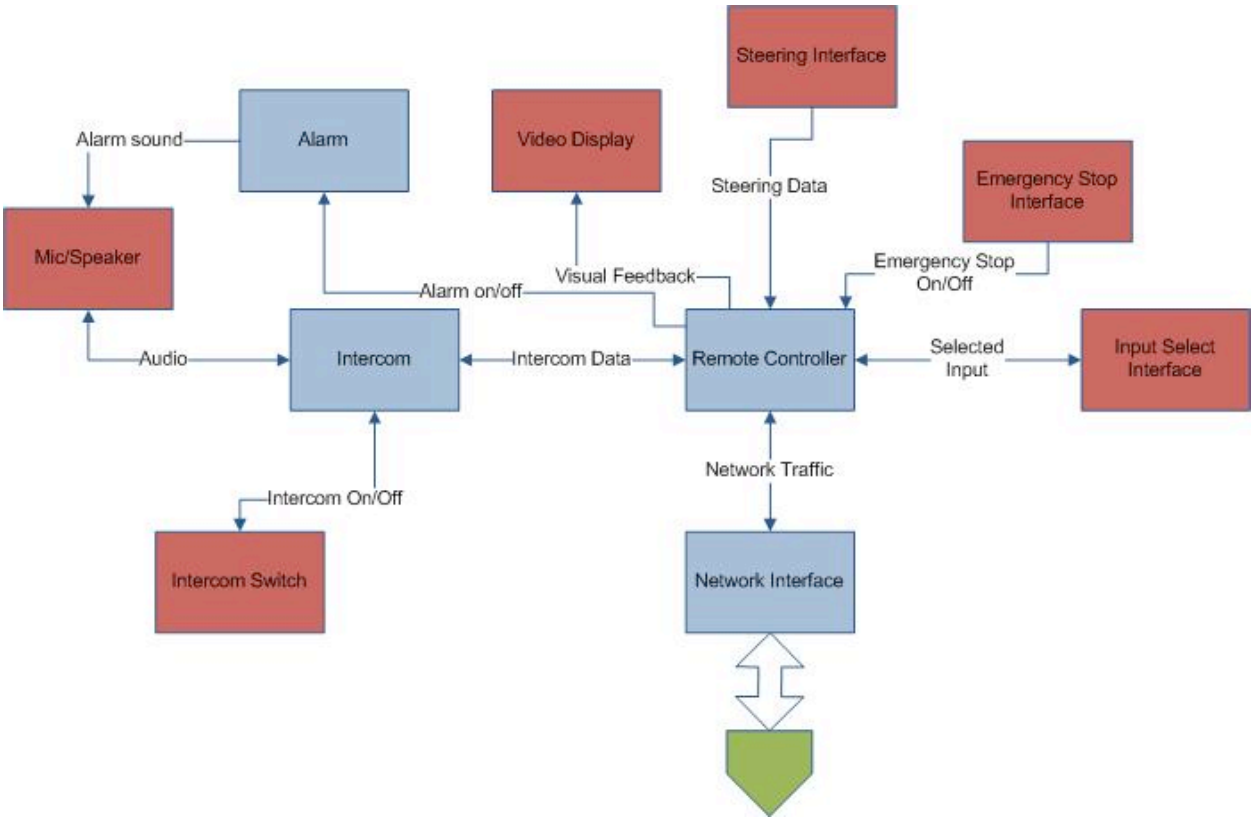
The emergency stop takes activation control from the wheelchair's stop button, the network, or the obstacle detector. The emergency stop will notify the alarm and the drive processor that the stop has been triggered.

Network interface

This is a common interface to be used between the remote control and the chair. It sends video from the image processor, alarm data and control, intercom audio and control, emergency stop control and status, and drive input selection control and state to the remote control.

From the remote, it handles remote drive control, drive control selection, alarm activation, emergency stop control, and intercom control and audio.

Remote modules



Red is hardware or user interface on hardware
Blue is software

Video display module

This module will display the video feed from the chairs camera on the remote control's screen and it can be toggled on and off.

Intercom

The intercom takes activation control from both the remote and the chair through the network. When active, it relays audio between the chair and remote to allow a conversation to take place.

Alarm

The alarm takes activation control from the chair, the remote through the network, and the emergency stop module. When active, it relays the activation between the chair and remote to alarm at both places. The alarm is sounded using the speaker.

Remote control processor

The remote control processor takes control data from the steering interface. The x and y coordinates of the input from the steering interface is then output to the network interface to sent to the chair to drive it.

Input select interface

The input select interface displays the currently selected control method, and the preferred input method can be chosen. The choice is sent to the chair through the network interface.

Emergency stop button

The emergency stop button is mapped to the chairs emergency stop status. It will send a stop signal to the network interface to stop the chair when pressed. When pressed again in stopped mode, it will change the stop status through the network.

If the stop button is pressed on the chair, the stop control is also sent through the network to the remote button.

