Industrial Graduation Projects 2020

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BİLKENT UNIVERSITY
MECHANICAL ENGINEERING DEPARTMENT

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BILKENT UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

INDUSTRIAL DESIGN PROJECTS

2019 – 2020

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Content

PREFACE

The primary goal of university-industry collaboration is to provide future engineers with a broad understanding of industry and business. An important outcome of this collaboration is bright, creative ideas that the students offer for solutions to design problems.

In support of this goal, we have a two-semester long design activity for the senior-level students. This year, sixteen groups, each consisting of six/seven students, were provided with design projects from leading industrial organizations. Projects were selected such that students could leverage their undergraduate studies to design a product needed in today's world, but also bring out their creativity in both the design phase, which is completed in the first semester, and in the manufacturing phase normally completed in the second semester.

At their final presentation sessions, the students are provided with a unique opportunity to present detailed design specifications of their products and the manufactured prototypes.

The exceptional circumstances due to the dangers posed by COVID19, our students, instructors and industry advisors had to adapt to deliver the project outcomes using online communications and they have done well.

Our website and this booklet demonstrate the design and manufacturing goals, constraints, challenges, and, of course, the students' efforts that led to their accomplishments. The continuous guidance and advice provided by their academic and industrial mentors, instructors, and teaching assistants are very much appreciated.

On behalf of the Mechanical Engineering Department, I would like to thank all those who have generously contributed their time and resources that enabled tomorrow's engineers to gain invaluable experience during this process and demonstrate their capabilities in these trying times.

Adnan Akay
Professor and Chair
Mechanical Engineering Department
Bilkent University

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PROJECTS

Drone For Missing Children

KidsWithME (1)

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ABSTRACT

The aim of this project is to design and manufacture a half-autonomous drone which can detect a missing child with a detection system, and inform the authorities in search and rescue operations. The design was developed according to the constraints outlined by Bilkent University Kindergarten. In order to accomplish these goals, the system is divided into two parts; UAV and Detection System. The detection system consists of a thermal camera with image processing and a quad-copter is used as the UAV. Two systems are designed and assembled, and tests were conducted for both systems separately. It is verified that both systems are working functionally. However, due to the current pandemic circumstances, these two systems cannot be fully integrated.

Introduction

In the last decade, there was a significant increase in missing children incidents. According to Turkish Statistical Institute (TÜİK), 116,094 missing children incidents occurred between 2008 and 2017 [1]. Missing children cases gain a lot of attention in the mainstream and social media since children exploitation is more frequently mentioned. As statistics suggest, missing children incidents are common in Turkey. These incidents include an age group which is between 0-6 years old. Children aged between 0 and 6 have low perception level of cause and effect relationships and are eager to explore the environment due to their high curiosity [2]. Therefore, their actions are unpredictable and a one-hour period after the incident has occurred is a critical time period to find the missing child. In most cases, operations are run on land. This situation increases the searching time and reduces the efficiency of the searching path. For instance, a child who went missing in Siirt was found alive after 4 days of intense search including 87 law enforcement personnel and more than 100 villagers [3]. Also, statistics suggest that 25 people are able to search an area of one square mile in 35 hours while a drone can search the same area in 30 minutes [4]. Usually, as seen on the news, children found after a critical time are neither alive nor unharmed. So, the integration of a technology which eases the scanning of challenging terrains and wide areas can help reduce the time it takes to find the missing child. The purpose of this project is to design a half-autonomous drone which can detect the child from a designated altitude by a detection system and inform the authorities.

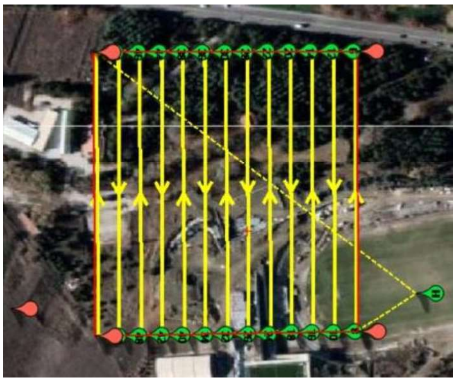

Figure 1: Flight pattern

Design Constraints

- Flight duration: 10 minutes
- Weight: up to 4 kg
- Minimum altitude: 15 meters
- UAV must follow predetermined path patterns
- Scanning area: minimum radius of 100 m
- Rectilinear flight pattern
- Minimum flight speed: 5 m/s
- Two-way communication
- Thermal footage of the area will be processed
- Live video feedback of the searching area
- Location data of the missing child will be sent to the operator

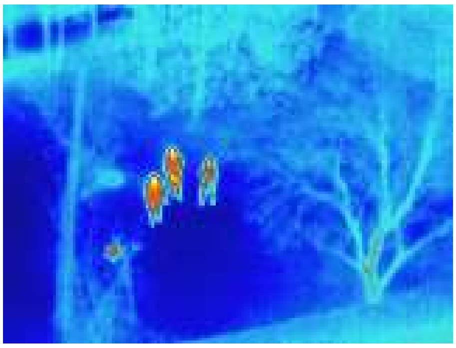

Figure 2: Thermal footage obtained from 15 m

[1]: “Güvenlik Birimine Gelen veya Getirilen Çocuk İstatistikleri, Merkezi Dağıtım Sistemi” TÜİK. [Online]. Available: https://biruni.tuik.gov.tr/medas/?kn=98&locale=tr. [Accessed: 9-Oct- 2019].
[2]: S. Team, “Home,” Kreedo, 16-Nov-2018. [Online]. Available: https://kreedology.com/0-to-6- years-critical-years-in-the-life-of-a-child/. [Accessed: 17-Oct-2019].
[3]: Dha, “9 köy, kayıp Salih'i arıyor (3),” Hürriyet, 04-Jul-2018. [Online]. Available: http://www.hurriyet.com.tr/9-koy-kayip-salihi-ariyor-3-40886681. [Accessed: 16-Oct-2019].
[4]: "Drone rangers: Thousands of lives will be saved by drones in the next five years", Medium. [Online]. Available: https://medium.com/thebeammagazine/ drone-rangers-thousands-of-lives-will-be-saved-by-drones-in-the-next-five-years-a7a1044ed9dc. [Accessed: 01- Nov- 2019].

Design

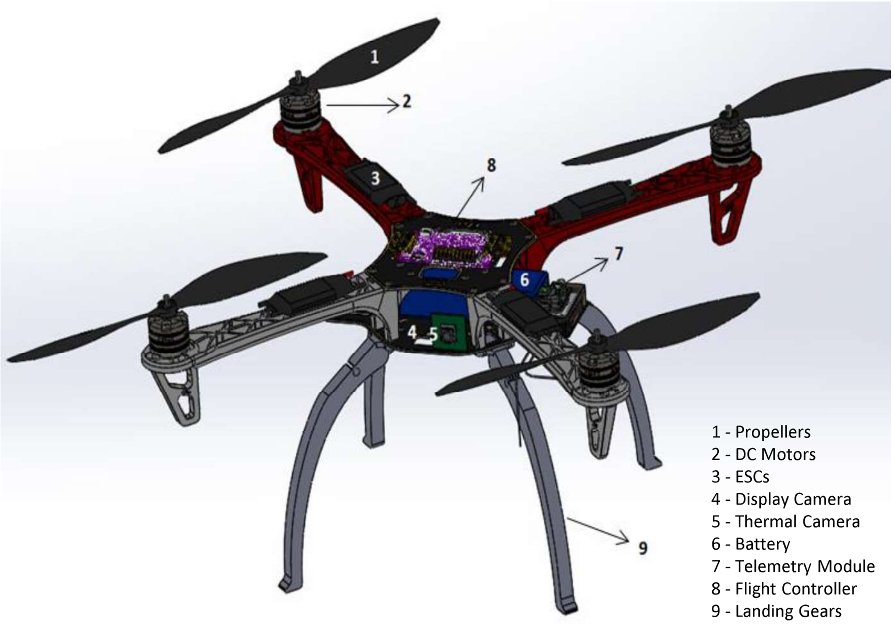

Figure 3: UAV CAD model

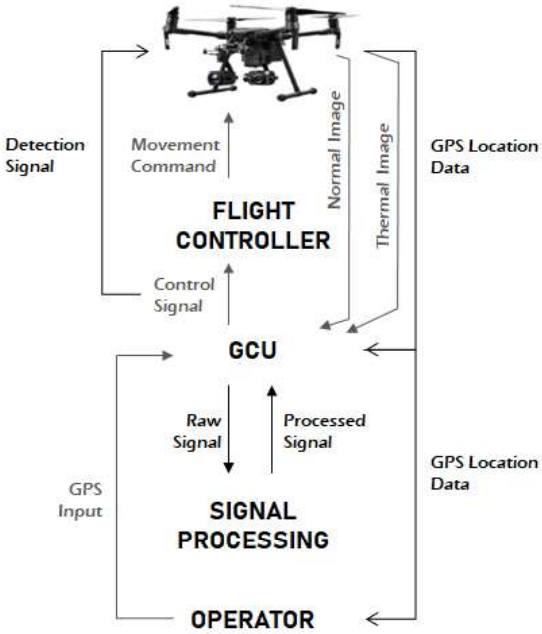

Figure 5: Working Principle of the System

Flir Lepton 3.5 thermal camera is used as a detection system. According to the design, two main subsystems are created; UAV and detection system. UAV system is responsible for the autonomous flight, flight speed, required altitude and other subjects which are related with flight of the total system. Detection system is responsible for developing a software for detecting missing children and sending related information related with the target to the operator. Components and CAD model of the system can be seen in Figure 3 and Figure 4 shows the real-life assembly of the system.

Figure 4: Assembled UAV

Working principle of the total system can be shown in a flow diagram as shown in Figure 5:

- Operator inputs the GPS input of search area to the Ground Control Unit (GCU).
- Software creates the flight path.
- This input and flight controls are sent to the Flight Controller via transmitter.
- The Flight Controller sends the movement commands to the UAV and the mission starts.
- Detection system starts scanning the area.
- Thermal footage is sent to GCU from the UAV to be processed as well as the live video footage for visual verification if needed.
- If any heat signature in human body temperature range, which may belong to the child, is detected; the system notifies the operator.
- If the object is verified as the missing child by the operator, a detection signal is send to the UAV and it sends this current GPS location to the operator.
- If the detected object is not the child, the mission continues until the child is found or the searching area is scanned fully.

Adaptive Vehicle Front Grills

(2)

Taha Khursheed - Zakaria Ali Shah - Gökhan Bütün - Hamza Ashfaq - Saqib Jabbar - Rawaha Nakhuda

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Dr. Şakir Baytaroğlu
Industrial Advisor : Cem Kurt
Teaching Assistant : Ali Kerem Erdem

ABSTRACT

Armored Combat Vehicles are equipped with a set of grills at the front of their engines that allow heat transfer between the engine and the surrounding air to maintain the engine temperature and to provide the ballistic protection to the engine. Currently these grills consist of set of flaps that are fixed at an angle of 45º, which provide a balance between heat transfer and ballistic protection to the engine. This project aims to optimize the ballistic protection of the vehicle and also improve the air intake efficiency by redesigning existing grills in a way that the flaps can rotate between 0º and 90º based on two inputs. A control system will take the vehicle velocity and the engine coolant temperature as inputs and its output signal will move the flaps to the desired angle. Fully closed flaps will provide maximum ballistic protection to the engine and the fully open flaps will allow maximum rate of heat exchange from the engine. For the project, a new design was conceptualized which allowed the flaps to be rotated using a single linear actuator having one degree of freedom. An algorithm was also made which decided the angle for the flaps based on the inputs and the condition. Furthermore, a combat mode was also added which the driver can initiate on need basis.

Introduction

4x4 Armored Combat Vehicles (APCs) are equipped with a grills at the front of their engines that allow heat transfer between the engine and the surrounding air to maintain the operational engine temperature, and also to provide the ballistic protection to the engine. Currently, these grills consist of set of flaps that are fixed at an angle of 45^o to the ground, so that it provides a balance between cooling air influx and ballistic protection to the engine. Ideally, fully closed flaps will provide maximum ballistic protection to the engine and the fully open flaps will allow maximum rate of heat exchange between the engine and the surrounding air.

It can be generalized that an APC needs more ballistic protection when they are slow, since they are easier targets, and requires less engine cooling efficiency due to the low speeds. Correspondingly, more engine cooling efficiency and less ballistic protection are required for an APC at higher speeds.

Considering this, the aim of this project is to design an electro-mechanical system that optimizes the ballistic protection of the engine and cooling air intake efficiency by rotating the flaps between 0^o (fully closed) and 90^o (fully open). For this purpose, an adaptive control system is designed, which takes the vehicle velocity and the engine coolant temperature as inputs using sensors, and outputs a signal that moves the flaps to the desired angle with the help of a linear actuator, depending on the vehicle speed. For the controller, an algorithm that outputs the optimal angle as a function of vehicle velocity and engine coolant temperature is developed, by conducting CFD analysis and studying the combat scenarios provide by the company. Exceptional situations, such as engine over heating and emergency situations are also considered in the development of the algorithm.

Figure 1: EJDER YALCIN III [1]

In order to design such a system, certain requirements and constraints were followed. These are described below:

Operation: An autonomous control system which is fed by vehicle speed and ambient/engine coolant temperature should choose the optimum angle for front grill flaps. The mechanism that rotates the flaps should operate the angle from 90°(fully open) to 0°(fully closed)

Relation between Flap Angle and Cases: ballistic protection has to be maximum at low speeds, and cooling performance has to be maximum at high speeds.

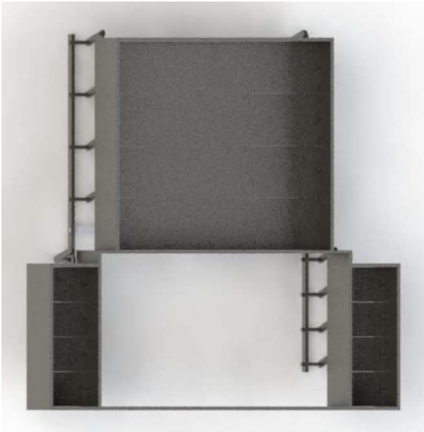
Dimensions: The total front grill area of the vehicle is 1000 mm x 1000 mm.

Material: Regular Carbon Steel will be the used for the outer frame and the flaps of the grills.

Algorithm: Output of the system is going to be the angle of the flaps. This angle will depend on: engine coolant temperature and speed of the vehicle. An interrupt command will be present which allows the user to close the flaps (0°) to obtain maximum ballistic protection. An Arduino is used to implement this alogorithm.

[1] “Ejder Yalçın.” Ejder Yalçın Web Sitesi, http://ejderyalcin.com/.

Design



(a) Closed Flaps

(b) Open Flaps

Figure 2: Finalized design

The open and closed systems are detailed in figure 2 above. This figure represents the finalized design for the Adaptive Front Grills system. The frame of the system was designed in accordance with the Ejder Yalcin III vehicle and the flaps are made sure to rotate through a single actuator.

In order to rotate the flaps in synchronization, a hinge based mechanism was used. A straight connecting rod is attached to links connected to the flaps. This system ensures that only this connecting rod needs to be actuated in order to rotate the flaps. A detailed look for the mechanism can be seen in figure 3.

These connector links force the rod to only move in a vertical direction in order to rotate the flaps. This make sure a linear actuator is attached to this rod in order to actuate the entire system.

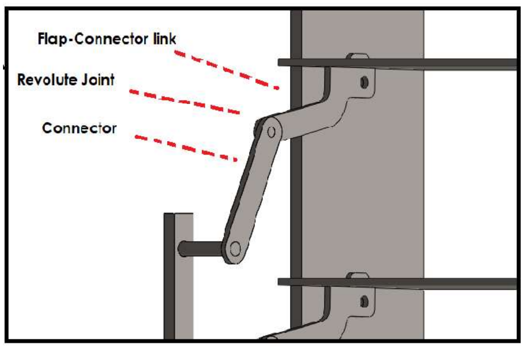


Figure 3: Rotating Connection

In order to manufacture this design, the assembly is divided into components and subcomponents to provide ease in manufacturability. The design was constantly improved upon to make it simple and cheap to manufacture.

The goal was to use laser cutting for individual subcomponents, then all of these would be welded together for 3D assembly. An example of a component is shown in figure 4.

This exploded view was developed for each component, namely: the frame, flaps, rotating hinges and the connecting rod.

These were to be given to the manufacturer to start the process of building the prototype.

