The Basic Idea

TUX 2 is an innovative wheelchair design based on the same proven principles as the Segway Human Transporter. TUX 2 uses a two wheel base with a full standing restraint system to hold the passenger in a standing position. Because the passenger is disabled and cannot lean to control the device, an extra layer of control complexity is also required to allow joystick operation.

Mechanical

Control System Approach

The control system of TUX 2 is broken down logically among the different pieces of hardware to simplify design and testing. By splitting up the system, it is also possible to avoid the typical transfer function approach which would be overwhelmingly complex for this system. Also, by distributing the logic among multiple processors a true parallel computing environment can be established as well as increased fault tolerance. The diagram on the right is a simplified flow chart for TUX 2.

Dynamic Center Of Mass

The key difference in the TUX 2 control system versus a Segway control system is the ability to shift the center of mass position. Because the passenger is disabled, they are not able to shift weight in order to maneuver. This adds to the complexity because in order for the device to move forward, it must first position the center of mass in front to accelerate and then move it back again to stop. On a Segway, the rider does this. On TUX 2, the Dynamic Center Of Mass algorithm accomplishes this task using the sensor input. The result is that the rider is able to control the system with a joystick. The diagram on the right graphically depicts the basic idea of how this is accomplished.

Development

To develop the system, a proof-of-concept prototype (TUX 1) was first built which had the same basic hardware setup. By experimenting on a smaller base, the software could be advanced more rapidly because the mechanical design was much simpler. The software for both TUX 3 and TUX 2 was written almost entirely in C, with the exception of some Assembly. Much of the lower level functions such as FIR filtering and high speed math were written in Assembly in order to utilize the specialized DSP instructions of the processor efficiently.

Software

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