Anonymous Go-Kart: Specification Report

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Abstract

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Approach and Preliminary Design

Brake

The go karts brakes will be controlled via a linear actuator. This will be connected by removing the brake pedal and connecting the actuator directly to the input of the hydraulic brake systems. It was decided to use the existing hydraulic system rather then attach a controlled actuator directly to the brake disk. This was done as it allowed the system to be attached and operated with minimal modifications to the existing kart. Another reason this decision was made is that actuators with relatively low force and large travel were much more readily available and cheaper then those with small movement and high force and the existing hydraulic system already converted this large movement into the high force required resulting in a cheaper system. Through rough testing it was determined that a human could apply approximately 300 N to the brake pedal. The leverage in the brake pedal was estimated at be roughly a 2 to 1 system. This meant the ideal actuator had to provide 600 N of force to operate the brakes. To go from full off to fully on the actuator required 30 mm of travel.

The actuator selected to power the brake was a 24V Warner linear m-track1. Its specifications deviated from our requirements slightly. The actuator had 100mm of travel more then three times the required making it longer then necessary. However space was not an issue so this was not seen as a problem. The actuator could only produce 450 N of force, it has yet to be seen how fast a deceleration this will allow however as 600N is the maximum a human could reasonably apply we are confident 450N will be sufficient. In the unlikely event this force proves too small in testing the large travel of the actuator means it can instead be mounted to the brake pedal using the leverage to give the required force. The actuator moves at 15mm per second under load. This means that from off to full lock takes 2 seconds. This speed is far slower then desired however the brake pads do not actually touch the brake during the first half of the travel. This dead zone is there to prevent drivers accidently applying the brakes and to accommodate different thickness brake pads as they wear. If the servo is recalibrated on a regular bases this dead zone can be all but removed allowing full brake control in a second. The main driving decision in the purchase of the actuator was price. The actuator was an end of line product that had been heavily discounted to sell this meant that it only cost $110 NZD including shipping to New Zealand from America. An actuator of similar specs could not be located for less then $220 in the US or within New Zealand for less then $300.

Steering

The steering on the go-kart operates on a rack and pinion system. The steering wheel rotates from lock to lock in 270 degrees. At rest on concrete the wheel requires 7 Nm to turn, this value represents a worst case scenario with significantly less force required when the kart is moving or on grass. Initially a servo was going to be used to drive the steering wheel however servos with the ability to produce 7Nm of continuous torque at a reasonable speed were found to be both difficult to locate and prohibitively expensive ($500+). Instead a system of a dc motor

gearbox and encoder is to be used. For the motor to be attached the steering column will be removed and the output of the gearbox will be attached directly to the pinion with the motor bolted in the space left by the removed column.

The motor system selected for use in the go kart is the IG52-04 52mm gear motor. It comes with a 1:353 gearbox and a Hall Effect encoder attached to a second rear output shaft on the motor. This motor produces 10 Nm of continuous torque which will allow it to easily turn the wheel. Its gearbox output rotates at 10 RPM allowing it to travel from lock to lock in 4.5 seconds. A concern with using this motor is that it has the ability when stalled to produce a peak torque of up to 100 Nm. This high toque has the potential to damage the steering system or the gearbox which is only rated for peak torques of 30 Nm. Because of this it must be ensured that the wheel is never driven right up till the end of its travel to prevent the motor stalling against the end and generating these forces. The encoder must be configured upon each setup of the system. This is because the position of the wheel when the system is mounted may change when each setup occurs. Because of this limit switches will be triggered by a small plate attached to the shaft to indicate when the wheel is at the end of its travel. Then on start up the wheel will rotate till it triggers each limit switch providing the position of the wheel. These limit switches will also act as kill switches during operation to prevent the motor reaching the end of its travel.

Controlling the motor and actuator

Both systems operate on 24V. This was done as the go-kart already had a 24V rail for driving the main motor. Using the same voltage as this saved money and simplified the design as it prevented the need for any converters that would have to be able to take the high peak currents of up to 5A produced by the system. Both systems are controlled through an H-Bridge to interface with a sam7 process connected on a can bus. These sam7s take care of all the low level instructions required for operating the drives allowing the main control computer to operate them via a high level and simple process that corresponds to the desired behaviour rather then the operation of the drives.

On the wheel the sam7 will take in the desired wheel angle. It will from this perform the low level actions of reading and keeping track of encoder pulses, calculating the angle from these pulses and performing PID control on the PWM signal sent to the H-Bridge controlling the motors voltage.

A similar situation occurs on the linear actuator. The sam7 will be passed the current speed and the desired speed of the go-kart. From this and the voltage output by the potentiometer built into the linear actuator the error in the actuators location is found. This is used via PID control to set the PWM sent to the H-bridge controlling the actuator.

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Bibliography