Final Report

Chazer Gator

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Abstract

Chazer Gator is a mobile robot build upon a RC monster truck. Among its many features, its sole purpose is to charge at a target specified by the controller. The methods of attack include either ramming the target or shooting it using a mounted airsoft gun. It uses real computer vision for target acquisition.

Executive Summary

Figure 1: Talon SWAT/MP

Use of robots for tactical purpose is nothing new in history. There were and still exists many tactical military robots used for offensive action and reconnaissance today. Examples include the Talon SWAT/MP used in Iraq for close quarter combat and the famous UAV used for reconnaissance.

However, the problem with each is that they still required manned control behind the scene. Imagine having an autonomous robot to which the user only has to provide the target and the attack is carried out autonomously by the robot. This behavior is what Chazer Gator intends to mimic. Having such a technology on the battle front can free the manpower required to operate a manned military robot.

This paper discusses the issues and process of developing an autonomous target destroying robot. The paper proceeds by discussing the logic behind the robot followed by the platform of construction and method of actuation, followed finally by results.

Introduction

The concept behind the robot is as simple as the user gives Chazer a target and it chases the specified target shooting or ramming it down. It is built upon a hacked off-road RC truck thus capable of high speeds and good maneuverability. With today's improving technology, it is possible to make robots autonomous rather than having them be man controlled. Smaller and smaller chips can process data faster than ever before and that leverage is enough to implement intelligent behavior previously impossible to conceive. Using the 32MHz 16bit AVR chip, Chazer is capable of complete autonomous control except however in processing visual algorithms which require enormous computation and memory to run. For such technology of transceivers is readily available to communicate large amounts of data very fast between multiple processing units. Chazer utilizes all the above discussed methods to avoid obstacles and track moving or stationary targets and attack them either by ramming or a installed weapon system.

Integrated System

The processing system behind Chazer intelligence consists of a 32MHz microcontroller (the brains of Chazer), a communication chip which in this case is a Bluetooth module installed both no Chazer and on the final system, the 2.0 GHz computer. The information and logic flow diagram below shown below explains how the components interact.

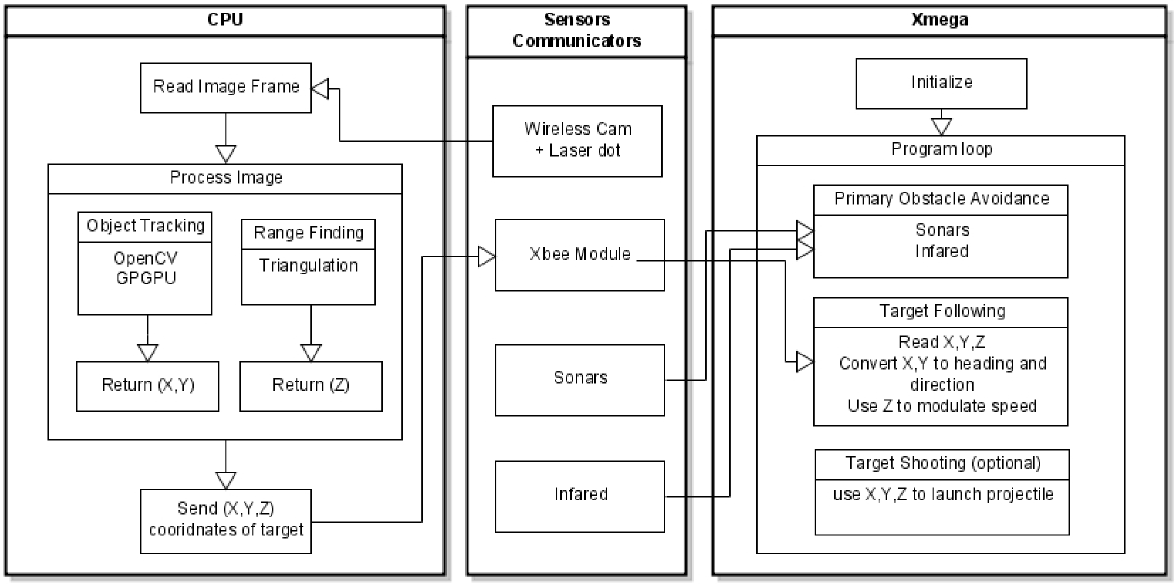


Figure 2: Logic/ Data flow 1

After the Xmega (Chazer's brain) is initialized, it continuously queries the CPU for information on the target. The wireless camera with a laser range finder provides the CPU an image to process. Using open-source vision algorithm library called OpenCV, the image frame is processed for target specified by the user. Then the position in x,y,z is sent back to the Xmega using the transceiver module. Once the Xmega knows its target location, it decides the method of attack to use.

Mobile Platform

The mobile platform constitutes of an RC truck base torn out of its original radio controller chip. The resulting platform consists of two DC high torque motors configured to provide a deferential based four wheel drive capability and a servo for steering the front wheels. The platform will serve as actuation and hence be the muscle behind Chazer's brain.

Figure 3: Platform

Actuation

Robot actuation and displacement will use two DC high torque motors built within the RC truck framework. The front and back wheels are controlled by two DC motors and each wheel pair is configured as deferential rotation. The front two wheels are capable of turning using a servo based steering system directly controlled by the board.

Figure 4: Standard DC Motor

Figure 5: Pan/Tilt System

Pan-Tilt system also uses servos controlled by the Xmega board. It is used for actuation of a wireless camera for vision and an airsoft gun for target takedown. This system was acquired from lynxmotion, a company who specializes in servo brackets for such purposes.

Sensors

Sonar systems will be used for distant obstacle avoidance and swerving away from obstacles. They act as the low level feedback where the Xmega disregards the high level input from the CPU and acts to avoid the sensed obstacle. The sonar shown in Figure 6 was from Maxbotix. These sonars have built in timers which measure the send receive pulse time and output a analog, PWM, or digital reading. Analog readings were used in the robot.

