Combat Robotics as a Sport

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Abstract:

Combat Robotics is a sport in which hobbyists build and participate with a custom-built machines, using various methods to incapacitate or expel rival robots .The machines are generally remote controlled vehicles with a weapon system. Teams scoring the maximum points wins the championship.

Keywords: Robowar, Combat Robotics, Kinetic Energy, Battlebots

Introduction:

Robot combat uses weight classes, with the heaviest robots able to exert more power and destructive capabilities. The rules of competitions are designed for the safety of the builders, operators, and spectators while also providing for an entertaining spectacle

Robots come in a variety of designs, with different strategies for winning fights. Robot designs typically incorporate weapons for attacking opponents, such as axes, hammers, flippers and spinning devices. Safety measurements are taken for enjoyment of participants and spectators..

Currently, India has the following weight categories:

1. Hobbyweight (8 kg)
2. Featherweight (15 kg)
3. Lightweight (30 Kg)
4. Middleweight (60 Kg)

- Types of combat robot
- Materials
- Electronics
- Transmission (Drive) Systems
- Designing & optimizing a spinning weapon for maximum energy transfer.
- Build idea of a featherweight Combat Robot

1. Types of Combat Robots

After deciding the weight class the next step we'll look choosing the what type of Robot you built , because many types of combat robots are there. Each Roboteer will usually end up designing and building a robot that reflects his or her personality.

There are several type of combat robots, it can be difficult to choose which kind to build. No type of robot is the best and a well designed bot can win and survive against a robot of any type.

Basically Robots are categorized into 16 types:

Rammers, Wedges, Lifter, Launchers, Thwackbots, Overhead thwackbots, Horizontal spinners, Sawbots, vertical spinner, Drumbots, Hammerbots, Clamper, Crushers, Flamethrowers, Multibots, and Spearbots.

Other bots also exist but they also categorized into one of the 16 types or above or in combination of them.

•Rammers – Rammers are ramming robots that damage the opponent by pushing them against the borders of the arena or throwing themselves against them. They have 4 or 6 wide wheels with traction and a sturdy drive system and are often designed to be fully operational when inverted

•Wedges –Wedges are armed with a sloped plate shaped like a wedge. It generally have a very resistant drive system they usually have 2 or 4 wheels. It rarely cause direct damage, but are incredibly effective against spinners, and making them flip over when hitting the wedge. Wedges win when they enter under bots and drag them under the arena, or flip them at high speed.

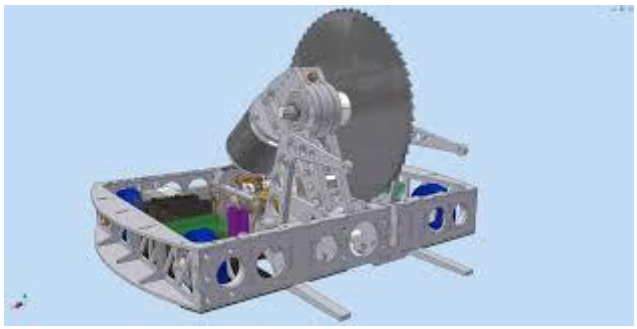
●Lifter – lifter bot is a robot that simply lifts its wedge to get the other robot off its driving wheels. Lifter are capable of lifting their opponents, aiming to immobilize them/turn them over. It's efficient against bots that depend on traction, like rammers and wedges

•Launchers / Flippers - An effective flipper can throw opponents end-over-end through the air causing damage from the landing impact. If we add more power to the lifter, it becomes a flipper it will be able to flip your opponent over.

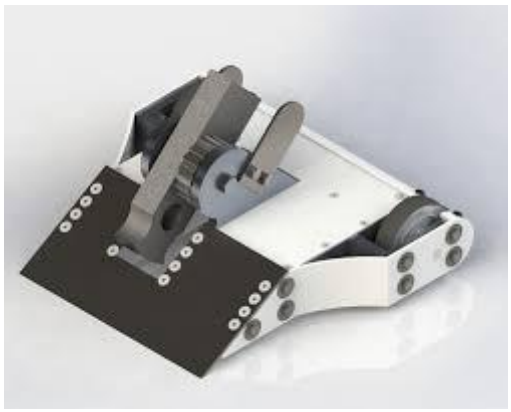
•Thwackbots – A small speed, two-wheel drive train attached to a long boom with an impact weapon on the end creates a robot that can spin place at a speed, swinging the weapon in a horizontal circle. They usually have 1 or more long rods with a axe, hammer or some extra piercing weapon.