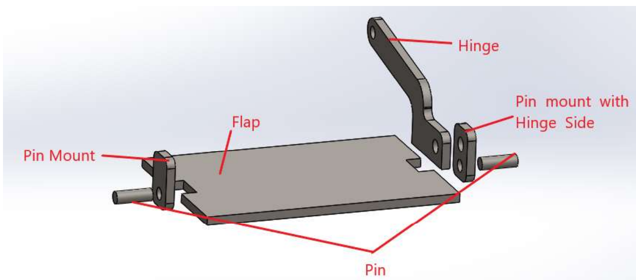


Figure 4: Exploded View of Main Flap

Autonomous Robotic System for Ceramic Tile Placement

CAMEBAG (3)

Academic Advisor : Asst. Prof. Dr. Ali Javili
Industrial Advisor : Hikmet Sinan Üstün
Teaching Assistant : Didem Fatma Demir

ABSTRACT

There are several bullet resistance tests in Roketsan Inc. that examines the impact of the bullets and strength of the vehicle armors. During tests, bullets launch on to ceramic tiles. Assembling and combining process of those ceramic tiles are made by hand and it takes time. The purpose of this project is to design an autonomous robotic arm that works on different axes and connects ceramic tiles together based on technical drawing so that the process becomes much faster, cheaper and more efficient. This project has three main parts called mechanical, controller and image processing parts. For the mechanical part type, dimensions and components of the robotic arm are decided based on engineering kinematic and mathematical analysis. In order to lift the object and place them precisely to their place indicated on technical drawing, vacuum system is used. For the controller part to ensure automation motion, precision and accuracy of the system Arduino is used. Image processing and shaped detection operations are performed by implementing corner detection algorithms with the Raspberry Pi camera.

Introduction

Military vehicles are armored by modular structures which contain ceramic tiles that have different shapes and geometries as shown in Figure 1 to enhance the protection. There are several different ceramic tile geometries, hexagonal or square are the most used ones, depending on the structure. The vehicle module is covered by either hexagonal or rectangular tiles in the most optimized way. For the assembly of ceramic tiles in a module, adhesive is applied to the faces of tiles and tiles are placed. Ceramic tiles are placed 0.1 mm apart from each other. As a result, rectangular or square packages out of different shaped ceramic armour tiles are produced. Gluing and placement operation are carried out by hand and this causes the process to become time consuming and more expensive. In this regard, the purpose of this project is to execute this operation with an autonomous robotic arm to make process faster and cheaper.

Before the operation ceramic tiles are placed parallel to the ground and should be distinguished by the robotic arm. The project is expected to satisfy the following constraints:

- The arm should be able to carry ceramic tiles up to 3.6 kgs.
- The system should be able to do a placement with 0.1 mm precision between the ceramic tiles.
- The system should be able to perform a placement operation for a 1000x1000 mm^2 module at maximum.

Figure 1: Ceramic tiles and demonstration of an example placement. [1]

Therefore, the working principle of the system starts by taking the technical drawing file of the packed ceramic tiles as input. The coordinates of the center points of ceramic tiles in module are saved and a categorization is conducted on the ceramic tile geometry. With the information taken from the technical drawing, the machine starts to detect ceramic tiles in the woking space. It calculates the center point of the ceramic tiles on the working plane, categorizes the tiles and calculates the rotation of the tile according to its position in the assembly file. The calculated center points and the rotation information are used in calculation of the rotation of stepper motors. Then, the system takes the desired ceramic tile from working plane and places the tile to its location by using the center coordinate value previously taken from the technical drawing. The placement process continues until every ceramic tile in the technical drawing is placed to the module in working space with desired orientation.

[1] "Technical Ceramics from The Ceramic Experts," Technical Ceramics. [Online]. Available: https://www.ceramtec.com/ceramic-materials/. [Accessed: 30-Oct-2019].

Design

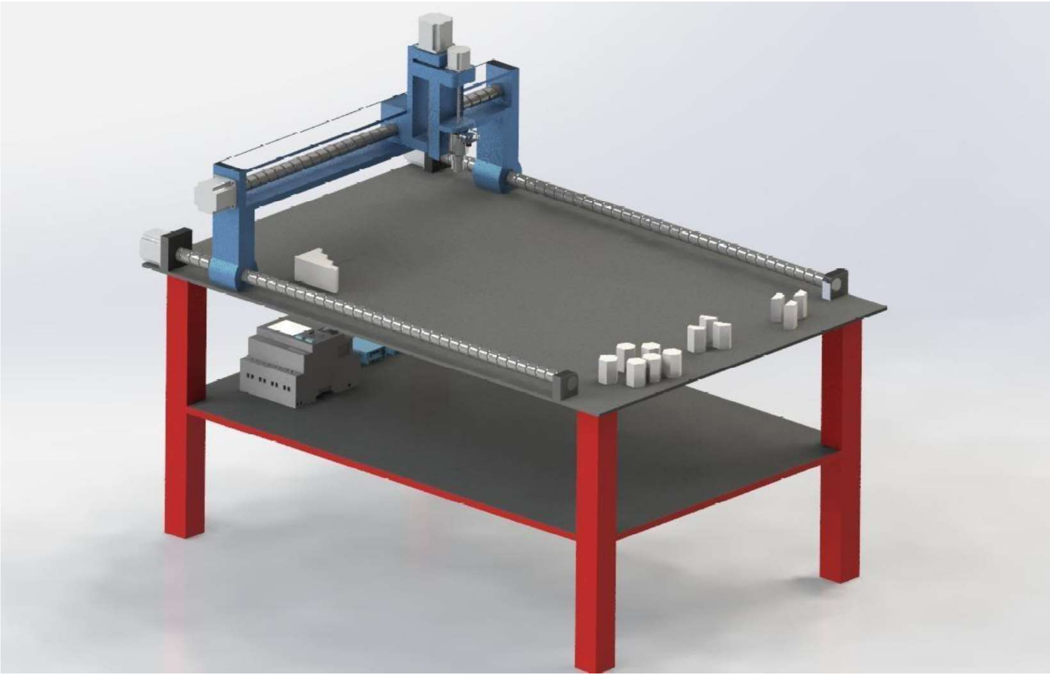


Figure 2: A CAD drawing of the Design.

Cartesian coordinate robot in other words a gantry robot is a selected concept for this project with respect to the design matrix that is created for the mechanical concept selection. The purpose and application of such robots may vary from industry to industry. The most common applications of cartesian coordinate robots are CNC milling and 3D printing machines [2]. This system is capable of moving along the x, y and z axis. In addition to movement along those axis, spindle of the robot can rotate in order to place ceramic tiles correctly to their positions. Movement along axis is performed by a ball screw mechanism to achieve desired precision and convert rotary motion to linear motion and the spindle can rotate with the help of a stepper motor attached to it. Detailed modelling of the robotic system can be seen in Figure 2.

Vacuum system is the most suitable system for picking and placing ceramic tiles because of the 0.1 mm gap constraint between all ceramic tiles.

The designed robotic system is able to understand module, different shape of the ceramic tiles and pattern of those ceramic tiles on the module. In order to perform these operations Raspberry PI camera is used. The images taken by the Raspberry PI camera are processed in Raspberry PI, by implementing corner detection methods different ceramic tiles are distinguished and corners are identified. Corner points are used in order to detect center points of each ceramic tile. Coordinates of center points are sent to the Arduino to move the system on the top of ceramic tiles for lifting operation. The required number of revolutions for stepper motors are calculated inside the Arduino for 3-axes. In order to complete the process precisely, PI controllers are designed in Arduino environment by implementing motors and ball screws parameters.

[2] "CARTESIAN COORDINATE ROBOTS," *Cartesian Robots*. [Online]. Available: https://www.hteautomation.com/item/index/Cartesian Robots. [Accessed: 31-Oct-2019].

Design and Production of a Remotely Controlled Scaled Target Fixture for Ballistic Tests

AEGIS (4)

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Teaching Assistant : Emre Eraslan

ABSTRACT

In this project, the aim is to design a remotely controlled target fixture in which the specimen is placed and where the fixture can linearly move in 2 axes and rotate in 1 axis. While doing these motions, the fixture is expected to obey the settings of the test room, shooting test standards and withstand the ballistic impact. The project will be used in the test room of the Ballistic Protection Center in Roketsan. With the current setup, an experimenter has to readjust the specimen after each shooting test by manually calibrating its spatial location in x, y and roll axes. By automating the specimen adjusting procedure, test duration will be reduced and the human errors due to manual control of the fixture during positioning event will be minimized.

Introduction

Ballistic protection is an evolving field that provides protection against projectile penetration including any kind of bullet ammunition (explosive, corrosive, hyper speed etc.). Ballistics testing is a process where products are tested to determine if they meet protection, safety and performance criteria. The aim of the ballistic tests is to examine the pressure-temperature changes, the acceleration movement of the bullet in a specimen, the movement of the bullet in the air, the effects of the bullet on the target by firing the weapon. ROKETSAN Ballistic Protection Center (BPC) has been established to fulfill the ballistic protection requirements of military and civilian platforms. This center is responsible to design, develop, produce and test composite and explosive reactive armor for armored vehicles. The Design and Production of a Remotely Controlled, Scaled Target Fixture for Ballistic Tests Projects includes design and manufacturing of an innovative and autonomous system model to speed up the testing procedures. The testing of an armor specimen includes examining the effects of different levels of ammunition from certain angles. Because, while some applications require protection against normal impacts, some may require protection against oblique impacts only.

Ballistic tests must follow the NATO/STANAG 4569 standard which requires tests conducted at exact positions and angles of attack with very low tolerances. The current target fixture setup at Roketsan Ballistic Protection Center (BPC) is fully manual, which makes it very time consuming to achieve the precise positional requirements of the test standards.

In this project, an automated target fixture is designed to address these issues. The automated target fixture utilizes stepper motors, encoders, linear actuators, and various other mechanical components to position the armor plate in the desired position with high precision.

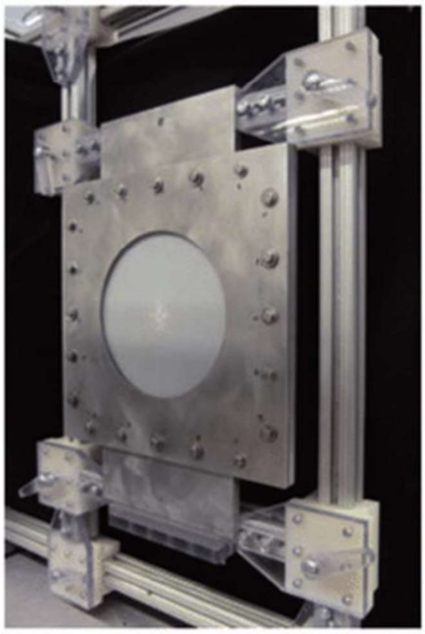

Figure 1: Target Fixture Sample

The automated target fixture is capable of satisfying the following constraints:

- Accurate 300x300mm horizontal and vertical positioning
- Pitch rotation of the target plate with 15° increments within 0.2° tolerance
- Withstanding the impact shock of 7.62x51mm ammunition (NATO/STANAG 4569 Level 3)
- Resistance to corrosion and impact from ricocheting bullets

Design

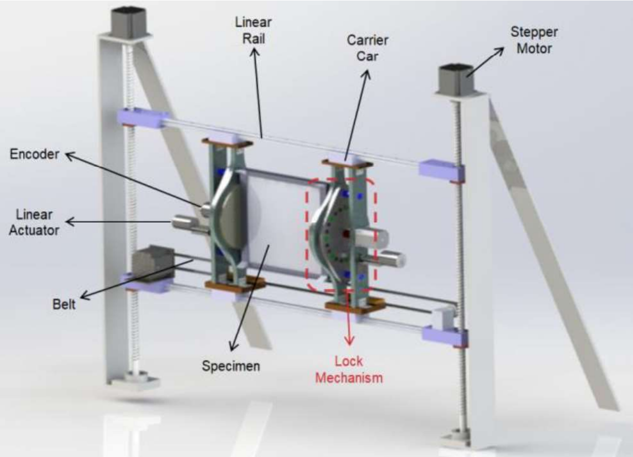

Figure 2: 3D Model of the Target Fixture

The specimen is placed by the experimenter and then its position is remotely controlled in three axes. The motion of the x and y axes are controlled by NEMA 34 stepper motors, for the control of the roll axis, a NEMA 23 stepper motor is used. A pulley-belt system is placed under the inner frame for horizontal motion, and lead screws placed at the sides of the outer frame are used for vertical motion. Since there are certain angles that the specimen needs to cover with a high tolerance (i.e. 15, 30, 45 and 60 degrees) the NEMA 23 stepper motor moves with micro stepping to provide precision in roll axis. Concerning precision, also an encoder is used at directly opposite of the NEMA 23 to control the angle it turns.

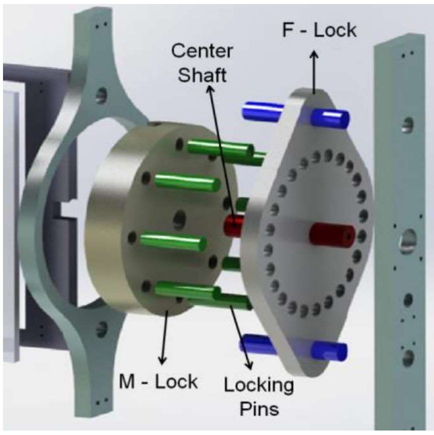

Figure 3: Locking Mechanisim of the Target Fixture

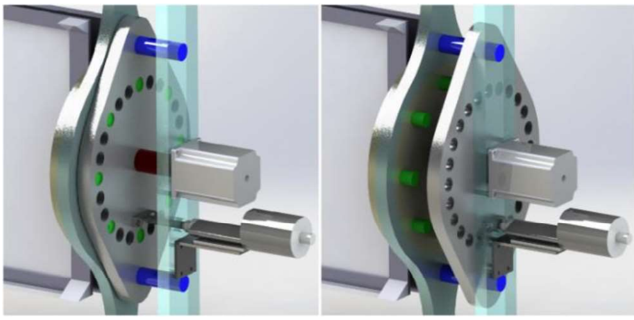

Figure 4: Detailed View of Locking Mechanisim

The system needs to hold the specimen still against ballistic impacts, therefore a lock mechanism activated by linear actuators is used. Once the specimen is brought to the required angle, linear actuators push the perforated parts to lock the specimen holder. After the shot, linear actuators disengage the lock mechanism so the target can be rotated again.

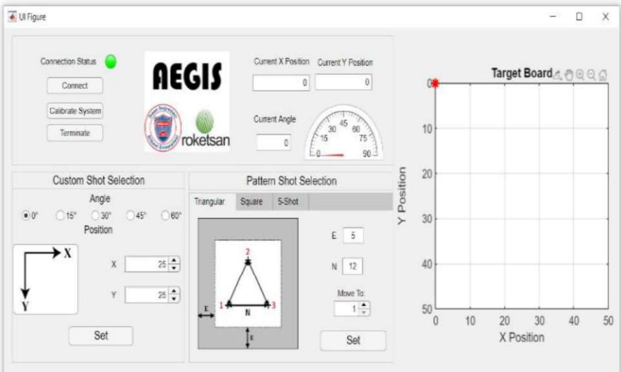

Figure 5: Matlab GUI of the Target System

The control of the motors and thus the position of the specimen before shooting is arranged by the experimenter by using the prepared Matlab GUI. After the angle, x-y position and shooting pattern is selected in GUI motors move accordingly. The motion of the motors are observed on the current position and current angle parts on the GUI. Also the position of the target is demonstrated by using the coordinate grids to see where it corresponds in the actual specimen.

Mobile Robots Performing Specific Tasks With Humans Using Common Intelligence

FOLLOW ME (5)

Left to Right: Alptuğ Kaan Hasçelik, Emre Kurtulmaz, Muhammad Tamim Akhtar, Muhammad Fahad Ejaz, Osama Zahid, Syed. M Haris Ali, Noman Ali

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Industrial Advisor : Bilge Kaan Görür and Muhammad Yüksel
Teaching Assistant : Osman Berkay Şahinoğlu

ABSTRACT

The purpose of this project is to create a self-driving 'mule' robot, which will carry the payload of a single soldier. The robot would make the soldier agile by carrying some of the equipment that the soldier would have to carry otherwise. The autonomous vehicle designed tracks the soldier and follows it while avoiding the obstacles in its path. The project was divided into three areas: mechanical (includes the drive type, chassis and wheels), electronic (sensors, batteries and the motors used) and programming (algorithms and codes for tracking and following human). The components, such as Lidar, Raspberry pi that are bought in accordance with the concepts selected as well as the basic circuit diagram of the vehicle and the possible codes to implement the algorithms discussed. The report also details the analysis performed for the selection of the motor, calculating the maximum rpm as 105 and the maximum torque on each motor as 2.0 Nm, which are then used to calculate the power requirement of the robot as 44 Watts, and thus outlining the requirements of the battery to be used.

