Needs Assessment and Project Scope

EML 4551C – Senior Design – Fall 2011 Deliverable 1

Team # 2

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Needs Assessment

As the advancement of image fuze sensor progresses, a nondestructive method is needed to evaluate the performance of the fuzing sensors at the endgame of flight to ensure peak performance and reliability. This project will require the use of nondestructive test methods in order to evaluate the accuracy of the fuze burst point control algorithm during static testing. In addition, the speed and accuracy of the tagging system should be compatible with continuous target updates as the fuze sensor closes on the target and refines the burst point decision.

Project Scope

Problem Statement

Design and fabrication of a nondestructive computer controlled aiming and tagging system. The system will use a barrel with a full range of motion that will mount on the forward hemisphere of a surrogate warhead. Our system will serve as a proof-of-principle demonstration at Eglin Air Force Research Laboratory for future implementation of fuze sensors on dynamic cable testing and munitions.

Justification/Background

The Air Force Research Laboratory (AFRL) needs a method to evaluate performance of fuze sensors and algorithms in a dynamic field test environment. The fuze sensors are designed to image the forward hemisphere in front of a weapon's velocity vector for the last 100 meters of flight, detect targets of interest, classify these targets and pick an aimpoint on the target. For proof-of-principle demonstrations, AFRL plans to use a dynamic cable test rig that will allow the fuze sensor to fly a realistic trajectory toward the ground at scaled velocities. Targets of interest would be placed at respective realistic distances from the weapons to trajectory to evaluate the effectiveness of the active imaging fuze sensors in this dynamic data collection environment. A paintball gun like system is needed that can be aimed and fired by the fuze sensor during these dynamic cable runs.

Objective

Design, fabricate, and demonstrate a computer controlled aiming and tagging system that can eventually be integrated with developmental active imaging fuze sensors for proof-of-principle demonstrations. The prototype must be able to receive a user defined set of coordinates, move the barrel to the target and accurately fire several paintballs to tag the target. It must do this with a high level of precision and accuracy and at a defined speed.

Methodology

The first step to creating and testing a computer controlled aiming and tagging system is to identify the customer's constraints. This will help us better understand what the customer is expecting as a final result. Next, extensive research must be done to better understand how the system will function. We will first need to research different types of paintball guns and barrels for our system and chose the most accurate and cost effective one to use. Reaction forces produced by firing the system will need to be analyzed as to decide on a proper mounting system and motors that will be used to turn the gun. Research in paintballs will need to be done since they will most likely be the main reason for inaccuracy. Finally housing the gun and determining what hardware and software will be used to control the movement in addition to the programming required to run the entire system will need to be researched.

After conducting research, design concepts will be drafted and chosen with approval from the customer. Finally system components will be ranked using a decision matrix and the best ones chosen. Once the design and components are chosen a prototype will be built and tested. The main focus of our system will be minimizing the dispersion and maximizing the repeatability.

Constraints

There are a few factors to examine before a prototype can be produced. The tagging system is eventually planned to be airborne so weight will be an issue to ensure flight will be sufficient, therefore the design cannot exceed fifty pounds. A goal is for the azimuth & elevation aiming accuracy to be less than 1 degree. The azimuth and elevation slew rate should be sufficient to re-aim the barrel in any direction in less than 1 second to ensure minimal latency and smooth motion by the barrel for aiming purpose. Cost and time will be the ultimate deciding factor to ensure the project is under budget and ahead of schedule.

Safety

Since our design is a live firing system, there will need to be safety precautions implemented to make sure our device only fires when commanded to do so. The most important and easiest way to guard against unexpected firing is to have a safety key that, when removed, the system is unable to fire at all. This interrupt can be a physical or electrical interrupt depending on our final design and as which one is determined to work the best.

Another safety precaution that we will take to prevent any unwanted discharges is that our device will have an external trigger input. This will be a separate and secure input system that is only used to tell the system when to fire. The device will have a completely separate input system that controls the azimuth and elevation of the firing device. This precaution is to prevent any bad information being sent to the trigger while the aiming system is still aligning itself. These are going to be the main two ways of preventing the system from firing unexpectedly.

Expected Results

By the end of the senior design project, our goal is to have a fully functional, nondestructive marking device that will allow AFRL to test the accuracy and repeatability of their computer controlled aiming and tagging system. The product will have the capability of computer interfacing to allow even more testing capabilities for the Munitions Directorate. Our final product will be lightweight enough to carry the necessary control systems and have some sort of marking system that will be able to range the entire forward hemisphere of the device. The product, fully functional, will be within the given safety standards and will be able to fire multiple marks with accuracy and be able to repeat all static tests.