• Horizontal Spinners- the Horizontal spinners have a disc or bar that spins up at high speeds, and can be called an undercutter when the weapon spins very low near the ground. The weapon should spin as fast as possible, and accelerate to a speed that can cause damage in less than 4 or 5 seconds. It is one of the most destructive robot.

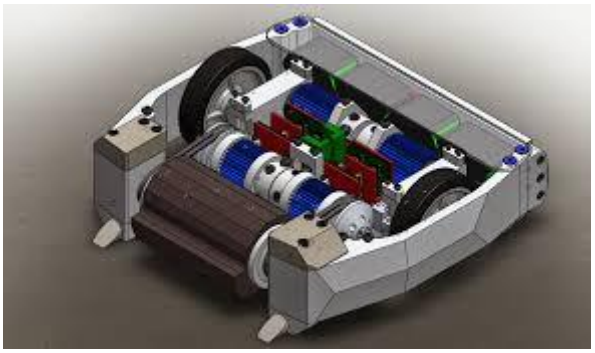
•Sawbots-Sawbots have toothed or abrasive disks that are powered at high speeds. A weapon in the early time of robotic combat, these robots use a motor to power either a modified chainsaw or circular saw, or a custom made cutting disc, usually at high RPM (up to 10,000 rpm).



•Vertical Spinners – Vertical spinners generally use disks with very few teeth, or bars, spinning on a vertical plane. They damage their opponents when the opponent is hit, and when the opponent hits the ground.Vertical spinners should have a wide base so that they don't tumble when turning due to the gyroscopic effect of the weapon.



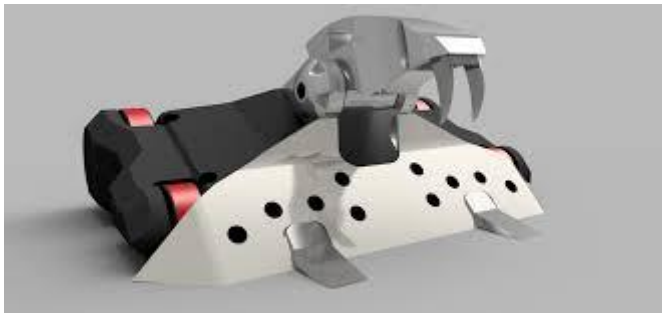
•Drumbots - Drumbots are more compact versions of vertical spinners, with less moment of inertia in the weapon, allowing the drum to accelerate quicker. Because they have a low center of gravity, they are relatively stable and can be invertible. A drum will give a bigger hit than a blade or bar because it typically weighs more.



• Hammerbots – Thee bots with hammers or axes that hit the top of their opponents. weapon can be fired quickly and continues, and is independent of the drive system, hammer or axe system works as a mechanism to right itself if it gets flipped.

•Clampers- The clamper assemble an arm or claw that descends from above to confirm the opposing robot in place on a lifting platform. The whole things then lift up and carries the opponent . It is sually pneumatically actuated (faster), or they use an electric system with high gear reduction (slower). This need to be fast enough to reach their opponents before they can escape from their claws

• Crushers – Crushers bots that use hydraulic claws to slowly puncture and crush their opponents. Crushers can be separated into horizontal and vertical variants. The crushers use a hydraulic cylinder assemble to a sharp piercing arm to pin and slowly penetrate the top armor of the opponent.



•Flamethrowers- The flamethrowers are usually used together with other weapons, such as wedges.usually inefficient to disable other robots because most opponents are fireproof, except if the electronics is exposed or the wheels are flammable. Some few competitions allow the use of flamethrowers.

•Multi bots – It made of 2 or more different robots that when assemble add up to or near to the weight limit of the event they are participate in. A robot that breaks apart into multiple, controlled robots has appealed to a few competitors.

2. Materials used in combat robots:

In combat robotics, materials is one of the vital component for the structural rigidity of the combat robot for making it more durable and destructive within the weight limit.

There are many kinds of metals and alloys which are used to build a combat robots. They are selected by keeping in mind the following properties:

•Weight.

•Hardness

•Resilience.

•Impact Toughness.

•Fracture Toughness.

•Availability.

Types of material used:

Aluminium alloy :

Aluminium is a very light metal. Its density is $1/3^{rd}$ of steel which makes it attractive for robot builders. Due to its low weight compared to steel we can use thicker plates of this metal which makes it more impact tolerant.