Problem Definition

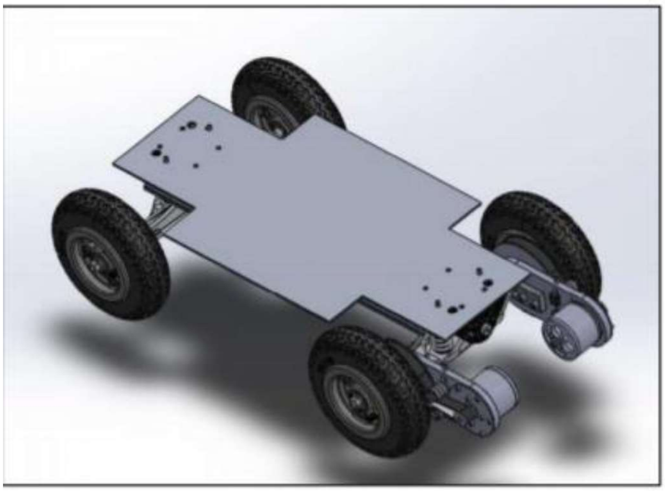


Figure 1: SolidWorks Model[1].

It is the aim of every military to become technologically advanced and up-to-date as far as weaponry and equipment is concerned. The military's aim is to delegate as many tasks of the military personnel to machines. In the modern era, robots are increasingly being used for various purposes. Robotics is being integrated into various departments of the military. The purpose of this project is to design a robot which will perform basic tasks for the soldiers.

With the current boost in technology, the limit to how advantageous a soldier is compared to others is based on how many supplies he has and rushing supplies over to a soldier can prove to be dangerous, as well as expensive. The need of carrying supplies and essentials for soldiers proves to be quite overwhelming. It is a challenge for soldiers to carry large amount of weights which includes gear, armor and medical supplies. Specialized soldiers have to carry an even larger weight which harms them in a couple of ways: it slows them down and leads to long-term chronic back pain. Therefore, the main aim of this project is to design a robot that will follow soldiers and specialized personnel.

There are multiple reasons why the design of this robot solves a couple of problems. The currently existing solutions are: to transport the weapons, equipment and first aid material, currently Squad Multipurpose Equipment Transport (SMET) vehicles are being used. However, they carry the material for the entire squad of infantry soldiers and they are not efficient to transport goods related to an individual. This is where the robots come in handy as they are quick and can carry personalized goods according to the needs and requirements. For instance, one robot will carry

first-aid and will follow the assigned soldier, which means the soldiers can focus more on tasks which directly require their expertise. This is where the robot can solve the problem of following its soldier and carrying his material without putting any sort of burden on the military personnel.

Design

Figure 2: Mechanical Design of the robot

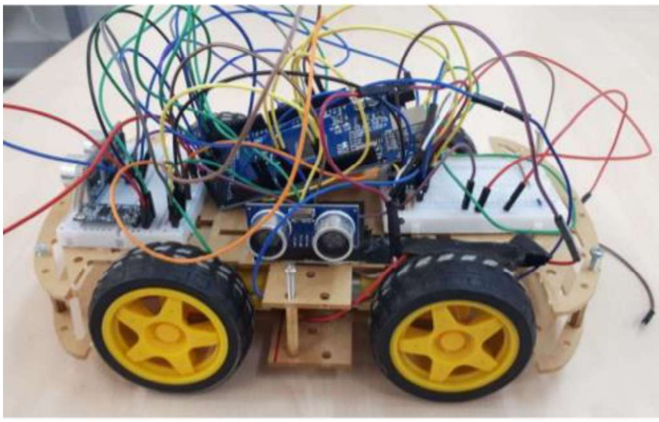


Figure 3: Prototype for Obstacle Avoidance

The aluminum chassis was manufactured in the dimensions to fit the available design of the suspension, wheels and the motors. To increase the strength of the chassis, sigma profile was screwed using screws and T-nuts at the bottom of the plate. The top of the chassis would carry a plastic box where the payload of 10 kg will be kept. However, in the testing it was found that for a payload of 25kg, the maximum deformation of the chassis was only 0.181 mm. The motors were positioned outwards to protect them from uneven surfaces and also to allow the robot to climb up an inclined surface. The combined length of the Aluminum 6064-T4 chassis is 600 mm. The width and thickness is 300 mm and 3 mm respectively. The extrusion at the ends was to place the sensors, microcontrollers, camera, LiDAR, power banks etc. The diameter of the wheels used in the design is 200 mm.

For tracking of the soldier, the robot makes use of GPS readings and a camera when the human is within the range. GPS coordinates are sent using HC-12 Radio Frequency Modules which have a range of 1 kilometer. For the camera tracking system, an image detection model using PyTorch is used and image processing is done using Raspberry Pi. The GPS modules used are Adafruit Ultimate GPS Breakout and a Neo-6M. To create a link. between the transmitter and the robot, two HC-12 RF Modules were used. To align the robot with each turn, HMC5883L compass is used. The robot is driven using brushless Trampa motors which are controlled using an ESC.

For the obstacle avoidance, ultrasonic sensors were used (as shown by the prototype in Figure 3). The algorithms used were potential field algorithm, which makes use of two forces. The first force is the attractive force which increases as the robot moves further away from the person. The second force is the repulsive force which increases as the object gets closer to a robot and there is a need for the robot to be directed away from the obstacles. Both of them are combined to create a potential function for each cell. The robot also makes use of the bubble rebound algorithm in which the obstacle density near the robot is detected. The robot moves in the direction with lesser obstacle density, until it gets within the view of the goal. At this point, the robot starts moving towards the goal again. The ultrasonic sensors are placed at 45° intervals. This sums up the complete design of the mobile robot.

Design of a Cold Gas Manifold with Four Selectable Nozzles

Project Nova (6)

Project Nova Team (From Left to Right):

Elruz Rahimli, Rufat Mammadov, Kardelen Şenyurt, Yavuz Koray Özbay, Seyfullah Orhan, Mohammad Haris Afzal

Academic Advisor : Assoc. Prof. Dr. Barbaros Çetin
Industrial Advisor : Ayşegül Tarçın and Nuri Altürk
Teaching Assistant : Alper Topuz

ABSTRACT

The objective of this project is to present the selected concept for a cold gas manifold system to be built in a restricted size and weight. The system requirements have been determined to be related to size, weight, pressure and response time. A thorough concept selection analysis led to the choice of the Poppet Valve design as the optimal design among several other alternatives. Thrust calculations in relation with the Mach number, inlet velocity of the gas and atmospheric pressure were conducted. This was followed by a comprehensive ANSYS Fluent analysis in order to ensure that the pressure drop across each channel is always within the allowable limit.

Introduction

Cold gas propulsion systems (CGPS) are widely used in space applications to provide translation and rotation in 3D space. They usually consist of pressurized gas propellant tank, flow control valves, and thrusters.

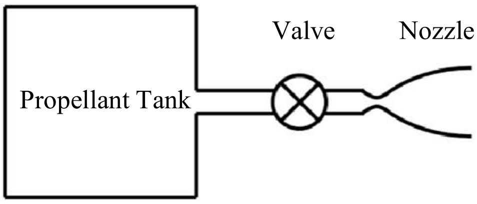


Figure 1: A typical CGPS [1]

The flow is controlled with the help of valves, which are activated upon request. In many space applications, such a system might need to be as small as half a meter [2]. In order to realize this specific design problem, a proper manifold system is required. The aim of the manifold system is to divert and control the gas flow by taking into account the stringent size and weight envelops. This project aims to build such a manifold system, not only according to the size and weight restrictions but also to thrust, pressure loss, response time and leakage predisposition.

Figure 2: Poppet Valve Design [2]

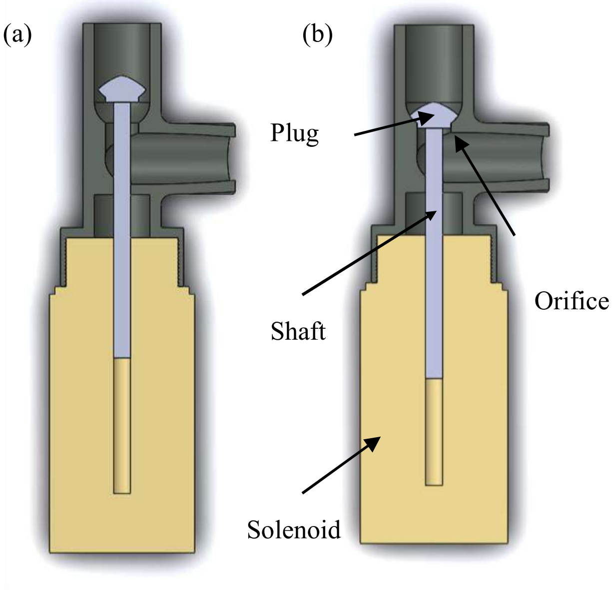


Figure 3: (a) Valve Open. (b) Valve Closed. [2]

Figure three demonstrates the working principle by focusing on one of the four T-pipes of the final design depicted on figure two, up close. The control system of the final assembly is activating the solenoid, whose shaft is connected to the plug. In active configuration, as seen in figure 3.a, the solenoid is energized and the plug is pushed upstream. The resulting orifice allows the flow to pass and contributes to the creation of the thrust at the nozzle. In the closed configuration, as seen in figure 3.b, the solenoid is de energized, which leads to the solenoid shaft being pulled backwards, in which case the plug returns to its seat. This procedure is designed to completely seal the orifice.

The main challenges of the project were related to ensuring the adequate amount of thrust generated given the specified weight, size, response time and pressure drop restrictions.

[1] J. Furumo, "Cold-gas Propulsion for Small Satellite Attitude Control , Station Keeping , and Deorbit", *Semantic Scholar*, 2013. [Accessed 31 May 2020].
[2] K. Özbay, R. Mammadov, K. Şenyurt, E. Rahimli, S. Orhan and H. Afzal, "ME481: Detailed Design", Bilkent University, Ankara, 2020.

Design

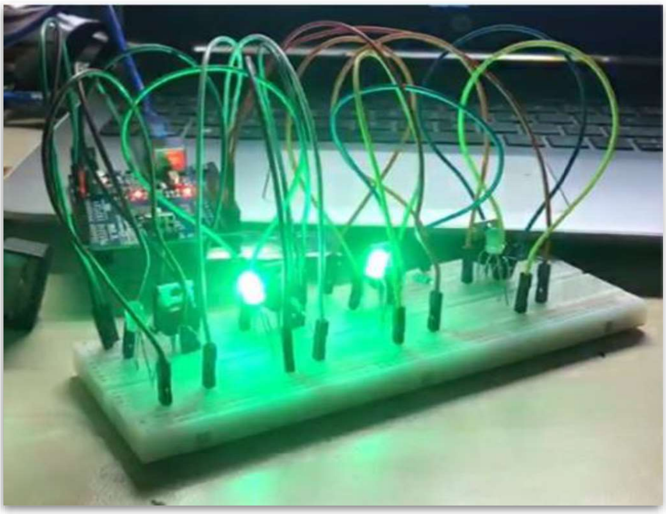


Figure 4: Control system testing with LEDs [3]

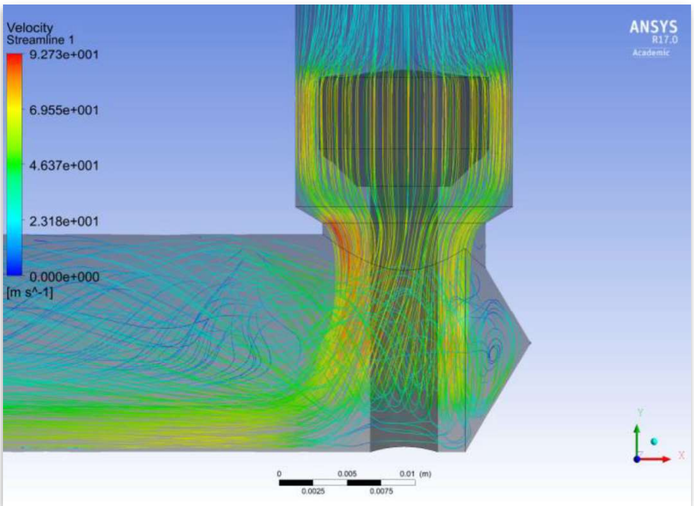


Figure 5: CFD simulations of the manifold [3]

The design stage of the prototype has been divided into multiple steps. First, our team has brainstormed and realized more than five different preliminary designs of the manifold. Different factors such as predisposition for leakage, fatigue, response time, weight and size were considered. After a thorough manufacturability evaluation, the final design was determined. A full digital assembly was realized with the help of SolidWorks. The preliminary engineering analysis has been developed with the use of the isentropic flow model. On the basis of the initial simulation, more complexities have been added to the final engineering analysis to accommodate for compressible flow and transient effects. All components were represented with their own technical drawings showcased in the detailed design report [2]. This has been done for the ease of the future manufacturing processes. A set of both 2D and 3D CFD simulations were conducted on ANSYS Fluent to determine if the design meets the requirements and constraints outlined in the introduction. The plug, which represents one of the most crucial components of the assembly has been tested a number of times with the help of CFD simulations. In accordance with the simulation results and recommendations from industry professionals, the plug has been optimized to ensure the consistent operation and required pressure drop emerging from flow disturbances. The simulations have given an insight into how the evolution of the flow affects the thrust generated. The calculated values were compared to the requirements, which led to design finalization. As part of prototyping, we have successfully built and tested the control system of the project. In order to validate the results, an experimental setup has been designed for any future consideration, if deemed necessary.

[3] K. Özbay, R. Mammadov, K. Şenyurt, E. Rahimli, S. Orhan and H. Afzal, "ME482: Progress Report I", Bilkent University, Ankara, 2020.

Remote Controlled Multi Launch Rocket Launcher Using Rifle Sight

Paint the Target (7)

Academic Advisor : Asst. Prof. Dr. Selim Hanay
Industrial Advisor : Hüseyin Avni Güner
Teaching Assistant : Emre Eraslan

ABSTRACT

The objective of the project is to design and develop a target marking system prototype that is integrated into the infantry rifle and can communicate with the rocket launcher wirelessly. This system enables rocket launchers to swiftly target on the enemy units via transmitted coordinates data from the rifle kit carried by infantry, so that it provides advantage to the military in terms of effectiveness and safety. Development of this system consists of literature survey, computer aided design of the system, analysis, simulations and manufacturing. Operational, physical and budgetary constraints have taken into consideration in the design process and essential codes and standards were used. This prototype is a preliminary study for Roketsan to develop a similar system in the future.

Introduction

In modern warfare, precision and speed are of great importance. When a fighter infantry is required to hit a target, the location of the target needs to be determined in a way that leaves almost no room for error. Also, action needs to be taken fast enough to meet the requirements of the fast-changing nature of the battle. After the location is determined, the rockets must be launched in the same fast and precise manner. Besides, when the field is an urban warfare, it has complicating factors such as the presence of civilians and the complexity of the urban terrain because of the buildings. Fighting in urban areas poses a high risk for heavy artilleries which are easily targeted because of their size. Ambushes laid down by small groups of soldiers with handheld anti-tank weapons can effectively destroy them. Therefore this kind of battlefield allows the military forces to only combat with infantry rifles.

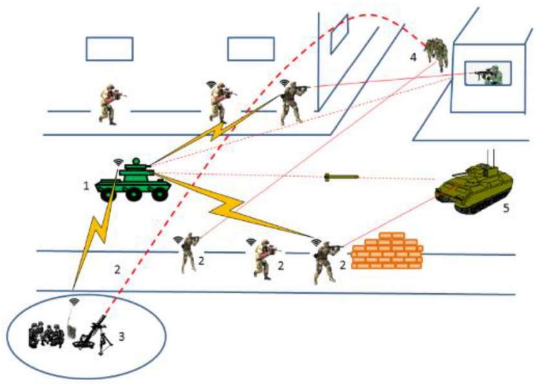


Figure 1: Urban Warfare Depiction

Currently, an infantry called "forward observer" scouts the enemy territory and uses heavy and bulky distance finding gears to determine the distance of the important locations. Then, via radio, sends the distance data to "fire control center" which consists of personnel who calculate the target coordinates from distance information. Then the fire control center sends signals to artillery units who prepare the aiming. This solution has some problems since their set up process takes too much time due to heavy gears and this makes the observer, who stays in the field, an open target. Also, too many personnel are working for this artillery fire support scheme and more personnel comes with more uncertainty in calculations and firing.

Figure 2: Current target location detection system [1]

This project aims to create a target acquisition system that can determine the coordinates of the target with a single push to a certain button; and to develop multi-rocket launcher cradle that are locatable at a strategic point off-site where they can shoot the targets, by working integrated with the target acquisition system to aim towards the target swiftly and accurately. The target acquisition system carried by infantries, is mounted onto a rifle, which is making it hard to notice and easy to carry. Thus, without bringing ammunition to the battlefield, target detection and elimination can be accomplished only with infantries. By implementation of this system, casualty rate of infantries during operations are expected to reduce significantly.

[1] *I. Bilekli, "ibrahim bilekli (@ibrahimbilekli) | "Twitter. [Online]. Available: https://twitter.com/ibrahimbilekli?lang=ar. [Accessed: 01-Dec-2019].

