Mars Rover

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Functional Description

The goal of this Capstone project is to build a semi-autonomous vehicle to operate on the ECE department's Mars landscape. This vehicle will have similar functionality as its predecessor, Pioneer 1, but the Mars Rover will have a 7 day battery life. In addition to running a web server, there is an Ethernet connection via a wireless card, a camera mounted on the front of it, and is lacking an umbilical cord. The Mars Rover has five modes of operation: wait mode, sleep mode, low battery, charge mode, and user mode. The details of operation are in the paragraphs that follow.

Modes of Operation

Wait mode - All systems are powered, except the motors, and the CPU monitors the wireless card for activity from the user. The last image captured from the camera is stored on the hard drive. If the user does not give a command within a specific amount of time, the rover goes into sleep mode, where most subsystems are powered down. The exceptions are the CPU which is active and monitoring battery level and the wireless network card

Sleep mode - The sub-systems are powered down except for the CPU and the wireless network card. If possible, the CPU will run in a reduced power mode. The rover monitors activity from a remote user through the wireless card port, and receives battery status from the CPU. The wireless card only receives data to conserve battery power. The rover remains in sleep mode until it receives a signal that the user wants it to perform a specific action.

Low battery mode - When the battery drops below a set level, the rover goes into low battery mode. At this point, the rover sends an email to Dr. Malinowski telling him to charge the rover and performs a software shutdown to prevent deep discharge of the lead-acid batteries and possible damage. Before the rover shuts down, it saves all information to the hard drive, so on power up the system knows why the rover shutdown.

Charge mode – The operator must press the 'ON' button for rover to power up. Once the rover powers up, it checks to see why it shutdown; if the rover shutdown because of low battery and the charger has been hooked up, then charge mode takes over, otherwise the rover goes into wait mode. The rover remains on the charger and converts to a trickle charge once a full charge is obtained. The CPU monitors the network for any activity; once activity has been detected, the rover acquires a new camera image, issues a wake up statement to the rover, and moves approximately one meter forward from the charging station.

User mode – The user dictates the distance the rover must travel and in which direction. The instructions for the rover in this mode are as follows: move forward or reverse continuously, forward or reverse for a certain distance, and how many degrees to rotate clockwise or counterclockwise. As a precaution, an immediate stop command is used in case the remote user needs to stop the rover from previous commands.

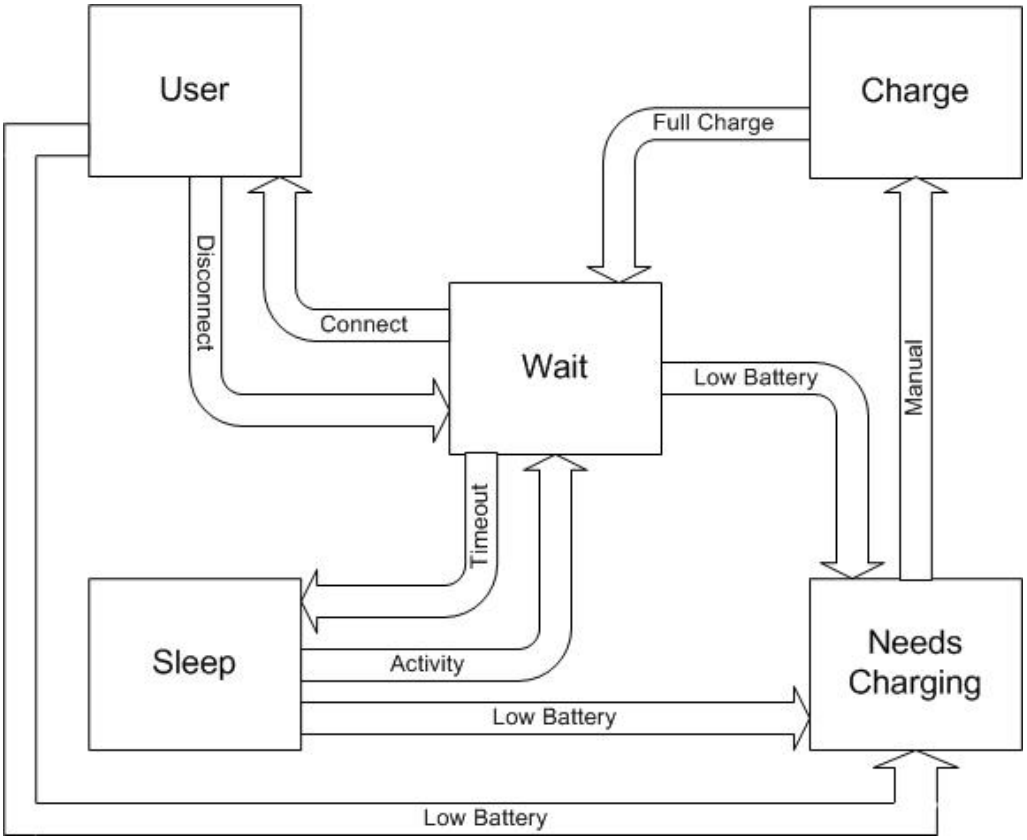

Figure 1 → Modes of Operation Flow Diagram

System I/O

Inputs-

Web/ Software-

Stop- The stop input halts the rover.