Mostly in the field of the combat robotics there are 2 types of aluminium alloys used such as Al6061 & Al7075.

•**Al6061**- It is the most common structural Aluminium alloy. It was developed in 1935 originally called Alloy61s. It has good mechanical properties and can be welded easily and it is a very ductile material.

•**Al7075**- It is an aluminium alloy and zinc being the primary alloying element. It is comparatively more harder than Al6061 which makes it more impact resistant but susceptible to embrittlement.

Steel :-

It is an alloy of iron with few percent of carbon, and few other element depending on the type they can be extremely resistant owing to its high density it can make robots extremely heavy. However many types of steel needs heat treatment after machining to achieve high strength.

Types of steel used :-

• Mild steel

• Tool steel

• High Carbon steel

• AR steel

•**MILD STEEL**:

It is kind of carbon steel with low amount of carbon which makes it easily machinable. They are generally used in shafts and internal structure, Heat treatment only gets to increase its strength and hardness of the surface only.

•**TOOL STEEL:**

It has high impact toughness in addition to its hardness which makes it very strong to use in the weapon parts. However they are required to be heat treated and tempered. S7 tool steel is a very popular choice for the weapon.

•**HIGH CARBON STEEL:**

It is a popular grade of through-hardening alloy steel having high percentage of carbon and molybdenum in its alloy. They are generally used in the gear, weapon shaft and places which have a tendency to break. To achieve desired impact toughness heat treatment is required.

•**AR STEEL:**

Abrasion-resistant steel is a high carbon alloy steel plate. It doesn't need additional heat treatment as it comes pre hardened. It is generally used in wedges and armours due to its high resilience.

Titanium:-

It is an alloy that contain mixture of titanium and some other chemical elements. Approximately it is little more than half the density and 2.5 times the strength of steel. They are very light weight and have the ability to withstand extreme temperatures. They are generally used as weapon shaft and armour because of their balanced ratio of high strength and low weight.

NON-METAL:-

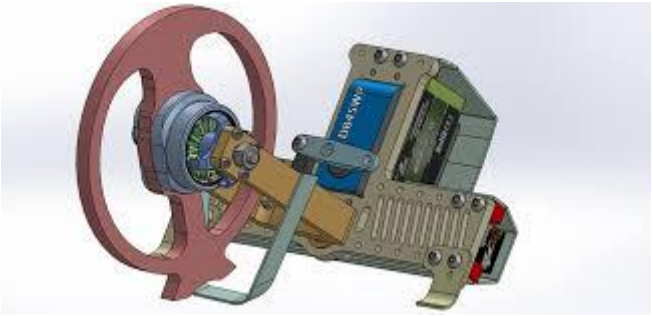
In robots of lower weight classes where metal cannot be used owing to there heavy weights certain non-metals are used such as polycarbonate, acrylic, UHMW, HDP, Carbon fibre, etc. They can be used robot structure chasis and also as an ablative armour.

3. Drive system

Locomotion is the most important system in a combat robot. If your robot can't move inside the arena, it will be deemed immobilised and the opponent will win. So a strong drive system should be build. Normally there are three types of drive system – tank tread system, gyro walker, wheeled drive.

Tank tread system - In this type of system, continuous tracks are driven by two or more wheels. The larger surface area of the tracks increases ground friction that helps in better traction. But this type of drive system waste lots of energy and they are very slow while turning.

Gyro Walkers – This type of robots utilises the gyroscopic forces of a vertical spinning weapon. It has legs to support the robot and by moving the vertical flywheel, it mimics a walking mechanism.



Wheeled drive – This is the most popular type of locomotion system used in combat robotics. There are two types of steering system used. The Ackerman steering (a large motor is used to move the robot forward and backward, and a smaller motor to move the front wheels for steering) and tank steering. Mostly tank steering system is used in combat robotics.

In tank steering system, the entire left side of the robot is driven independently from the right side. By varying the speed and direction of either side of the drive, turns are accomplished.

2 wheel drive 4 wheel drive Multi wheel drive

4. Electronics

Electronic components work as a heart and brain of a robot. Electronic components are any basic device or a small physical entity in an electronic system. Electronics are involved from drive to movement control and weapon control also.

Main electronic components which is used are

1. Power Supply

2. Electronic speed control (ESC)

3. Motors (Brushed/Brushless)

4. Radio transmitter and receiver. (Rx/Tx modules)

4.1. Power supply

A power supply is an electrical device that supplies power to the robot. The mode of power supply may be different but the primary function is same.