Remote network interface

The remote network interface sorts out the data to be sent to the chair through the network. The interface needs to handle x,y control data to drive and steer the chair, the signal to stop the chair in an emergency, and audio from the intercom.

This will also take in control data from the chair to be displayed on the remote. This includes the emergency stop status, alarm activation, and intercom activation. Data transferred through the network interface includes the video feed from the chair's camera as well as audio from the chair's intercom.

Configurability and Flexibility

Control modes

The current method of control can be selected via the control selection interface on the remote as well as the chair. A second control may be selected to temporarily override the first control as in the drive education mode.

Safety features

The local joystick can be disabled or given limited control depending on the users handicap. The safe range detected by the proximity sensors can be adjusted to be further for more safety or closer for need to travel through tight areas.

Add ons

The user can select which modules to add on to the core system to suit their needs. For example, if a user wishes to have autonomous control, they can add the needed hardware and software required to perform the tasks. Conversely, if they do not need autonomous modes of control, they can be omitted to reduce cost.

Risks of the system

Technical Risks

Obstacle Sensors

The data provided by the sensors needs to be accurate to the current situation around the wheelchair. If the sensors malfunction, accidents may occur when operating the wheelchair with inaccurate data.

Camera Use

The camera must be able to provide realtime video of the movement of the area around the chair to ensure the operator can make correct decisions.

The Human Factor

In order to ensure safety of the rider, the simplest and most intuitive user interface should be created. The operator should also be trained in the use of the wheelchair to ensure the safety of the user.

Budget Risks

Despite the creation a base model, as well as one with additions, the main risk we face is justifying the features that are on the base model to insurance companies. Failure to justify features to the insurers would make the chair far more expensive to customers.

Schedule Risks

Going over the budgeted schedule will likely increase the cost of the system. This would make the system less attractive to the targeted costumers.

Network Security

Since our system will be streaming control of the wheelchair wirelessly, a secure connection will be needed to prevent tampering with the system. For example, a SSL connection with a password can be used to initially link to the wheelchair every time it is powered up. Once that password is entered, no one will be able to gain access to the connection between the chair and the remote. The user could be put into grave danger if an open connection was used, another remote with wireless capability could be used to control the chair, putting the safety of the rider out of both the rider's and caretaker's hands. As an added safeguard, control of the chair from outside sources could be disabled until the password is entered. Passwords will be encrypted.

Chair security

In addition to the safeguards between the chair computer control and the remote, safety measures must also be taken on the chair to prevent tampering when the user is not in it. The drives should be in a case that can be locked in order to prevent someone from installing their own software on them.

Overall System

Since the system will not store confidential data, network security accompanied with the remote and chair security will suffice.

Change Request Form

INSTRUCTIONS FOR COMPLETING THE FORM

The purpose of this form is to inform the company of a change or a problem with the current system. A bill for parts/changes/fixes will be sent at a later date if not covered under warranty or if necessary.

MAIL OR EMAIL THE FORM TO

sitarski@buffalo.edu

Please allow up to five business days for your form to be received and processed. A representative will contact you so that an appointment can be made for the chair to be repaired or changed.

Change Request Form Tracking Number(office use only): _____

User Name (Last, First)	**Phone Number (include Area code)**
Address	**Email Address**

Change or Problem Type

Check one:

Hardware _

Software _

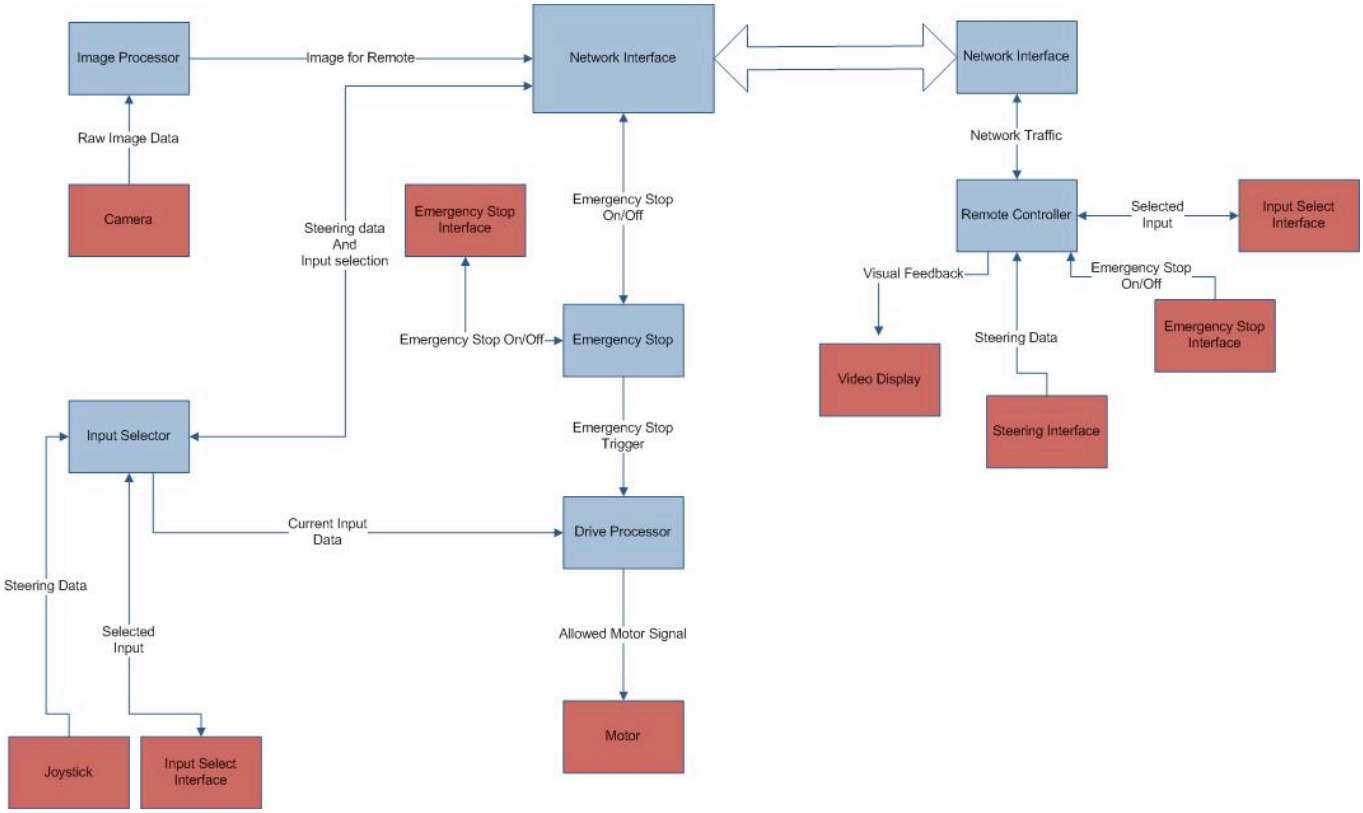
Unsure of Category _

What is being Requested :

Cross reference listing:

1) Retain standard operation of the chair through the original hardware
2) Enable operation through some sort of remote control
3) Video camera attached to the chair
4) Integrated sensor for use in the follow the leader mode
5) Spatial sensors to detect obstacles
6) Spatial sensors to detect a void
7) Main computer to handle all signals
8) Intercom system: microphone and speakers in both wheelchair and remote
9) A secondary restraining device for the chair, such as those of a motor vehicle
For the remote:
10) Touchscreen capability
11) Networking capability
12) Video display
13) Sound and microphone for intercom system
14) Controls will mimic those of the wheelchair itself
15) Switch for changing between different operation modes
16) Emergency stop feature with a button on the remote
17) If connection is lost unexpectedly, the emergency stop is applied
During Normal Operation:
18) Emergency stop feature and intercom must still work
19) Onboard sensors and safety measures still apply
During Remote Operation:
20) Joystick controls are disabled
21) Intercom and emergency stop feature still work from the chair
22) Onboard sensors and safety measures still apply
During Split Control: "Driver's Ed"
23) Both remote and joystick controls will work
During Follow the Leader:
24) Automatically follows the path the remote followed
25) Emergency stop feature and intercom still work from both remote and chair
26) Onboard sensors and safety measures still apply
27) Will apply emergency stop if remote becomes out of range
28) Otherwise it will try to keep up with the remote
During Line Rider:
29) Wheelchairs will follow directing system to travel from one place to another
30) Video feed will be kept
31) Emergency stop and intercom will work from both the remote and chair
32) Alarm will sound if the chair is stopped unexpectedly
During Chair Retrieval:
33) User can control the chair through the remote
34) Uses video feed to direct it

General Safety Features:
35) Spatial sensors to detect obstacles
36) Spatial sensors to detect a void
37) Secondary restraining device for the chair, such as those of a motor vehicle
38) All sensors need to be very accurate: there is no room for error
Proximity Detection:
39) Obstacles that could impair the safety of the user must be avoided
40) When obstacles are detected, the chair stops
41) Voids, such as staircases, need to be detected and unable to drive into
42) The difference between small gaps and voids needs to be noticed
43) Obstacles need to be in the path of motion to halt the chair
44) Alarms to be activated on both the chair and remote in an emergency stop
Emergency Stop Button:
45) Needs to be large, brightly colored, and easily accessible
Intercom:
46) Button-activated
47) Speaker and microphone need to be on both remote and chair



Integration Thread

Components

The basic components to be used in the integration thread for use in the initial testing platform are as follows. The network interface is to be defined to carry drive control data as well as video. The drive controller should be connected to the input selector which is connected to the network to take input to control the motors.

The remote will have the interface analogous to a control stick on a wheelchair, video display, and the network connection to the test wheelchair.