Reverse/ Forward motion continuous- The continuous motion command allows the rover to move forward or backward continuously until the stop command is called, an obstacle is detected to be too close, or a maximum distance is reached.

Reverse/ Forward motion distance- The distance motion command allows the rover to move a distance specified by the user either forward or backward.

Clockwise/Counterclockwise rotation- The turn command rotates the rover a specified angle in a clockwise or counterclockwise, from a top view.

Hardware-

ON button – Powers up the rover.

Battery Voltage- Lead Acid batteries are used to power the rover and the terminal voltage is an input to the CPU.

Camera- The camera captures photons that are directly in front of the rover. The image produced by these photons is stored on the hard drive in a buffer.

Front/ Back acoustic sensors- The sensors receive an echo signal, which is the signal that was emitted by the acoustic transmitters bounced off of an object. The distance from an obstacle is proportional to the time between the transmitted and received signals.

Wheel sensors- The wheel sensors track the movement of the wheels. They emit a digital bit stream that is captured by the CPU and decoded to find the direction and distance traveled. Once the desired distance is achieved, the CPU can stop the rover.

Wireless Card- The wireless card provides a link between the internet and the rover.

Outputs-

Web/ Software-

Low battery- An email is sent to Dr. Malinowski telling him to charge the rover. This output also issues the CPU to save all information to the hard drive and shutdown everything.

Camera image- The camera image, composed of photons captured by the camera, is stored in a buffer, and sent to the web interface where the user can view what the rover 'sees.'

Obstacle distance front/back- Through software, the distance away from objects is calculated by measuring the time between the signals emitted and acquired by the acoustic transmitters and receivers. This distance can then be displayed on the users screen to warn of potential hazards. If an object is too close, the rover will stop and will not allow the user to advance in that direction.

Hardware-

Front/ Back acoustic transmitters- The acoustic transmitters emit a signal that bounces off of objects and received by the acoustic sensors to determine how far away an object is.

Vehicle motion- The user enters the direction and distance they want the rover to move.

Wireless Card- The wireless card sends images and data from the rover to the web interface so that the user may control the rover.

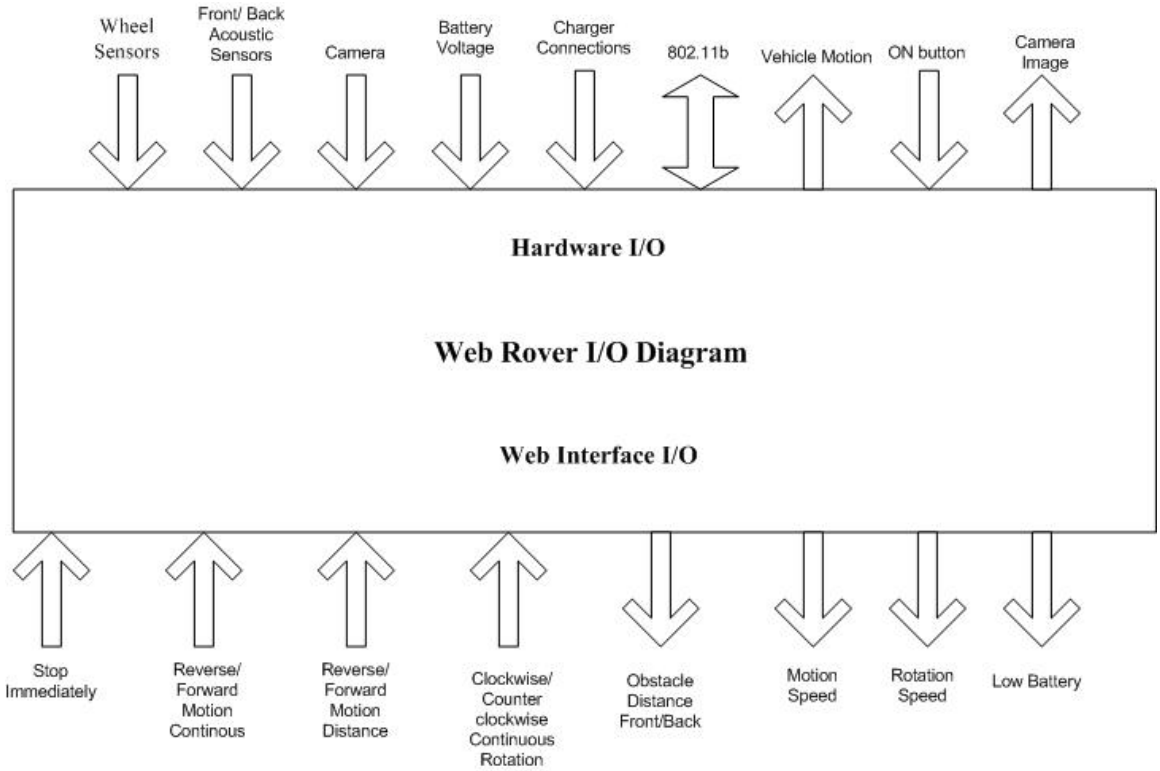

Figure 2 → System I/O