Design

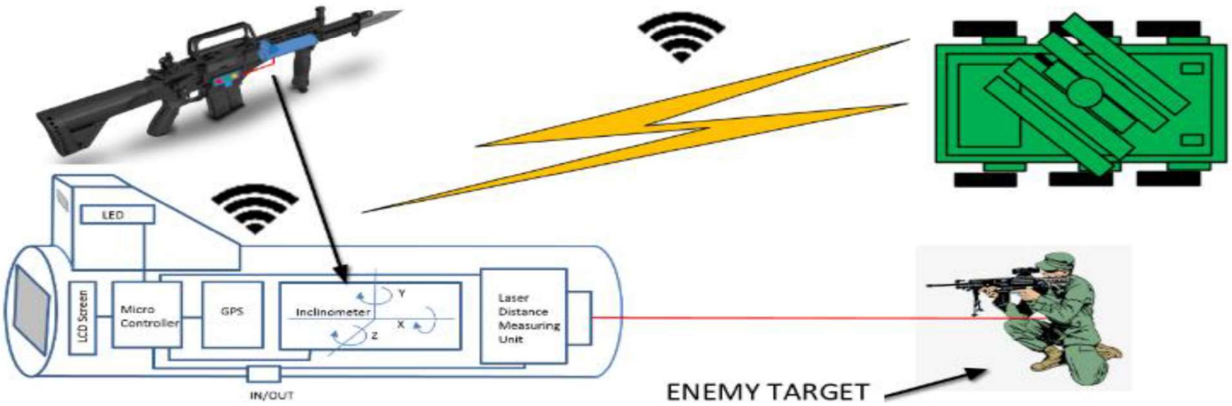


Figure 3: Target Acquisition Kit – Cradle Communication

The system’s working principle is as follows: using the laser and inclinometer of the infantry marking system will calculate the location of the target. Location information will be transmitted wirelessly to the rocket launcher and after the rocket launcher system has made the necessary calculations, it will be directed towards the target. Meanwhile, live stream of the camera on the rocket launcher will be broadcasted wirelessly on the commander's tablet responsible for the shooting order. Fire order will be given by the commander via the tablet, so that a possible error in the direction of the rocket launcher can be corrected in this step. The design stage of the proposed enhancement consists of the design of the the rifle kit part, which determines the coordinates of the target and the design of the cradle, which aims rocket-launchers towards to the target.

Rifle Kit Design

Rifle kit consist of inclinometer sensor, GPS module and LIDAR distance sensor Raspberry Pi single-board computer, Arduino Nano for slave subsystems, small OLED screen and membrane button set. Its computer uses ROS to parallel processing the sensor data and Kalman filters to reduce the noise. It has a 3D PLA casing compatible for MPT-76 rifles.

Cradle Design

The cradle mechanism provides rotation of rocket launchers in 2 axis. Precision is the most crucial factor for the system, so the stepper motors with encoders and gear reducers connected to them, the cradle can achieve rotation with 1 artillery mil precision.

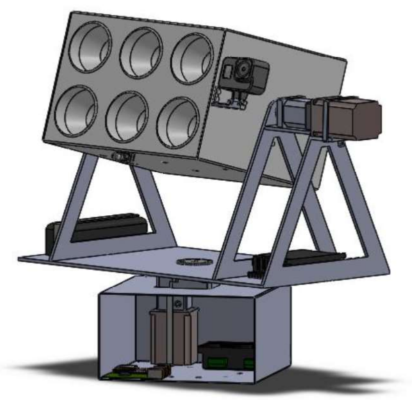
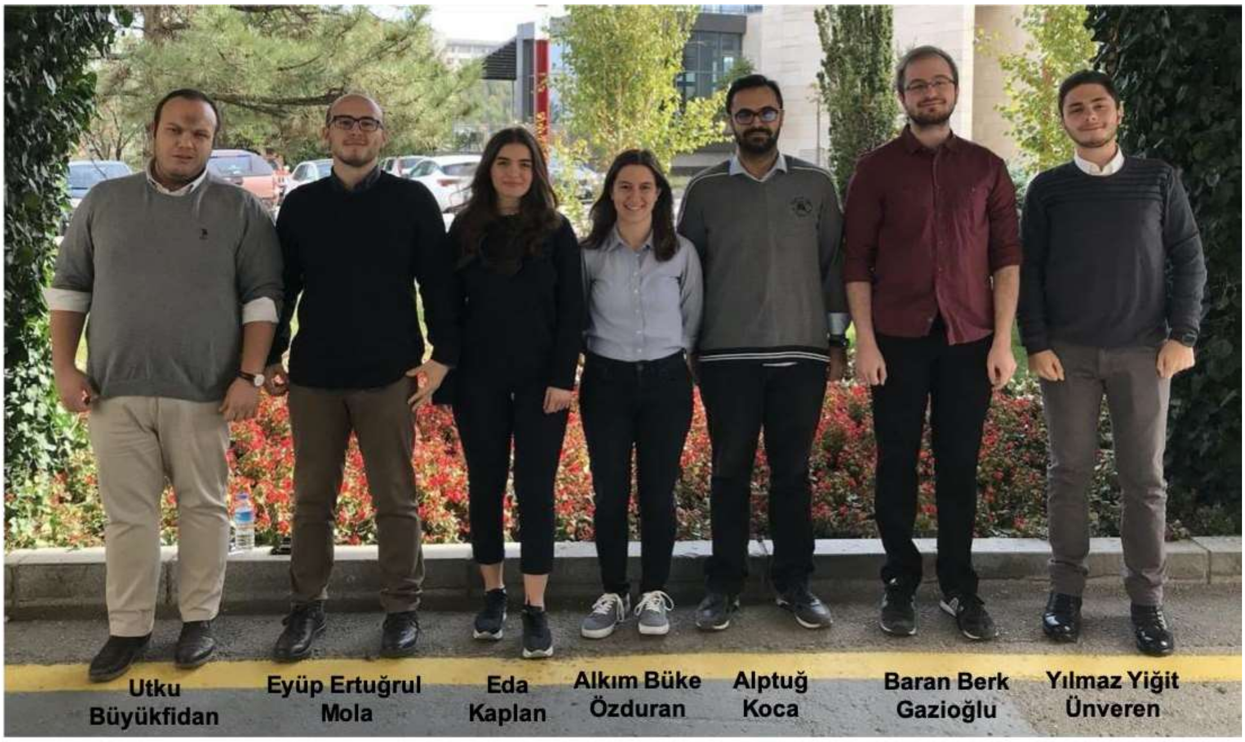


Figure 4 : Cradle Design

The cradle also contains Raspberry microcontroller to receive data wirelessly and to process, camera for broadcasting to the tablet, a laser pointer for aiming on the target and a GPS module to get coordinate data.

Design and Production of an Active or Semi-Active Isolation System for Missile Avionics

AntiNodes (8)



Academic Advisor : Asst. Prof. Dr. Onur Özcan
Industrial Advisor : Esra Gözde Yalçın Yıldırım
Mümtaz Afşın Esi
Teaching Assistant : Osman Berkay Şahinoğlu

ABSTRACT

The aim of this project is to design and produce an active or semi-active vibration isolation system for missile avionics. In a missile's avionics system, the inertial measurement unit is used to take measurements concerning speed, direction and acceleration. The inertial measurement units are hardwired to the outer body of the missile, which results in the structural vibrations in the body to cause defects in the measurement taken by the inertial measurement unit. The project aims to isolate the internal measurement unit of the missile from the mechanical structural vibrations of the missile body between 30-180 Hz. The solution product is a Stewart platform based semi-active vibration isolation system. Since the serially connected semi-active vibration isolation system can reduce the required stroke distance and speed of the actuators, this type of an isolation mechanism was chosen. The proposed solution of the project is to design a mechanical filter to eliminate these defects in the measurements taken by the inertial measurement unit that is a result of unwanted structural vibrations.

Problem Definition

Vibration isolation has a crucial impact on designing a system in order to make them work safely and reliably during their transport and operational cycles. More importantly, vibrations exert their own accelerations on the body, interfering with the acceleration-based sensors connected to the guidance computer. Occurrence of vibrations, especially in amplification region frequencies may cause a fluctuation on measured data, causing critical errors in the guidance response.

Missiles are composed of primarily three parts which can be sorted as propulsion and control surface assemblies, guidance and warhead section which includes avionics of missile and lastly radome or control unit. Particularly, avionic systems of a missile contain Inertial Measurement Unit (IMU) which has multi DOF motion and 6-axis accelerometer sensors. Data that is collected by IMU is transferred to the navigation controller.

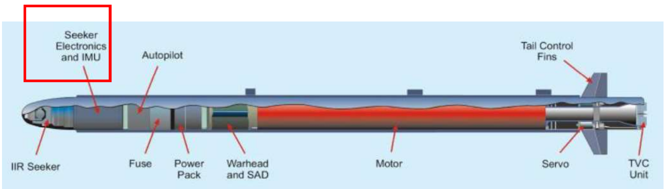


Figure 1: General Structure of the Missile [1].

Like all structures that are dynamical, missile bodies are affected by their structural vibration. Therefore, they propagate structural vibration in the 30 Hz to 180 Hz frequency range. Aforementioned structural vibration disrupts the data input of guidance IMUs, which leads to errors in measurements.

Figure 2: Honeywell HG1700-SG IMU [2].

When hardwired to the missile body, the navigation computer filters these vibrations in a signal domain; yet isolating the vibrations themselves in mechanical domain eliminates both the physical factors of deformities and the sensory vibration input exerted on sensitive equipment. In addition to the main problem, isolation of the structural vibration of a missile, due to limited free space in it, the dimensions of the system is another constraint.

In terms of operation, the system needs to be a multi DOF vibration isolation system and the frequency range is between 30 and 180 Hertz. The system must also be a fast response system since the structural vibrations of the missiles are in high frequency. The exact dimensions of the solution product are defined by Roketsan.

The solution product will be subjected to MIL-STD-810 G standard. This standard is the Department of Defense Test Method Standard which is used for Environmental Engineering Considerations and Laboratory.

[1] "Dmitry Shulgin | Air Force | Modern Weapons | Page 178," Available:http://www.dmitryshulgin.com/author/wagner666/page/178/. [Accessed: 21-Dec-2019].
[2] G1700 Inertial Measurement Unit", *Aerospace.honeywell.com*, 2019. [Online]. Available: https://aerospace.honeywell.com/en/learn/products/sensors/hg1700-inertial-measurement-unit. [Accessed: 13-Oct-2019].

Design

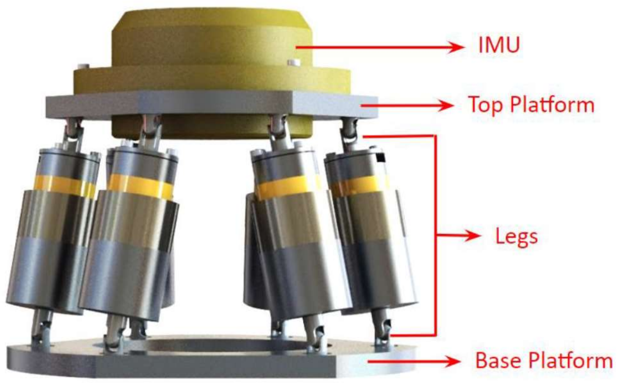


Figure : 3D Model of the System

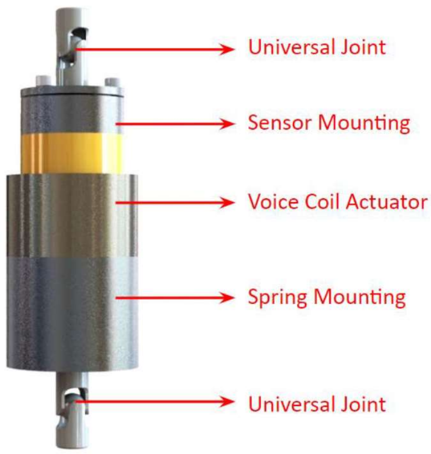


Figure : 3D Model of the Leg Subsystem

The design of the system was finalized as a 6 DOF system that relies on the concept of a Stewart Platform design to provide the necessary DOF. The system is composed of a top platform, where the IMU is housed, 6 legs and a base platform. The system was designed based on a number of concepts, measurements and calculations such as inverse kinematics of the geometry and modeling a 1 DOF system that reflected the model of the 6 DOF system.

Each leg of the system are connected to the top platform and base platforms at each end of the leg using universal joints that provide two angular degrees of freedom. At the top end of the leg, there is a sensor mounting where the Force Sensitive Resistor (FSR) is placed. Beneath the sensor mounting, the voice coil actuator, which provides the motion of the leg as needed, is placed. At the base end of the leg, there is a spring mounting which houses a specially designed spring for the passive isolation part of the system.

Outcomes

This system is a mechanical design project that combines the mechanical engineering knowledge acquired at dynamics, control systems and mechatronics courses. It is done in several steps through the 2019-2020 academic year given as below:

- Literature research
- Determination of sub-systems according to requirements provided by ROKETSAN
- Engineering analysis including:
  - 1DOF/6 DOF System modeling
  - Control system construction and analysis
  - Mathematical modeling
  - Inverse kinematics analysis
  - Frequency response analysis
- CAD drawings
- Safety Analysis
- Planning of manufacturing processes, assembly, design verification and testing of the system

Development of a 4 Wheel Active Suspension Drive and 4 Wheel Steering Ground Vehicle Prototype

Bilkenter Maschinenbau Werke (9)

Vehbi Kerem Keykan| Baran Sinan Keykan| Batuhan Emre Kaynak| Erkin Karatas |Ekim Ekiz |Gürkan Demirkoparan
Dr. Melih Çakmakcı

Academic Advisor : Asst. Prof. Dr. Melih Çakmakcı
Industrial Advisor : Asst. Prof. Dr. Melih Çakmakcı
Teaching Assistant : Ali Kerem Erdem

ABSTRACT

The aim of this project is to design and prototype a scaled ground vehicle with 4 wheel active suspension, 4 wheel independent driving and steering done by electric motors, which will be suitable to run with various control algorithms to simulate different driving scenarios and conditions with an aim to test the dynamic responses of different configurations of vehicles and different control algorithms at low cost. The design is made of four quarter car systems assembled together on a chassis. Each quarter car system has independent steering, suspension and driving systems that enable the four wheel steering, active suspension and four wheel drive functionalities. The project is conducted in cooperation with the Bilkent Mechanical Engineering Department and supported by Tubitak.

Introduction

The automotive industry has been and continues to be among the world's leading sectors with major influence over the global economy. Through just 2018, 78.6 million cars were sold worldwide [1]. Commensurate with the scale of demand, the race for coming up with the best new technologies is progressing rapidly. The technologies that are in research and development pave the way to the future success of the car manufacturers. Companies need to supply the customer with new and innovative designs to catch their attention in an overly saturated industry. The R&D departments need testing systems that can fulfill their changing needs during development. Though there are high-scale testing systems available for the industry giants, no commercially available solutions exist for smaller parties or researchers. The currently available test rigs are too costly and difficult for smaller parties to implement. Another drawback of the available test rigs is their scale. They are much harder to manufacture and require large testing areas that are not readily available. There are no current solutions that provide much needed advantages like low cost, ease of manufacture and access, portability and customizability.

Figure 1: Vehicle Scaled Up Front View

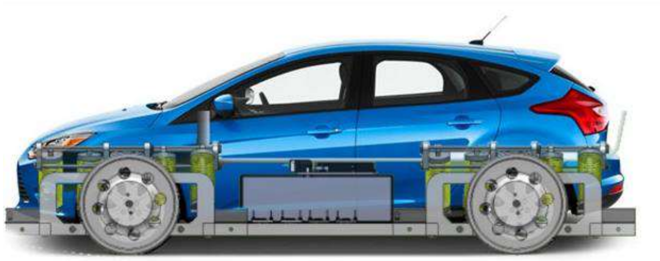


Figure 2: Vehicle Scaled Up Side View

Acquiring these advantages would speed up the R&D phases of new technologies, making the researchers and companies jobs easier. This project aims to achieve these by designing and prototyping a new test rig that is a modular, customizable, wirelessly real time controlled, scaled ground vehicle with 4 wheel active suspension, 4 wheel independent driving and steering done by electric motors, which will be suitable to run with various control algorithms to simulate different driving scenarios and conditions, with an aim to test the dynamic responses of different configurations of vehicles and different control algorithms at low cost.

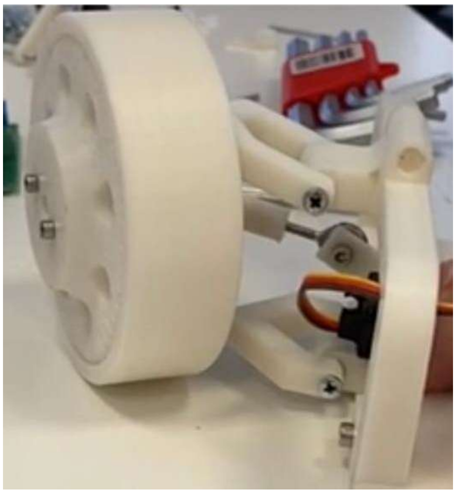


Figure 3: Manufactured and Assembled Quarter Car with Steering System

[1]"Global car sales 1990-2019," Statista. [Online]. Available: https://www.statista.com/statistics/200002/international-car-sales-since-1990/. [Accessed: 15-May-2019].