Figure 6: Sonar EZ1

Under the special sensors category, a wireless camera controlled by the computer served as the eyes for Chazer. The camera reports target object coordinates and range using a laser range finding system built manually. A built in microphone served as Chazer's ears for minimal audio processing.

Figure 7: Wireless Camera

The range finding was done using a laser module installed parallel to the camera's view such that the set distance between the camera and the laser was known. Using the triangulation equations shown in figure 8, range was calculated and sent to the Xmega for processing.

$$D = \frac{h}{\tan(pfc * rpc + ro)}$$

$\theta = pfc * rpc + ro$

Where:

pfc = Number of Pixels From Center of Focal Plane

rpc = Radians per pixel pitch

ro = Radian offset (compensates for allignment errors)

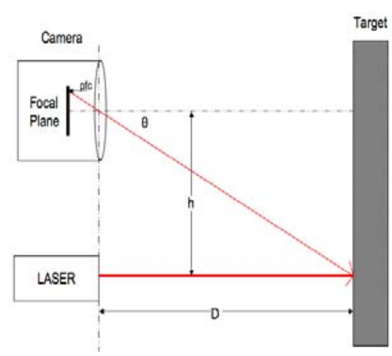


Figure 8: Laser module with equation

pfc, rpc, and ro are all calculated by the OpenCV pixal algorithm and hence known. The h variable is the pre measured distance of the laser camera mounted system. Thus, the equation in figure 8 returns the range of the object in focus.

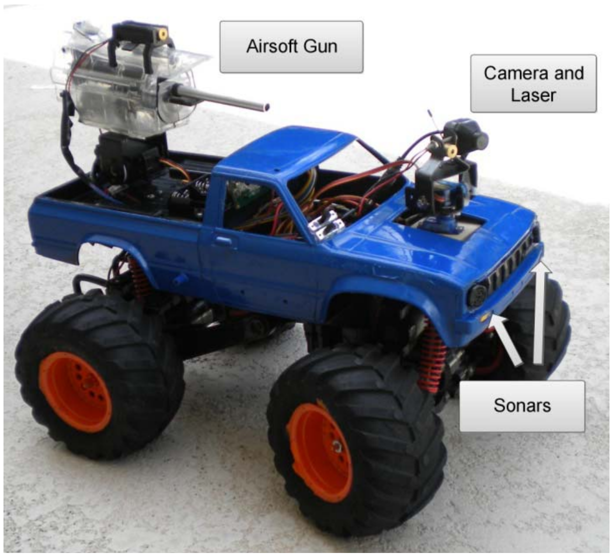
Behaviors

1. Initialize
2. Calibrate equipment
3. Connect to CPU
4. Program loop
    a. Listen to target data , if null
        i. Randomly drive and avoid obstacles
    b. Target and method of attack acquired
        i. If on ground, try to chase and ram the target
        ii. If in air, try to shoot it down with the airsoft gun

c. Send target down confirmation
d. Randomly drive and avoid obstacles

Experimental Layout and Results

Shown underneath are final robot setup pictures,



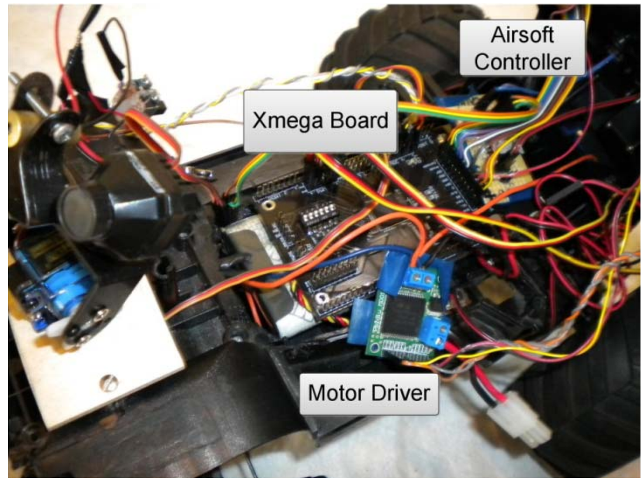


Figure 9: Robot setup info 1

Conclusion

The Chazer robot turned out to be a good success. It was able to obstacle avoid and attack the target as specified by the user. The major issues that made the project difficult was communication back and forth between the Xmega and the CPU. Due the USART restriction of 8 bit max transfers, problems were created trying to send target data to the Xmega. These problems were overcome by converting the 32 bit int value on the CPU to a scaled down version of only 8 bits. In this process vital information was lost, but the results were manageable given the scope of this project.

For future improvements, a powerful microcontroller then the Xmega, perhaps a 32 bit one, and higher bandwidth wireless communication is necessary for the robot to be truly remarkable. The airsoft gun can be converted to a real weapon in conjunction with the updated pan/tilt system. The platform itself could be converted to a track based vehicle giving it more versatility.

Documentation

Source code for the project provided at http://sites.google.com/site/nitro3/projects/imdl-chazer

Appendices

Rough cost to build provided below,

Item	Cost	Seller
RC truck	$ 0	Donated

Sonars	$ 75	Sparkfun Robotics
Wireless Camera	$ 100	SuperDroid Robots
Pan/Tilt System	$ 30	Lynxmotion
Airsoft Gun	$ 20	Walmart
Drive Servo	$ 20	Hobbytown
PVR board	$ 126	Mark and Thomas, IMDL
Laser modules	$ 5	DealExtreme
Xbee Module	$ 100	Trosson Robotics
Bluetooth Module	$ 65	Sparkfun Robotics
Total	**$ 541**	--