Basically 3 types of power supplies are there.

1. Switch mode power supply with variable or non-variable voltage regulator. (SMPS)

2. Battery eliminator with voltage variables.

3. Batteries. (Li-po batteries or lead-acid batteries.)

For wireless modules we mainly use li-po batteries.

Lipo Batteries- A lithium polymer battery, or lithium-ion polymer battery is a rechargeable battery of lithium-ion technology.

It uses the polymer electrolyte instead of a liquid electrolyte. These batteries provide higher stable energy than other batteries.

As it is so lightweight it is widely used in remote control devices or mobile phones.

There is some specific differences about which lipo can be appropriate for specific uses.

Li-po batteries can be distinguished by 4 criterias.

1. Cell configuration.

2. Discharge rate

3. Voltage

4. Capacity.

Cell configuration-The battery is made from rectangular cells which are connected together. The every cell holds the voltage of 3.7 volts. The voltage will rise if we connect more cells to it like for two cells connected the voltage will be 7.4 volts and so on. Connecting cells to parallel we can increase its capacity .Like some lipo has a rating of 6S2P, it means 6 cells are connected in series and 2 cells are connected in parallel.

Voltage-One cell of a lipo battery hold a nominal voltage of 3.7 volts. To rise the voltage more cells are connected to series from the primary cells. If some lipo has a rating of 6s then it means 6 cells are connected to series to form the rated voltage.

1s battery= 3.7 volt.

2s battery = 7.4 volt.

3s battery = 11.1 volt, and so one

Maximum 12s rated lipo batteries with nominal voltage of 44.4 volts are available in the market.

Capacity-Capacity can determines how long anything can run before battery completely runs out. A larger capacity pack may give longer usage time of it.

The capacity can be calculated by mAh. It is used to calculate how much power it can hold for an hour ,like some lipo battery have rating of 3000 mAh on its pack it means it can put 3000 miliamps for discharged completely in one hour.

Discharge Rate-Discharge Rate is how fast a battery can be discharged safely. The discharge rating is stated as C in lipo battery pack.If some lipo has 10 c rating and its capacity is 1300 mAh it means it can safely draw 10 times more than the capacity rating.

10c= 10 × Rated Capacity converted in Ah.

More C rating will give more discharge but it is more costly than the lower ones.

Numerical calculation on selection of the battery:

We can't calculate the battery capacity perfectly in a real time scenario we cannot predict what will happen during the match so the entire calculation is based on certain assumptions, these assumptions varies from robot to robot. Mainly for battery capacity calculation, bots can be classified in two types:-

1. **Attacking bot**- These bots have an active weapon on them such as vertical spinners, horizontal spinner, flippers, etc. In this types of bots battery capacity is divided in two parts one for the drive system and other for the weapon system.

2. **Defensive bot**- This bots have no weapon system such as wedge, rammers. The battery capacity is purely concentrated for the drive system.

Lets take an example for a featherweight category robot(spinner)

Hypothetically, let us assume two wheel drive system with the spinning weapon at the front.

For drive we have two motors with a stall current of 60A each at 6s (22.2v)

For weapon we have a motor with a stall current of 90A at 6s(22.2v)

Typically the average length of the match is 3 mins all around the world.

Generally in a match both the drive motors and the weapon motor will not be stalled simultaneously all the time during the match.

Drive System -

Max current drawn at stall : 120 amps

Length of the match : 3 mins i.e 0.05 hr

Therefore, current used :120 x 0.05 = 6 Amp Hr

But ,this is not the scenario. The motors are not always stalled for the entire 3 minutes, motors do not have to run for the entire duration of the match. So let us assume 40 % of the total current is used.

40% of 6 Amp Hr = 2400 mah

Weapon system –

Max current drawn at stall : 90 amps

Length of the match : 3 mins i.e 0.05 hr

Therefore, current used :90 x 0.05 = 4.5 Amp Hr

We will not be using the motor weapon continuously for the entire match, after a collision the weapon motor has to be stopped else the motor will damaged. So let us assume 60 % of the total current is used.

60% of 4.5 Amp Hr = 2700 mah

Hence, Total Battery Capacity required : 2400 + 2700 = 5100 mah

4.2. ESC(Electronic Speed Controller)-

It is the main component which controls the movement of motors. It also controls and regulates the speed and acceleration of an electronic motor.It may also provide reverse rotation of the motor and implulsive breaking movement. Electronic speed controllers are used in radio controlled models. Electric vehicles have systems to control the speed of their motors.