Design

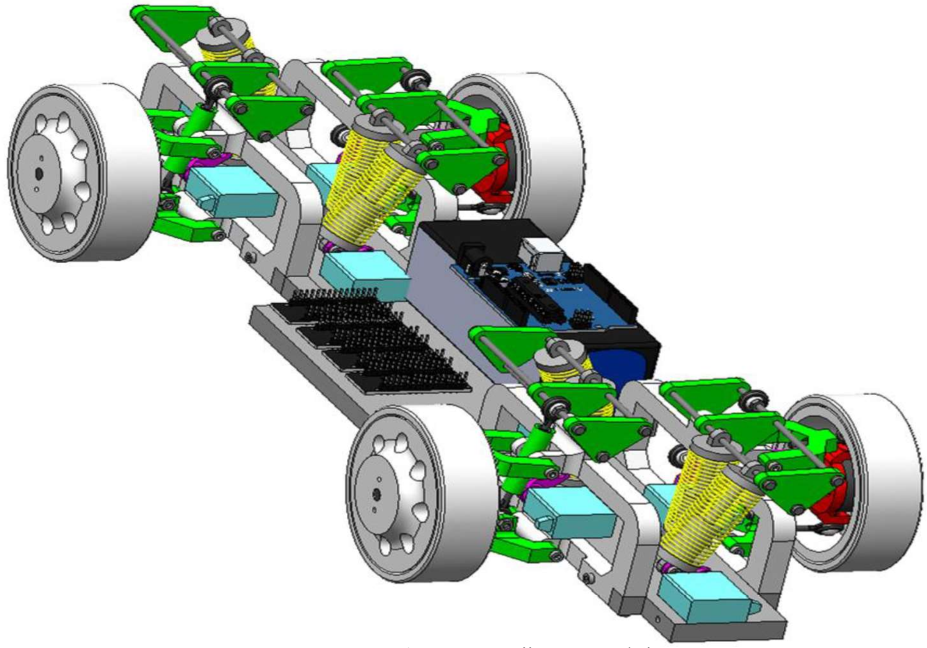


Figure 4: Full Car Model

The design of the project consists of four identical quarter car models conjoined together on the chassis of the vehicle. The quarter car model is designed to consist of a active suspension system, a steering system and a drive system. However, due to the circumstances brought by Covid-19, the full prototype wasn't realized, and the active suspension system was not able to be implemented. The proposed active suspension system has a double wishbone design. It uses a pushrod suspension actuation, where the upward motion of the suspension is transmitted through the cantilever onto the pushrod. A servo actuator is mounted on the pushrod arm to allow for the active manipulation of the suspension. The steering system has four servo motors, actuating the wheels separately, allowing the independent steering of the vehicle. To allow for the four wheel drive, separate electric motors are used in a hub motor design that eliminates the need for an intermediate power transmission system.

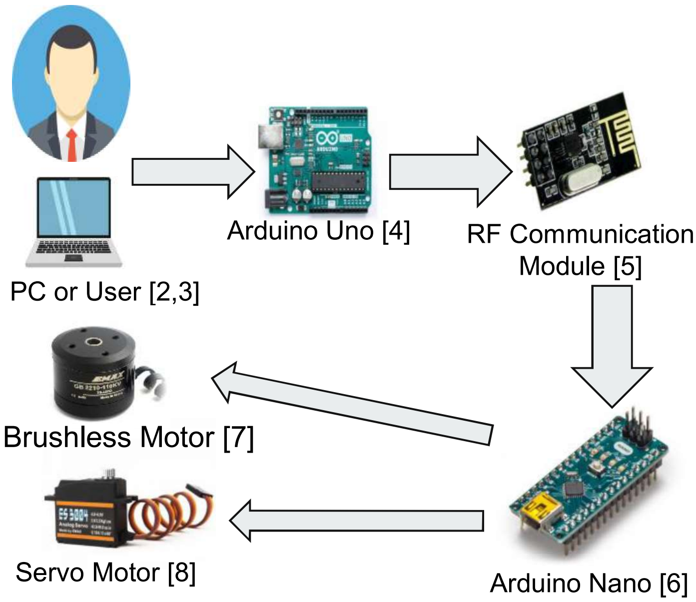


Figure 5: Schematic of Actuator Control Interface

Four Arduino Nanos are connected to an Arduino Uno, which is controlled via computer are used for the controlling the four quarters. A six degree of freedom acceleration sensor is used to gather motion data.

[2]"Avatar Icon Transparent & PNG Clipart Free Download," YWD. [Online]. Available: https://ya-webdesign.com/explore/avatar-png-icon/. [Accessed: 11-May-2020].
[3] "Laptop PNG, Notebook, Computer PNG Images, Vectors, Clipart For Free," Pngtree. [Online]. Available: https://pngtree.com/free-png-vectors/laptop. [Accessed: 11-May-2020].
[4}"Buy Original Arduino UNO R3 with cheap price," https://www.robotistan.com/. [Online]. Available: https://www.robotistan.com/orjiginal-arduino-uno-r3-new-version. [Accessed: 11-May-2020].
[5]"Wireless NRF24L01 2.4 GHz Transceiver Modül - 2.4 GHz Alıcı Verici Modül Satın Al," https://www.robotistan.com/. [Online]. Available: https://www.robotistan.com/wireless-nrf24l01-24ghz-transceiver-modul-24ghz-alici-verici-modul-1. [Accessed: 11-May-2020].
[6]"Arduino Nano (Orijinal): SAMM Market," https://market.samm.com/. [Online]. Available: https://market.samm.com/arduino-nano-orijinal. [Accessed: 11-May-2020].
[7]*"Skywalker 12A Esc Fırçasız Motor Hız Kontrol Sürücü Devresi Uygun Fiyatıyla Satın Al - Direnc.net®," https://www.direnc.net/. [Online]. Available: https://www.direnc.net/skywalker-12a-esc-fircasiz-motor-hiz-kontrol-surucu-devresi. [Accessed: 11-May-2020].*
[8]"EMAX ES3004 17g 3.5kg 0.13sec 23T Metal Gear Analog Servo For RC Airplane ES3104 upgrade," Home - Emaxmodel.com-R/C Store. [Online]. Available: https://emaxmodel.com/es3004.html. [Accessed: 11-May-2020].

SMALL-SCALE AUTONOMUS LEVELING MECHANISM

BamBoost (10)

Academic Advisor : Asst. Prof. Dr. Yegan Erdem Ercan
Industrial Advisor : Görkem Akgül
Teaching Assistant : Ahmet Furkan Güç

ABSTRACT

The project's main goal is to design and manufacture an autonomous leveling mechanism to eliminate the involvement of an operator in adjusting small-scale objects. Today, TAF (Turkish Armed Forces) uses a manual leveling mechanism to use the radars properly, which require a leveled reference plane to work. Hence, the autonomation of the process is necessary to eliminate human errors and to protect the operator in the combat zones. In order to achieve this requirement, a two degrees of freedom motion platform that is autotomized using a Raspberry Pi is designed and manufactured. Throughout this booklet, the working principle and design concepts of the "Small Scale Autonomous Levelling System" are explained briefly.

Introduction

Problem Definition

This leveling project arises out of the fact that there is a requirement of a reference plane for mechanisms such as radars and electro-optic devices to work correctly. A leveling mechanism provides movement across one or more degrees of freedom to eliminate the effects of the terrain's slope and make the payload parallel to the sea level. Such a mechanism that can move in pitch and roll directions to eliminate the current slope can be seen in Figure 2. Especially on inclined and uneven terrains where military operations take place, leveling becomes a critical issue.

Leveling the radar mechanism can be achieved in two ways: leveling the entire vehicle or leveling only the radar by using a small-scale mechanism. Since leveling the entire armored vehicle will be less reliable and time-consuming, with a small scale leveling, it is more logical, fast, efficient, and consistent.

Figure 1: A Manual Leveling Mechanism [1].

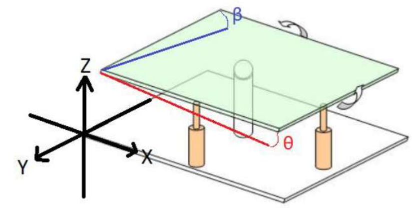


Figure 2: A 2DOF Leveling Mechanism [2].

Manual systems such as leveling the mechanism by hand require human involvement, which makes the operation time consuming and unreliable. Besides these disadvantages, manual applications in military operations may endanger the operator's life because the operator must get out of the vehicle to set up the system. An autonomous system should be integrated into the leveling mechanism to minimize all these problems about manual leveling. Today, ASELSAN uses a manual system that consists of a worm gear system to adjust the radars.

The problem with the existing system is that, as leveling is done manually, the difficulties of manual leveling systems mentioned above are encountered. Therefore, the project aims to design and manufacture a small-scale autonomous mechanism, which will decrease the problems and will provide a flat surface in a short time for military operations. To achieve the project, the leveling mechanism should control the reference plane by checking instant changes in the terrain's slope. Even there are several leveling mechanisms in the market; they do not meet the criteria and requirements because of the lack of autonomous control. For this reason, we have designed and manufactured an autonomous leveling mechanism as a project.

[1] https://www.youtube.com/watch?v=aZ1nI3YPQhg
[2] http://www.simprojects.nl/motion_systems.htm

Design

Figure 3: 3D Render and Real-World Image of the System

Our leveling mechanism has two different parts: the mechanic part and the electronic part. The mechanic part of the mechanism consists from a bottom platform that is placed on the reference surface and holds every component together, a top platform that has an interface to connect to the payload, joints that are used to ensure that the system has exactly two degrees of freedom and two linear actuators that are used to actuate the top platform in roll and pitch directions. Our electronic part consists of four different parts: a Raspberry Pi 4 which acts as the central controller for the system, a software that is primarily written in Python and JavaScript that runs on the Raspberry Pi, a MEMS-based inclinometer that is used to measure the current inclination angle of the top platform, and lastly, two motor controllers are used to control the linear actuators based on the signal coming from the Raspberry Pi.

While the system has a manual control mode in which the system can be operated using a gamepad, the system's actual working mode is the autonomous mode. In this mode, the user enters a target inclination angles using the GUI. After this, the system forms a feedback loop to ensure that the top platform is at the target angle. In this feedback loop, first, the current angle deviation is measured, and whether it is in the range (-20°, 20°), which is the operation range of the system, is checked. If it is in the range, then the controller commands the linear actuators to change their elongation incrementally. After each incrementation, the angle is rechecked. This process continues until the deviation angle is within the range of (-0.5°, 0.5°), which can be tolerated. When the leveling process is finished, the user is alerted using the LED on the system, and through the GUI. Any errors and warnings that may occur during the operation are also shown to the user through the LED and the GUI.

MECHANICAL DETERGENT DISPENSER FOR DISHWASHERS

Hydra (11)

Main Academic Advisor: Dr. Şakir Baytaroğlu
Co-Academic Advisor: Prof. Dr. Ömer Anlağan
Industrial Advisor : Uğur Kan
Teaching Assistant : Ali Kerem Erdem

ABSTRACT

The project's main design problem is to create a mechanical system that would dispense a detergent (powder, tablet or liquid) during the main washing cycle of Arçelik dishwashers which are characterized by the upper spray arm rotating and the heating element increasing the temperature of the water. The design should e able to dispense the detergent by a specific change in one of these conditions. The current design depends on a change in the water pressure being directed to the dispenser. Through engineering analysis and actual prototype testing by installing the design inside an Arçelik dishwasher, potential problems were observed. The design was updated accordingly and the final design is presented in the in the following section.

Introduction

One of the main elements in a dishwasher is a dispensing system that releases a detergent (tablet/powder/liquid) during the main wash cycle. This detergent is used for creating 'foam' and it combines with hot circulating water to remove soil from the dishes. Arçelik is looking to develop a mechanical based system that can dispense these detergents as an alternative to the conventional electronic dispensers. The reason for this is that the conventional dispensers take up too much space, which could otherwise be used for adding more dishware as well as the circuitry for the electronic dispensers is costly to manufacture and install, and it also uses electricity which decreases the energy efficiency of the dishwasher as a whole. A mechanical based system that would trigger a dispensing mechanism and release the detergent into the circulating hot water is required by Arçelik and designed by our group which complying with dishwasher standards set by both national and international organizations.

There are various requirements to be fulfilled and various constraints to be followed in our detergent dispensing project. The most important requirement was the size of the dispenser which must be about 40,000 mm^3, about the size of a tablet detergent. Also there should not be any disruption of water supply from spray arms to the washing dishes due to the dispensing system. The detergent can be dispensed all at once or gradually during the main wash cycle. One of the important factors is the material choice and since the washing compartment operates with hot water at up to 70 °C circulating the detergent which consists of different chemicals, the material used should be inert and able to withstand high temperature so Polypropylene (PP), a 3-D manufacturable plastic polymer was chosen. [1]

Figure 1: Powder detergent placed in our dispenser

After considering these requirements, a prototype mechanism was designed and tested in a Arcelik dishwasher plant in Ankara. The tests involved changing different parameters such as temperature, pre-wash and main-wash cycle durations, various plate settings within the machine, pressure change settings within a certain range and also ergonomic usage and breakage tests. A transparent screen setup was installed in place of the front door of the dishwasher which allowed us to view the real working of our dispenser. Tests with and without any dishes were conducted and all the tests were performed with both powder and tablet detergent as was specified in the project requirements and constraints. Our design functioned perfectly in all the stages of the testing with a generic washing program that opened the flap at the required time. The test ensured that our geometry had enough space to allow sufficient water to enter and dissolve the tablet detergent even if an extreme setting was chosen. The design allowed the detergent to completely disappear within 20 minutes of the washing cycle which is well within range of the required time. Slight design modifications were made to address the issues faced during the testing phase of the design.

[1]"ISO 21305-1:2019,"ISO,01-Feb-2019.[Online].Available: https://www.iso.org/standard/70507.html. [Accessed: 11-Mar-2020].

Design

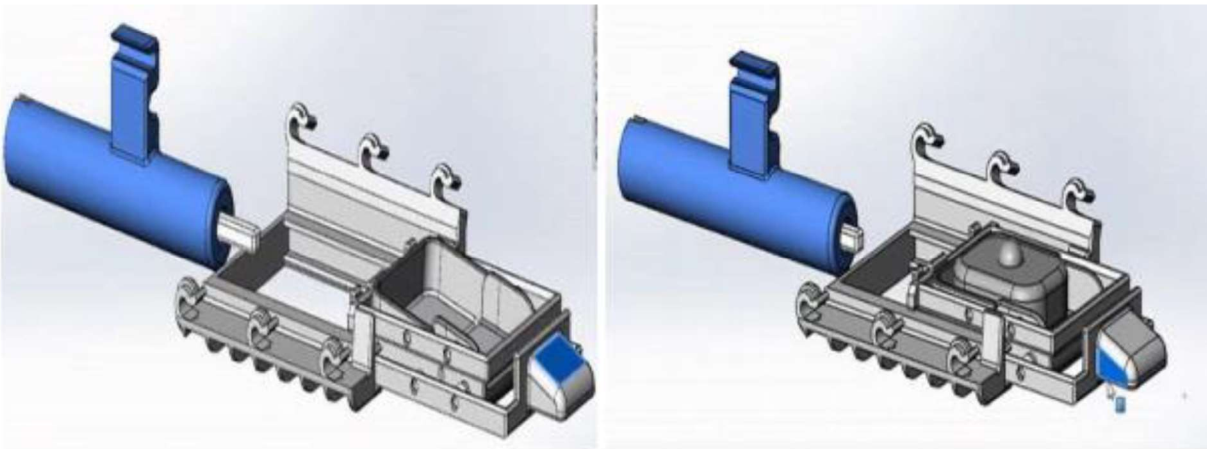


Figure 2: Detergent dispenser with and without the tablet detergent.

The working principle of the detergent dispenser is based on a water pressure-based mechanism that is defined by the main cycle starting. When the main cycle begins, the introduced water pressure is used to trigger an assembly of flaps, sliders, holders and other subcomponents that expose the detergent to circulating water from the spray arms, in the case of the tablet detergent. The continuously hitting water on the tablet eventually causes it to dissolve and trickle down into the system. In the case of the powder detergent, however, the fine granules slide down into the circulating water and the detergent is dispensed. An additional feature of the design is the holder that is used to easily pull and push the mechanism by the user.

The dispenser is installed into the dishwasher by using the holders to attach it on the basket. The user inserts the detergent (tablet or powder) into the dispenser after pulling it out into the open state and pushes it back. When the main cycle begins, a triggering pin will be linearly displaced and push the flaps so that they rotate and come into the open state (i.e. when the water from the arms can dissolve the tablet or cause the powder to fall). When the cycle is over the user will the see the dispenser in its open state and repeat the process again

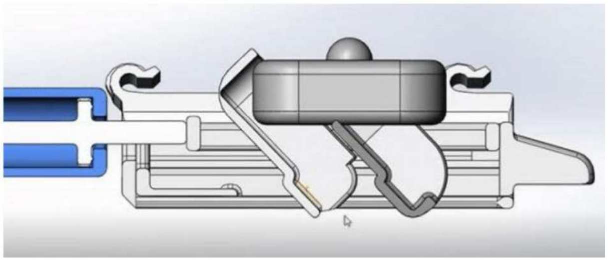
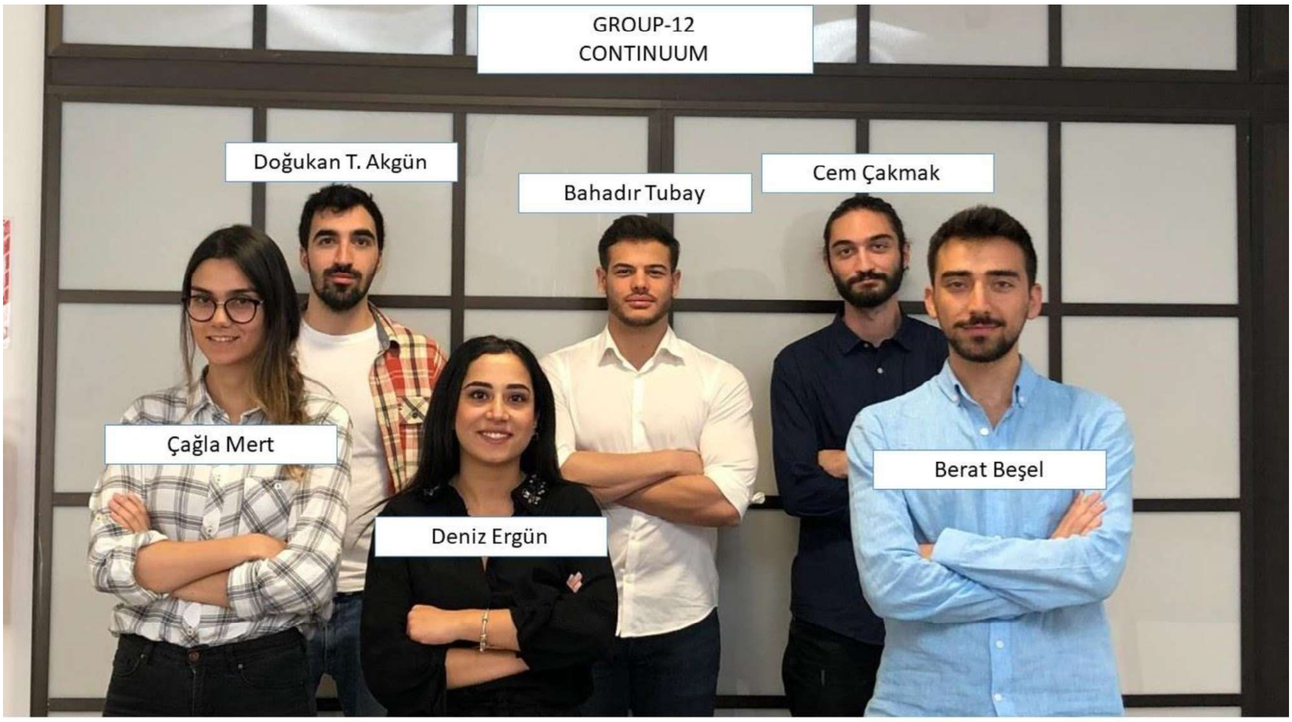


Figure 3: Section view of Design with flaps open

Figure 4: 3D print of assembly prototype

Automatic V Belt Drive Continuously Variable Transmission

Continuum (12)



Academic Advisor : Prof. Dr. Ömer Anlağan
Academic Advisor : Dr. Şakir Baytaroğlu
Industrial Advisor : Şamil Akaslan
Teaching Assistant : Emre Eraslan

ABSTRACT

This project aims to demonstrate how a Continuously Variable Transmission works and act as the prototype for further projects where this transmission system can be implemented on a lightweight vehicle such as a bicycle. Since the CVT systems found on the market are generally designed to be used in cars or industrial machines and do not allow for a clear demonstration; the concept should be modified to make it convenient for educational purposes and allow for an informative transmission system that is suitable to be used in a laboratory environment..

Introduction

The aim of this project is to design and manufacture a Continuous Variable Transmission bench for demonstration purposes which will be used in Bilkent University Mechanical Engineering Laboratories. Our design should consist designated features:

- Portable
- Self explanatory
- Adjustable
- User friendly
- Reliable
- Safe

Continuous Variable Transmission provides better power transmission performance and offers more efficient operations compared to manual and automatic transmission. CVT allows the engine to run at the rpm that produces the greatest power without restrictions on gear ratio. Also, it provides smoother driving experience. Therefore, usage of CVT would increase the performance of the engine and the vehicle.

Even though CVT was conceptualized and used back in 1879 on a saw milling engine, the use of this transmission system has become widespread only recently. Used mostly on motorcycles, snowmobiles, industrial machines as lathes and by several car manufacturers, it can be considered as a newly developing technology [1]. The demonstration of the transmission system will lead to further research and projects in the upcoming years where the system can be implemented on a bicycle or any other small vehicle. Considering the improvements in material properties to withstand larger torque values, the number of possible fields of application of CVTs continues to expand and this project will help to explain the main working principle of Continuously Variable Transmissions.

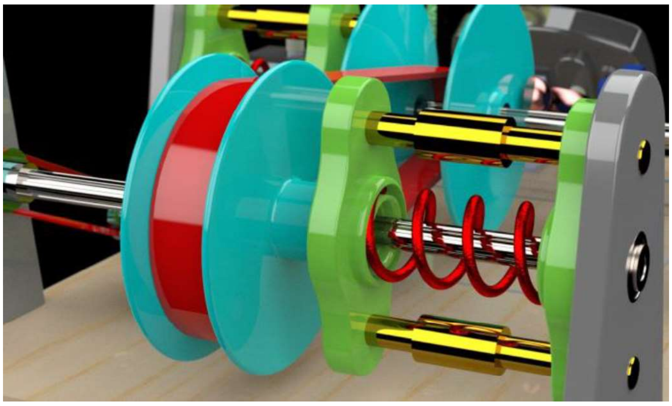


Figure 1: Input shaft

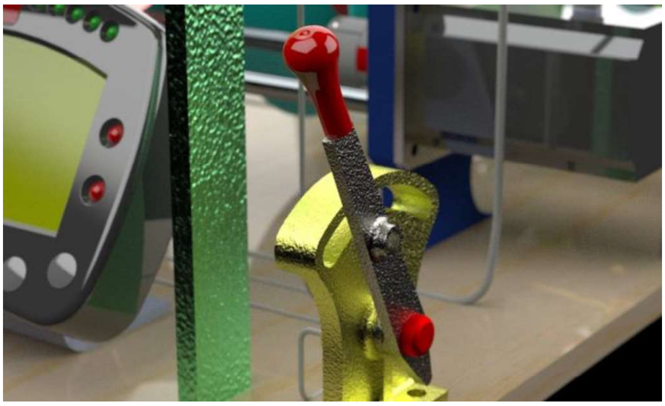


Figure 2: Gas lever

There are two major functions in our V-belt CVT system which are to transmit torque and speed from an engine to the output shaft and adjust the speed ratio. The risks on the system observed are listed below:

- CVT: cannot perform well to transmit torques and may not meet the slip conditions; components’ replacements needed
- Decrease of transmission efficiency: bad quality; noise, efficiency...
- V-belt: wear is dominant failure mode but replaceable item for low costs
- Wear of the roller
- Aging of the oil seal
- Wear between hub and bush of the driving pulley shaft
- Scratching of the sliding collar
- noise and shimmy of the system

[1] "Automatic Transmission vs CVT", *AAMCO Colorado*, 2018. [Online]. Available: https://www.aamcocolorado.com/automatic-transmission-cvt-which-is-right-for-me/. [Accessed: 17- Oct- 2019].

Design

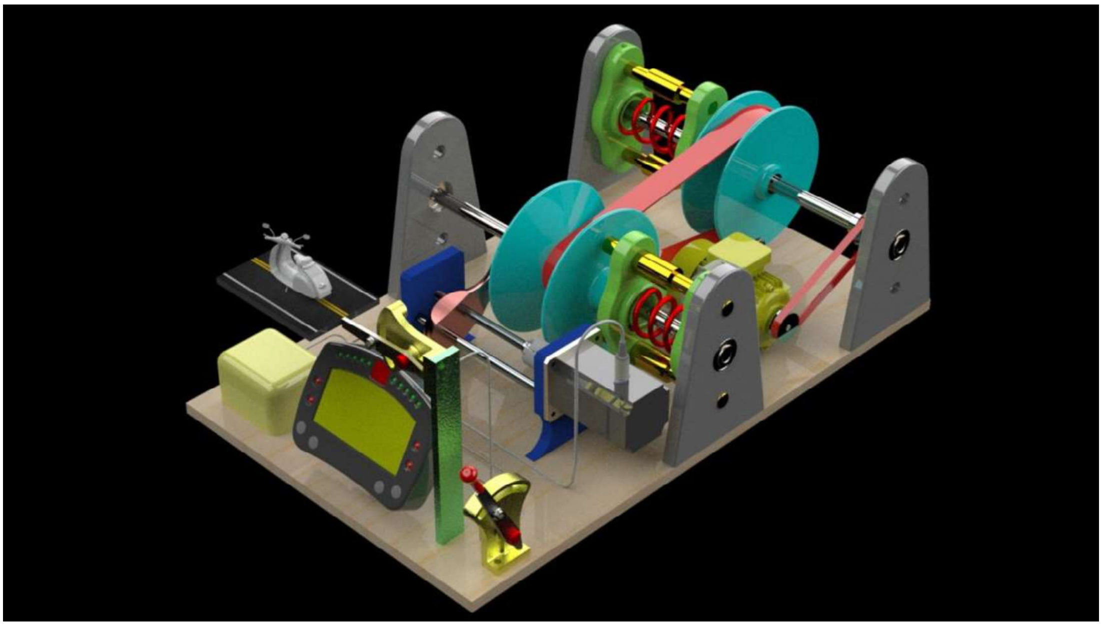


Figure 3: Whole system

- An input motor will drive the input shaft which represents the engine of a car.
- The motion will then be transferred to output shaft which represents the wheels of a car.
- A manual braking system with a handle will allow users to change the reaction torque by pulling the handle. This breaking mechanism represents an inclined road.
- The force created by the braking system will create a clamping force on the pulley and gear ratios will change. Changing gear ratios will change the angular velocities.
- Data acquisition and control unit allow users to monitor various parameters like RPM and control those parameters.
- Institution of Mechanical Engineering: Safety factor =>1.3 [2]. Our design has considerably more safety factor.
- Spring Loaded Pulley system was chosen as the most suitable option.
- Aluminum pulleys are produced by CNC machines with inner diameter of 60 mm, outer diameter of 200 mm.
- Market CVT springs are shortened on the size of the hole with spring constant of 700 N/m.
- Rubber V-Belt with 1000 mm long, 40 mm top width, 12.5 mm lower width, 20° angle, 5 mm thickness.
- Spline shaft and bush is used to prevent rotation between the shaft and the pulleys.
- Sigma profile is customized to be used as a base of the system.
- A DC motor is used to drive the pulley.
- Encoders are used to measure pulley rpm.
- Servo motor is used to control braking toughness.
- Potentiometers are used to control the braking and the speed of DC motor.
- LCD is used to display parameters.
- Button is used to turn the system on/off.

[2] J. Ji, J. Park, O. Kwon, M. Chai, D. Lee, and H. Kim, “Macroslip detection and clamping force control for a metal V-belt continuously variable transmission,” *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, vol. 228, no. 8, pp. 943–954, 2014.

Development of a Hunter Drone Platform

Game of Drones (13)

Left to right: (Bottom) Aayan Nusrat, Muhammad Khan (Top) Oğuzhan Öztürk, Kaan Aykol, Haritha Seddik, Arda Özcan

Academic Advisor : Asst. Prof. Dr. Selim Hanay
Industrial Advisors : İsmail Cem Türtük, Ceyhun Kelleci, İrfan Yıldız
Teaching Assistant : Osman Berkay Sahinoglu

ABSTRACT

The idea behind the project is to create a hunter drone with anti drone capabilities that could be used to protect sensitive areas from security threats and privacy breaches. The need for such technology arouse in the recent years due to the increase in the availability of various forms on unmanned aerial vehicles (drones). With the potential of causing harm to others without risking the users anonymity, drones have become a potential modern day weapon. The hunter drone will therefore carry a mechanism capable of neutralizing these threats. The mechanism consists of a gimbal that carries a pneumatic net gun. By employing object identification and tracking, the drone will be able to follow and subsequently neutralize its prey by entangling it in a net. The gimbal and its connections were designed so as to allow the onboard processing unit to be able to freely move it without compromising the strength of the design.

Introduction

Drone usage has become increasingly prevalent in today's world of technological advancements. This popularity has led to an increased misuse and spying/malicious activities threatening to public and private areas.

There are several countermeasure concepts employed in industry and this project actualizes a pneumatic net gun attached to a drone, regarding it as the most effective solution. This concept is chosen to be most capable due to:

- Its agility advantage over other solutions
- Allowance for neutralization of larger drones with a net release mechanism
- Effectiveness, range and cost advantage over radio frequency jammers

A net is propelled from its casing by an instant pneumatic pressure release from onboard tanks. Upon projection, the net opens up in the air and gets entangled with the target upon contact.

Upon detection of an intruding drone with standalone visual or electronic methods, the hunter drone will engage and intercept the last known location of the target. When the prey is within sight, the pilot will initiate the neutralization sequence. The image detection component will be used to autonomously recognize the prey.

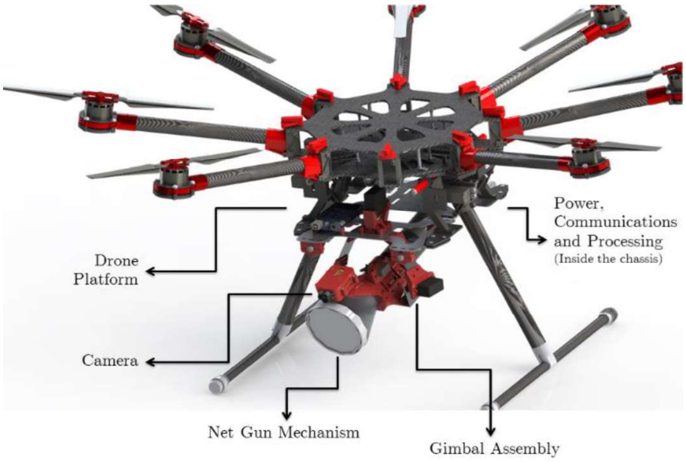


Figure 1: Assembly of the Hunter Drone

Image tracking code will actuate the gimbal and make sure that the target is always kept within the hitbox of the net gun. The pilot will maneuver the hunter drone so that it follows the path of the prey drone. When the target is within a range with a high probability of successful capture, the neutralizing mechanism will trigger, launching the net to the prey drone.

After the net has entangled the prey drone, its weight will either be carried by a connection on the hunter drones body which will carry it to base command. In the case that the weight exceeds the lift capacity of the drone, it will be released and allowed to fall.