Working Principle of ESC - An electronic speed control follows a transmission signal from the user and varies the switching rate of a network of the field effect transistors. By adjusting the pwm signal and controlling the duty cycle or switching frequency of the transistors, the speed of the motor is changed.

The ESC are basically powered by 3 phase AC signals and the correct phase varies with the motor rotation.The motor windings is used to detect this rotation by magnetic sensors or optical detectors.There are computer-programmable speed controls which have user-specified options which allow to control timing, acceleration, braking and direction of rotation differeny.

Types of ESC-

In combat robotics ESC are mainly used to control 2 types of motor.

1.Brushed Dc motor

2.Brushless Dc motor.

ESC of brushed DC motor.

It is directly connected from the power supply and the speed and rotation of the motor depends on the throttle signal from the user.

More throttle will causes more speed of the motor.

But brushed motor is DC and only required an ESC to have one row of FETs. These increase the flow of electricity to control the speed of motor. Rotation speed is taken care mechanically by the commutator.

ESC of Brushless DC motor.

A Brushless DC motor is powered by three-phase AC system. It is powered by three phase because it has 3 banks of Field effect transistors, one for each different phase. A Brushless Dc motor is always wound in a multiple of 3 phases and each group of windings are one phase.It have to switch the phases whereby the electromagnetic field of motor rotate from one phase to another pushing the magnets around the stator and limit the electricity getting to the armature coil . The quantity of electricity and pwm throttle timing is also controlled by it.

We are using brushless drive for the bot and the weapon is also operated with brushless motor.

Components are Brushless ESC.

1. Linear BEC module

2. Input and Senser Filtering Capacitors

3. Field Effect Transistors bank

4. Phase Voltage divider bank

5. MCU And Mcu regulator

6. Oscilator

7. Power management terminals

Description of the components:

1. BEC module:

There are two modules of BEC in standard ESCs. BEC stands for Battery Eleminator Circuit. There are two types of BEC available in the market. Linear and Switching BECs. Basically linear type is widely used in ESC.

Purpose:

BEC mainly used for converting the received pwm signal to some appropriate electrical power to rotate the motor as required.

It is also used to regulate the excess power from the power supply by converting power into heat.

One major drawback for BEC is if it gets more power than required then it will melt and the total ESC circuit will be destroyed by excessive power.

2. Input and Sensor Filtering Capacitors:

Input capacitor is connected in front of the power terminals and the sensor filtering capacitors are connected through parallel by phase sensing voltage dividers.

Purpose:

Input capacitor is a big capacitor. Its capacitance varies from voltage and current rating of the ESC

It mainly used to prevent voltage fluctuations and high voltage pulses.

Sensor filtering capacitors are used for preventing Noise. Noise is caused by quickly varying voltages, current and frequencies. It reduces the noise which is caused by voltage divider to the MCU.

3.Field Effect Transistor bank:

It is the main speed controller of an ESC.A field effect transistor is a three terminal semiconductor device. It is called the uni-polar transistor. It can operates without an input bias signal current and give a very high input resistance.

There are two type of FET available

1. Junction field effect transistors

2. Insulated-gate field-effect transistors (IGFETs)or commonly known as MOSFET.

Purpose:

It uses an electric field to control the flow of power.To make it work in a speed controller circuit it uses an variable Oscillator input from the reciever to the ESC. MOSFET are devices with three terminals: source, gate, and drain. To control the flow of current by the apply some voltage to the gate, which in turn conductivity between the drain and source.

4. Voltage Divider Bank:

Voltage divider banks are located between FET banks And sense capacitor.It is connected from Mosfets and sense capacitor to the MCU.

Purpose:

Voltage divider acts as a divider and distribute the voltage to MCU unit, The oscilator, the sense capacitor and the output terminals.

5. MCU And Mcu regulator:

A microcontroller is a single metal-oxide-semiconductor integrated circuit chip which control the movement of motors.

It is the main control unit of the ESC. It controls the movements of motor by sensing the armature position by optical sensor or electromagnetic sensors. MCU regulator are used to control the voltage entering the MCU.

Purpose:

The proggramming part of a ESC are stored in MCU.It causes the PWM signal pulse to reach out every phase and getting to the coil of the motor.

Time control,movement control,Rotation speed, acceleration, braking time all are controlled by MCU.It is also reprogrammable by some specific software as required.