Figure 2: Manufactured Gimbal Under the Hunter Drone

Design

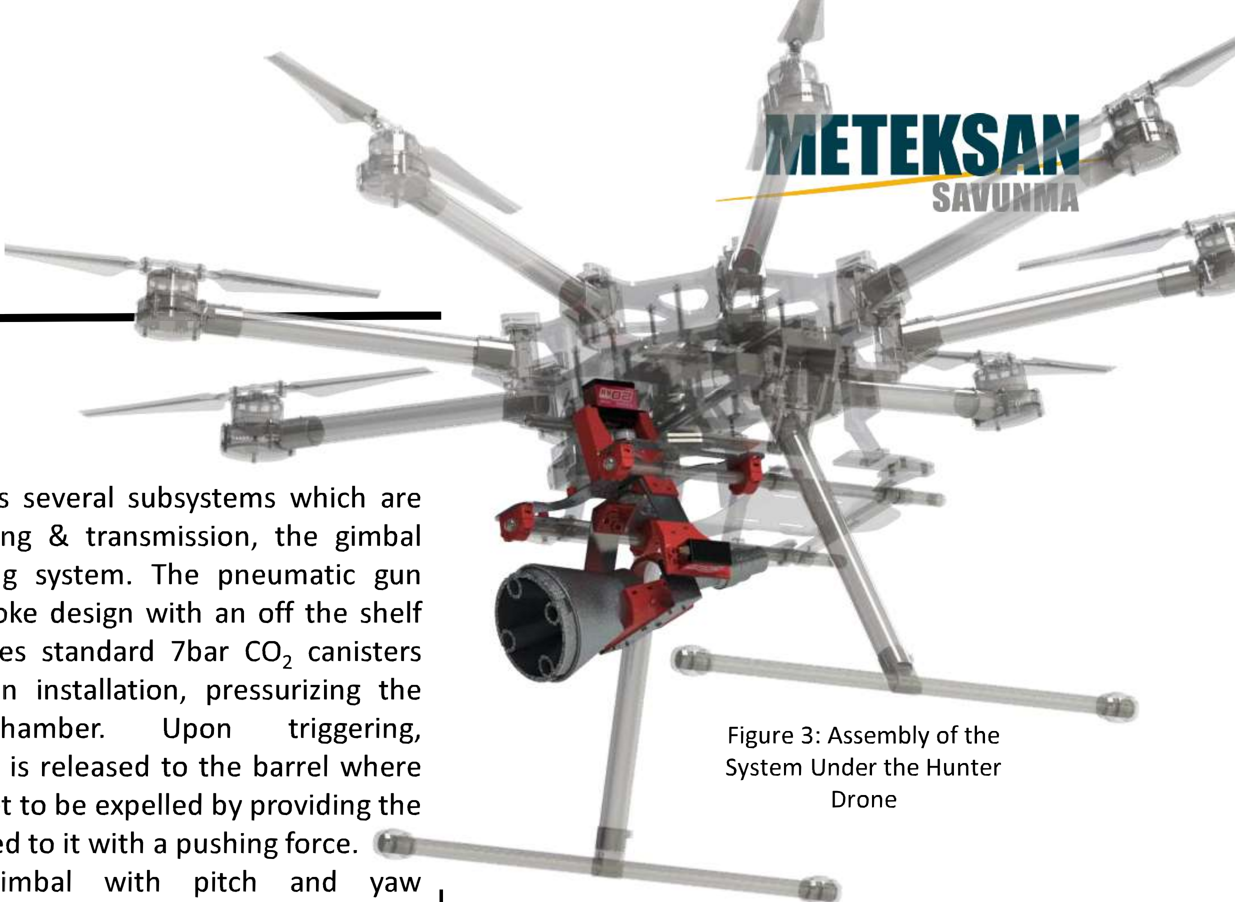


Figure 3: Assembly of the System Under the Hunter Drone

The project has several subsystems which are image processing & transmission, the gimbal and neutralizing system. The pneumatic gun used is a bespoke design with an off the shelf nozzle. It utilizes standard 7bar CO_2 canisters punctured upon installation, pressurizing the expansion chamber. Upon triggering, pressurized gas is released to the barrel where it causes the net to be expelled by providing the weights attached to it with a pushing force.

The 2-axis gimbal with pitch and yaw capabilities was designed and manufactured from the ground up tailored to the special application. Two individual servos are used to rotate the gimbal which receive instructions from the Jetson Nano image processing board mounted onboard. The gimbal was designed, analyzed and tested to be able to safely carry the flight loads and withstand the gun firing. With a robust design and flexible interfaces, the system can be mounted on almost any platform includes other drones or even ground vehicles. The image processing is further divided into two parts, object detection and object tracking.

Using YOLO architecture, a bounding box is created on the drone that can be seen in the live feed being obtained from the weapon camera onboard the gimbal. The image tracking then subsequently tracks the movement of the drone across the frame. The relative position of the bounding box on the frame is used to send instructions to the gimbal servos to move its arms. A lidar is mounted along with the weapon camera to give the distance of the prey drone from the hunter drone. Once the distance is within range, the gun is triggered and the net is fired.

Figure 4: Actualized Hunter Drone Real Mission Illustration

Fire Control System for Non-Visible Targets

360_NoScope (14)

From left to right: Batuhan SEKE – Arda ÖZGEN – Ersagun DURMUŞ – Mert GÜNEŞ – Mehmet Kartal TÜRKMEN – Mert EROL

Academic Advisor : Asst. Prof. Yegan Erdem Ercan
Industrial Advisor : Reha İnal
Teaching Assistant : Didem Fatma Demir

ABSTRACT

The objective of this project is to design a firing system that can detect targets that are hidden from the line of fire of the weapon. The main actors are the Target, the Weapon and the Observer. The Weapon represents a mountable turret type of weapon for use on armored combat vehicles, the Observer is a small device equipped with various sensors to use in detecting the Target. The main principle used is vector addition, in this case two vectors are constructed one from the observer to the target and another from the observer to the vehicle, the combination of both enables the weapon to aim at the targets direction without requiring visiual information on its wherabaouts. Software and electronics were used heavily throughout the project and essential codes and standards were followed for development and manufacture. After the design stages, tests were done on the prototype to ensure proper functioning and the project was finalized.

Introduction

In modern warfare, accurate information on the battlefield is crucial for quickly giving and executing the right decisions. Especially in urban settings the advantages of deploying an armored combat vehicle with a high-caliber weapon capable of penetrating walls can be negated by attacks from hidden enemies. The aim of this project is to make a system that can detect, and aim at such targets as fast and precisely as possible.

With this project Nurol Makina wishes to increase control on the battlefield. Our goal is to use a 3rd party observer to determine the position of a target that has no visual contact with the weapon due to an obstacle, and make sure the weapon aims at the target accurately and fast.

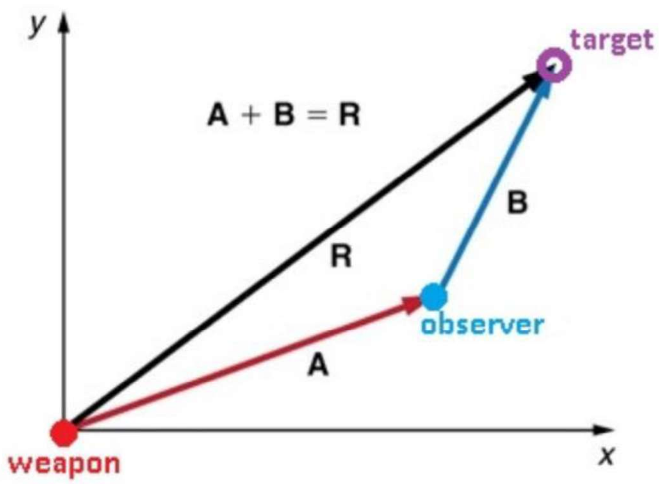


Figure 2: Vector Construction.

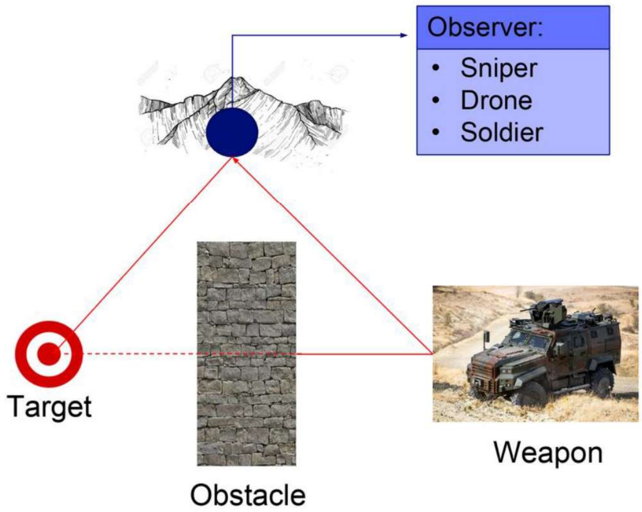


Figure 1: Problem Definition.

Vector Construction

The main concept here relies on 3D vector addition. The objective is to obtain the vector from the Weapon to Target, which is to be achieved by constructing the Weapon-Observer and Observer-Target vectors seperately and combining them. Distances and angles must be found for both vectors.

Design

The system has two main-units: The Weapon and The Observer. The Observer is a low-volume detection device equipped with a camera, 2 servo motors, and a laser distance sensor. The Weapon is a representation of an ACV turret, it has two sub-units: Camera System and Weapon System, both have their own servo motors for independent motion, and all systems are run by RaspberryPi 4.

Target Detection

The Target is detected in two ways: Stationary where, the target remains still with the observer already pointing at it, and Human-Aided, by controlling the on-board motors and camera of the observer.

Observer-Target Vector

Once the target is detected, the Observer-Target vector is obtained by use of a laser distance measurement sensor combined with the motor positions at that instance for orientation.

Weapon-Observer Vector

For the Weapon-Observer vector, an infrared based system is used. The observer is equipped with an infrared beacon while the weapon has an infrared camera and a laser distance sensor mounted on motors. The infraref camera picks up the infrared light from the observer and orients itself toward it, from which we obtain the vector.

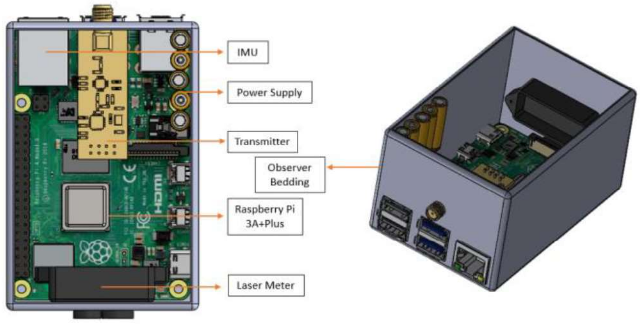


Figure 3: Observer Design.

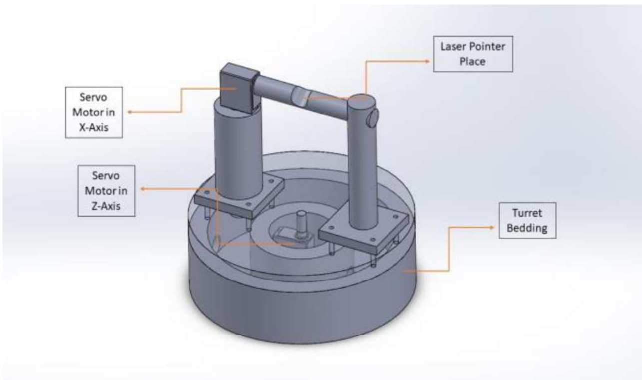


Figure 4: Weapon Design.

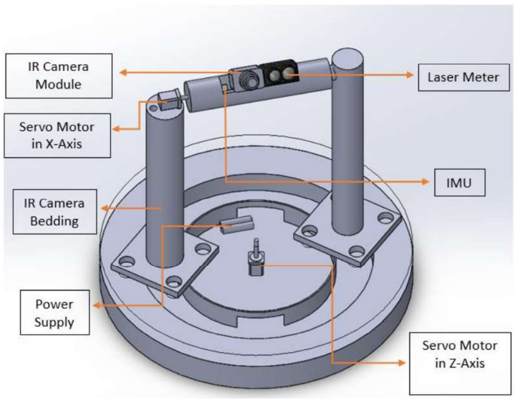


Figure 5: Camera Design.

SPIN TEST DEVICE PROJECT

BİLTEST (15)

Fahreddin Susar Şükrü Kaan Yener Mümin Türkyılmaz
Umut Ozan Çiçek Burak Akboğa Mehmet Emin Albayrak

Academic Advisors : Prof. Dr.Ömer Aka Anlağan
Dr. Şakir Baytaroğlu
Industrial Advisor : Kerim Çepni
Teaching Assistant : Ahmet Furkan Güç

ABSTRACT

The purpose of this project is to create a machine which will be able to spin a test fuze so that the operator working the machine can check whether or not the safety mechanism inside the fuse works.

A fuze is a weapon subsystem that activates the warhead mechanism in the vicinity of the target and also maintains the warhead in a safe condition during all prior phases of the logistic and operational chain. In this special case within this project, the safety mechanism is at off-position when ammo is not fired. When ammo is fired and leaves from the pod with a high rpm, the activation mechanism is at on-position and allows ammo to explode. The goal is to achieve an rpm of up to 6000 and also allow the motor to spin at different rpms up to 6000 rpm. To ensure that fuzes are fully reliable in terms of military standards, lots of real firing tests are conducted. However, these real firing tests are extremely costly and the iteration cycle of design takes so much time, as real tests require realistic conditions such as appropriate weather, geography and gunner skills. To reduce cost and time, a spin test device is desired from ASELSAN. This device will be used to check whether the ammunition will work or not without the firing test.

Introduction

Project covered primarily the fuze of a munition, about 0.04 kilograms. Moreover, ASELSAN underlined that the test sample could have up to 0.02 kg.mm unbalance value and this could not be removed from the samples.

Foreseen problems about the spin test device are; motor power and rpm, unbalance due to test sample and vibration due to unbalance. As a consequence of this vibration;

- Bearing life decreases
- The machine can create noise
- Vibration can cause machinery to consume more power
- Test sample could fly off, creating a safety hazard
- The vibration could wear down some nuts and bolts over time, which could lead to failure of one or many parts in the machine

BilTest group is focused on primarily how the unbalance could be fixed without removing unbalance from the sample, motor selection with respect to a given amount of budget, power transmission between motor and test setup and safety issues about the test setup since any malfunction could give serious harm to people at 6.000 rpm.

According to the requirements and criteria project model designed on *SolidWorks*. Design analyzed on *COMSOL* about static, dynamic and modal analysis. We updated our design (fig. 1) to the final state by considering the production concerns, analysis results and the advices of our consultants from University and ASELSAN.

Figure 1: Final Design of Spin Test Device

Final Design consist of:

- AREL 3Y M3 18000 rpm 3 kW engine
- SIEMENS 2.2 kW motor driver
- Elastic Coupling
- SKF 6304 bearings (x2)
- Heavy sigma profile 45x45x10, total of 8820 mm with 16 piece
- Light sigma profile 45x45x10, total of 660 mm with 4 piece
- Bracket, 40x40 mm (x16)
- Polyamide locked wheels, 50Rx70 (x4)
- Acrylic transparent plexiglass (x5)
- Raspberry pi
- IR proximity sensor
- I2C Enabled LCD Screen
- Potentiometer (x2)
- Dupont cables (x24)
- Resistor (220 Ω, x1)

Spin test device will provides significant cost savings in defence industry by simulating firing tests of ammunition fuse. Project funded with TÜBİTAK 2209-B.

Design

A table that consist of sigma profile structure is designed. The sigmo profiles are attached by using angle brackets and fasteners. Wheels are added to increase the mobility of the table in the workshop. Plexiglass is used to cover the rotating system to ensure the safety of the operator and the working environment.

Figure 2: Table Structure

Deep groove ball bearings are used to support the rotor in the radial and the axial direction against the weight and vibrational effects. A bearing mount is designed to fix the bearings at the desired height and increase the stiffness to increase the resonance frequency of the system. Designed bearing mount is shown in figure 3.

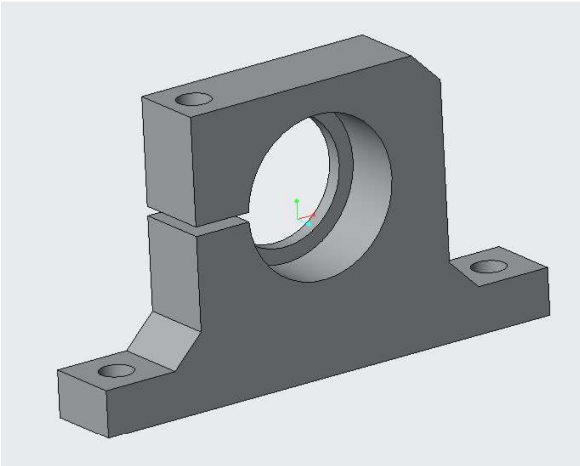


Figure 3: Bearing Mount Design

Flexible coupling is used to transfer the torque to the shaft to decrease the vibrational effects on the electric motor to increase the life of the motor.

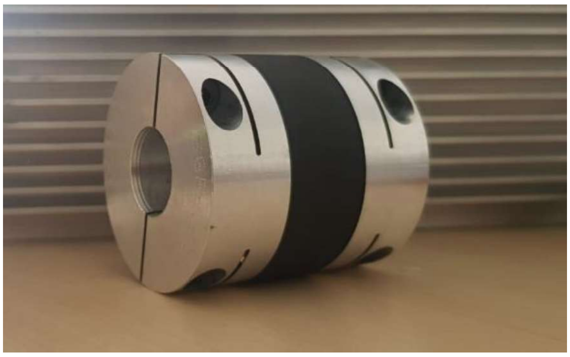


Figure 4: Flexible Coupling

Fixture is designed to easily place the test specimen on the shaft. The fixture is consist of threaded aluminum and threaded PMMA cylindrical parts. The test specimen is fixed in between those two parts.

TWO AXIS GIMBAL

iTrack (16)

Academic Advisor : Prof. Dr. Ömer Aka Anlağan
Industrial Advisor : Cankut Erkaya
Teaching Assistant : Didem Fatma Demir

ABSTRACT

In this project a two axis gimbal was designed and manufactured for Meteksan Savunma Sanayii A.Ş. The gimbal was designed in accordance with the set of constraints, physical and financial, provided by Meteksan Savunma. This project is a part of their ongoing research into making better unmanned vehicles. This booklet is informative in terms of why this project was conducted, what are the specifications of the project and how it works in detail.

Introduction

We are moving into an era where making technology mobile has become very essential. In order to achieve this mobility, it has become inevitable to make our system lightweight and small. In two-axis tracking devices, the first problem that arises is that small surveillance vehicles like RC cars and UAVs are unable to carry them. Secondly, defense companies have custom requirements where existing market solutions are quite expensive and might not accommodate all the features that they require. Defense technology is exclusive to its buyers and the rights to the technology are reserved, thus eliminating the possibility of mass production making the task expensive. Hence it is better to look for an in house solution based on personalized needs and preferences. The objective of this project is to design and manufacture a two-axis gimbal tracker to track an object which can be used as a test-bed for advanced company projects such as tracking using radio frequency signals. The final version of the project will be able to track an object using a two-axis gimbal.

In the project, there are various requirements and constraints about the operation, dimension, safety, material, timing and cost.
For the movement of gimbal system, minimum yaw was expected to be 90^o and minimum pitch to be 10^o. In our project we have managed to keep both these values as the maximum values servos could move which is 135^o as long as it didn't damage the system, turning too fast. Tracked object can be both static and dynamic, any colored small ball is suitable for the tracking application. The gimbal can track objects within a 3m. diameter.

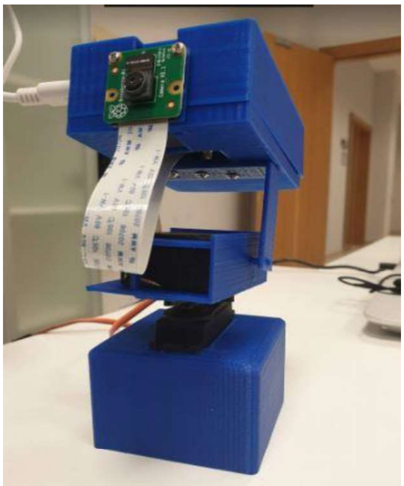


Figure 1: Assembly of Final Design

We could only manufacture the prototype for the gimbal system due to the COVID-19. Our initial plan was to create the prototype using 3D printed ABS plastic and after having a working prototype, we wanted to manufacture the final product, using thin aluminum sheets. Sadly we could only produce the prototype in this project.

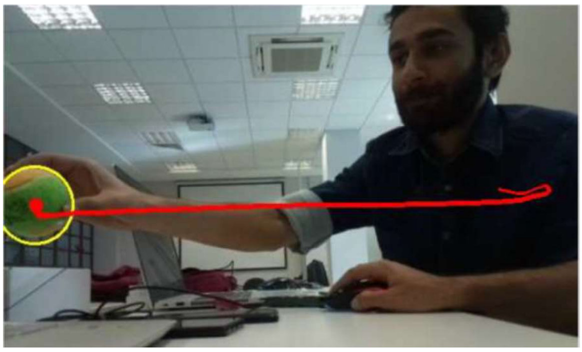


Figure 2: Tracking Algorithm

Design

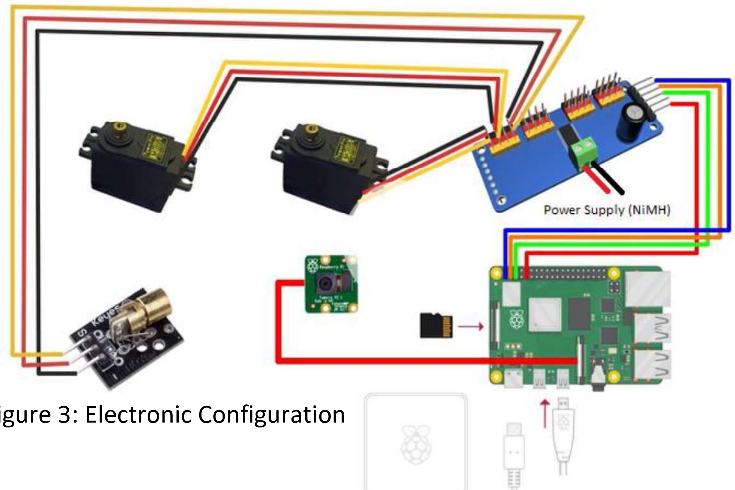


Figure 3: Electronic Configuration

Algorithm starts with detecting the color of the ball. First, we initialize which color range is going to be tracked in terms of Hue Saturation Value (HSV). After this step, we get the image as frames from the camera, and blur it while converting the colors to HSV space. After the image is coded in terms of HSV values, a layer is constructed that keeps the red colored objects in the frame, while deleting the rest of the colors. Eroding and dilating the layer helps reduce any small blobs left on the layer. Then, the algorithm chooses the biggest contour in the layered image. If there are multiple objects in the background which are red, the algorithm won't bother processing them and it will only focus on the biggest one, which is the ball. It then computes the smallest circle that will enclose the ball as well as the center point of this circle. There are four quadrants the ball can be in and according to the center position, Pi will send a PWM signal to the servo driver. For example if the center is (-x,-y) where x and y are numbers, Pi will understand that the ball is on the lower left side of where camera is pointing at, and will drive the servos accordingly to keep this center value at (0,0), which is the center of the processed image. A PID controller is used to achieve smallest error in this process.

The assembly consists of a base, 2 servo motors for axial rotations, a servo holder attached to the servo motor fixed in the base for yaw axis movement, a connector attached to the servo motor providing motion in pitch axis. Raspberry Pi case, which houses the raspberry pi, is attached on top of the connector. The pi-camera is attached in front of the case. This vertical assembly of components provides more stability, fixes the problem of dangling wires and it additionally adds flexibility in the movement in axial directions. This design provides more robustness compared to the previous design. All components are securely screwed together using standard M1 and M2 screws.

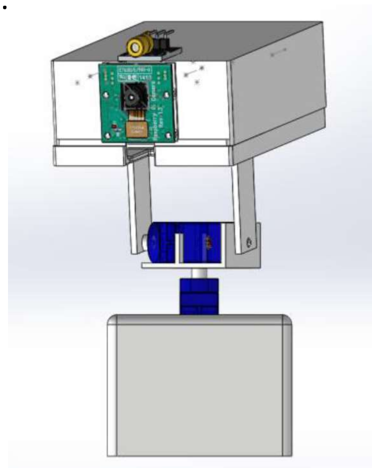


Figure 4: Mechanical Design

Endüstri Danışmanlarının Yorumları

"Bilkent'in bu uygulamasının her iki taraf için çok faydalı olduğunu düşünüyorum. Öğrenciler için eğitim hayatı boyunca edindikleri birbirinden değerli bilgilerin uygulama alanını gördükleri iş hayatı öncesi bir ısınma programı. Kendilerini okul sonrasında nelerin beklediğini görmeleri açısından eşsiz bir deneyim. Bizim için yeni nesil mühendisleri tanımak ve anlamak için büyük fırsat. Ayrıca düşünce esnekliklerine tanık olmak ve bu esnekliğin sonucundaki kazanımları görmek çok öğretici. Birlikte daha fazla zaman geçirebilmek isterdim.

Ekibin benim gözümde öne çıkaran değerleri; uyum, disiplin ve odaklanma diyebilirim. Yaptığımız toplantılarda ekip üyelerinin birbirlerine karşı tavırları ve tutumları örnek gösterilecek seviyedeydi. Ekip üyelerinin iş paylaşımı, üstlendikleri işleri sahiplenmeleri, sonuçlara ulaşmak için gösterdikleri azim ve kararlılık çok hoşuma gitti. Kafalarını karıştırabilecek bulgulara ve ara sonuçlara rağmen ekip hedefe ulaşmak için kararlılıkla ilerlemeyi sürdürdü. Süreç boyunca daima ayakları yere bastı, genç yaşlarına ve tecrübesizliklerine rağmen büyük bir olgunlukla hayali gerçekten ayırmayı ve daima gerçeklerin peşinden gitmeyi başardılar. Sonuçta iyi iş çıkardılar. "

Şamil AKASLAN

FNSS Savunma Sistemleri A.Ş.

"Bizler bu sene KidswithME: Drone for missing children grubundaki arkadaşlarımızla beraber (Alihan Bakır, Deniz Dallıöz, Deniz Dost, Doğa Özbek, Ömer Başar Özgüven, Emre Kaçar ve Kerem Gürdallı) oldukça keyifli bir çalışma dönemi geçirdik. Bu projede ana amacımız, bir anaokulunun yaptığı çevre-doğa gezisi sırasında kaybolan bir çocuğu en hızlı bir şekilde bulmaya yardımcı olacak bir dron tasarlamaktı. Bu dron hızlı bir şekilde belli bir alanı tarayacak ve ısıya duyarlı olcaktı. Grubumuzda ki arkadaşlar bu ana tema üstüne çalışmalarına başladılar. Kendi içlerinde minik gruplara ayrılarak iş bölümü yaptılar. İşin tüm teknik kısımları ile ilgili bana detaylı açıklamalarda bulunup, tüm toplantılara tam kadro katıldılar. Öne çıkan arkadaşlar geride kalanları da bir şekilde toplamayı başardı. Gerekli malzemeler alındıktan sonra dronun ana şekli ve çalışma presipleri oturtuldu. Sonuçta farklı amaçlara hizmet verecek, geliştirilmeye açık bir dron elde ettik. Grup içindeki tüm arkadaşlar çalışma boyunca son derece saygılı, eleştiriye açık davrandılar. Bu başarılı çalışma için hepsini tebrik ediyorum. "

Burçak ÖZONUK

Bilkent Anaokulu ve Kreş

"ROKETSAN A.Ş. olarak; üniversite sanayi işbirliğinin hem ticari gelişme hem de ülkemizin akademik ilerlemesi açısından önemli olduğunu düşünüyoruz. ROKETSAN A.Ş. ve Bilkent Üniversitesi Makine Mühendisliği Bölümü ile yürütülen bu proje; hem öğrencilerin mezuniyet öncesi pratik bilgiyi yerinde görmesini hem de üniversitedeki kazanılmış yoğun akademik bilgiyi ürün tasarımına yönlendirme imkanını da sağlamıştır. Bu projenin çıktısı olarak başarı ile tamamlanan tasarım süreci hem Bilkent Üniversitesi, Makina Mühendisliği Bölümü'nün akademik gücünü göstermekle kalmamış ROKETSAN A.Ş.'nin geliştirilen ürünlerine katma değeri yüksek girdi de oluşturmuştur. İleriki dönemlerde yapılacak benzer bitirme proje çalışmalarının da katma değeri yüksek ürünlere dönüşebileceğine dair inancımız tamdır. Bu doğrultuda Bilkent Üniversitesi'nin değerli akademisyen, idareci ve öğrencilerine saygılarımızı sunarız. "

Mümtaz Afşin ESİ & Esra Gözde YALÇIN

ROKETSAN A.Ş.

"Balistik Koruma Merkezinde bulunan atışlı test altyapısını geliştirmeye yönelik sunduğumuz projede, AEGIS grubundan istediğimiz kriterlere uygun bir test fikstürü tasarlamalarını ve üretmelerini istedik. Proje sürecinde, oluşturulan farklı ön tasarımlar değerlendirilerek en iyi tasarım seçilmiş ve bu tasarımın detaylandırılması yapılmıştır. Seçilen tasarım üzerinde isterlere uygun olarak analizler gerçekleştirilmiş ve kontrol alt bileşenleri seçilmiştir. Test fikstürünün uzaktan kontrol edilebilmesi için gerekli kontrol arayüzü ve bileşenlerin kodlanması tamamlanmıştır. Pandemi nedeniyle fikstürün üretimi gerçekleştirilememiş olmasına rağmen AEGIS grubu, üretim kitapçığı hazırlayarak, olası üretimin detaylarını açıklamış ve Solidworks, Matlab GUI ve Proteus kullanarak fikstürün kullanımını görselleştirerek projeyi başarıyla bitirmiştir."

Ali Sercan COŞKUN

ROKETSAN A.Ş.

"Geçtiğimiz öğretim yılı boyunca BilTest grubu ile yapmış olduğumuz çalışmaların bizim açımızdan memnuniyet verici olduğunu bildirmek isteriz. Koronavirüs salgınına yönelik önlemlerin alınmaya başlandığı tarihe kadar proje, beklentilerimizin ötesinde ilerlemiş ve bitirme projesi kapsamında ortaya çıkacak bir ürünü projelerimizde kullanabilme ihtimali bizi çok heyecanlandırmıştır. Başta öğrenciler olmak üzere bu çalışmalarda emeği geçen Bilkent Üniversitesi'nin değerli akademisyen ve çalışanlarına çok teşekkür ederiz. Gelecek yıllarda da benzer çalışmalarda yer almayı çok isteriz."

Kerim ÇEPNİ

ASELSAN A.Ş.

"Avcı Drone geliştirilmesi üzerine başlattığımız üniversite-sanayi işbirliği odaklı bitirme projesinde, ekipteki tüm öğrencilerin çalışma azminden, temposundan ve mühendislik altyapılarından oldukça memnun kaldık. COVID-19 pandemisinin ülkemizde de oldukça yoğun gözüktüğü günlerde gerçekleşen bu çalışmalar beklentimizin üzerinde sonuçlar vererek, ileride geliştireceğimiz ürünlerde bize farklı bakış açıları da kazandırmıştır. Bilkent Üniversitesi ve Makina Mühendisliği Bölümünün tüm çalışanlarına da bu süreçteki yapıcı ve ilgili yaklaşımlarından dolayı çok teşekkür ederiz. «

İsmail Cem TÜRTÜK

METEKSAN Savunma Sanayi A.Ş

"Roketsan BLS sistem mühendisliği olarak 4 senedir Bilkent Üniversitesi ile beraber yürüttüğümüz Bitirme projelerinde proje olarak verdiğimiz alt sistem ve sitem bazındaki projeler öğrenciler tarafından benimsenerek büyük bir istek ve başarı ile tamamlamışlardır. Özellikle projelerde karşılaşılan sorunlarda çözüm odaklı ve yaratıcı fikirlerle gelerek her zaman çözümün parçası olarak sadece makina değil, elektronik ve yazılım alanlarında da başarılı çözümler sunmuşlardır. Buradaki öğrencilerimizin başarısında tabi ki öğretim görevlilerinin de çok büyük katkısı bulunmaktadır. Ben gelecekte ülkemiz için çok önemli olan bilim ve teknoloji alanında kendi kendimize yeterli olunması kapsamında büyük katkıları olduğuna şahit olduğum Bilkent üniversitesinin emeği gecen tüm öğrenci, öğretim görevlisi ve idari çalışmalarını tebrik ediyor, geleceği şekillendirecek bu çalışmalarında başarılar diliyorum. "

Hüseyin Avni GÜNER

ROKETSAN A.Ş.

"Bilkent Üniversitesi Makina Mühendisliği Bölümü tarafından düzenlenen Sanayi Odaklı Bitirme Projeleri, katılımcı firmaları ve mühendislik öğrencilerini bir araya getirme biçimi açısından fark yaratan bir organizasyondur. Etkinlik dahilinde, son sınıfa gelmiş olan öğrencilerin endüstriyel ve akademik danışmanların da dahil olduğu disiplinli bir program çerçevesinde gerçek bir iş ortamını tecrübe etmesi, firmaların ise kendilerini tanıtma ve yeni mühendis adaylarına ulaşma fırsatlarına sahip olması adına, iki taraf için de oldukça faydalı bir ortam oluşmaktadır. Geçmişte öğrenci olarak da katılmış olduğum, ülkemiz sanayisinin gelişimine ve geleceğin mühendislerinin yetişmesine katkıda bulunan bu organizasyonda endüstriyel danışman olarak yer almaktan büyük bir memnuniyet duyuyorum. "

Cem Kurt

NUROL A.Ş.

"Bilkent Üniversitesi Makina Mühendisliği Bölümü bitirme projesi kapsamında, Arçelik Bulaşık Makinalarında özellikle Otomatik Sıvı Deterjan Dozaj ürünlerinde, ön yıkamalı programlarda toz ve tablet deterjan kullanımını sağlayacak mekanik bir dozaj aparatının tasarımı önerisi, Hydra Grubu tarafından sahiplenilmişti.

Hydra Grubu proje kapsamında farklı alternatifleri değerlendirerek, bulaşık makinası su besleme hattı üzerine yerleştirilen bir hidrolik (piston) tetikleyici ile harekete geçebilen bir tablet ve toz deterjan dozaj sistemini geliştirmiştir.

Hydra Grubu'nun tasarımı bulaşık makinası üzerinde çalışabilecek özgün bir tasarımı gerçekleştirmiş oldu.

Projede emeği geçen tüm Hydra Grubu arkadaşlarımızı tebrik eder, teşekkürlerimi sunarım.«

Uğur KAN

ARÇELİK