MCU regulators are nothing but some voltage regulators for the MCU it controls the unnecessary voltage and current which is harmful to the MCU.

Oscillator:

An primary oscillator is connected to the microcontroller and the mosfet terminals.

To oscillate simultaneously and create the sufficient pwm which is used to control the speed with FET and microcontroller.

Input and output terminals.

There are several connections to transfer the power through the esc

Input terminals- one negative one positive terminal for power input

Ground terminal- Excess voltage from the power source will go to the ground terminal.

Pwm input- Captures the Pwm signal from the receiver

BEC input/Output - Feeds the voltage to the BEC to convert the Pwm into voltage feedback.

Output: Three terminals from other side of the ESC which will produce AC 3 phrase output.

5.1 Motors –

In the field of combat robotics , DC motors are used. Typically there are mainly two types of dc motors :-

1. Brushed Motor
2. Brushless Motor

Brushed Motor

In this sort of motors, magnetic flux is produced by passing current through a commutator and brush which are inside the rotor. Hence, they are called Brushed Motors. The brushes are made up of carbon. These can be separately excited or self-excited motors. The stator a part of the motor consists of coils connected during a circular fashion in such how that the specified alternative north and south poles are formed. This coil setup are often serial or in parallel to the rotor winding forming series wound DC motors and shunt wound DC motors. The armature or the rotor a part of the DC motor consists of Commutator which essentially a current carrying conductor connected at one end to copper segments which are electrically isolated. External power can be connected to commutator via the brushes as the armature rotates.

Brushless Motor

Brushless DC motors typically contains a static magnet rotor and a coil wound stator. This design by using permanent magnets in rotor eliminates the necessity for brushes within the rotor part. Hence, in contrast to brushed DC motors, these type do not contain any brushes and therefore no wear and tear of brushes as little amount of heat is generated. Brushless DC motors are costlier than brushed DC motors and are more efficient than their brushed cousins.

5.2. Radio Transmitter and Receivers

Signal waves transmission by radio transmitter and receiver-

A radio transmitter and receiver consists of some elements that work together to generate radio waves that contain input information as digital data.

signal range and signal clarity are depend upon some physical factors like

1.Noise disturbance in the air

2.Humidity

3.Other strong waves.

Components of transmitters-

Basically transmitters have some components which is use to convert digital signals into radio waves.

Main components are

1.Power supply: Provides the necessary electrical power to operate the transmitter. The power supply could be any any available source like battery or some rated adapter.

2.Oscillator: Creates alternating current pulse at the required frequency on which the transmitter will transmit input data. The oscillator usually generates a sine sinusoidal wave.

3.Modulator: Adds input information to the carrier wave.

Like converting digital input signals to radio waves.

4.Amplifier: Amplifies the modulated carrier wave to increase its power for transmit the wave at required amplitude. The more powerful the amplifier, the more powerful the transmission.

Radio receivers

A radio receiver is used to receive transmitter waves. It uses an antenna to capture radio waves, processes those waves to catch only those waves that are in desired frequency and wavelength, extracts the signals to digital signals and feed it to speed controllers.

Components of radio receiver (RX module):

1.Antenna: Captures the radio waves more precisely. The antenna is simply a small length wire.

2.Receiver amplifier:A amplifier is used to amplify the very weak radio frequency signal tranmitted from transmitter antenna.

3.Tuner: A circuit that can extract signals of a particular rated frequency from a mix of signals of different frequencies and wavelength.

4.Detector: Responsible for separating the input information from the transmitted wave from the transmitter.

6. Designing & optimizing a spinning weapon for maximum energy transfer

The goal : Transfer maximum energy efficiently into your opponent.

The weapon is pretty much the heart of the bot. Here we are going to manly discuss spinning type weapon-vertical and horizontal spinners.

ROTATIONAL KINETIC ENERGY – ½ * I * $(w)^2$

I = Mass Moment of inertia of the weapon

W= Angular velocity

Factors that plays a key role :

- RPM of the weapon – As we can see that kinetic energy depends on the angular momentum of the weapon.
  We know, (w) = 2πN/60 [N = Rpm]
  That means the energy of the spinning weapon is directly proportional to the RPM

- Mass moment of inertia (I) – It is dependent not on the mass of the weapon but the average distance mass is located from the central axis. We have to maximise the MOI of the weapon to get the maximum energy storage capability. MOI is calculated at the rotating axis of the weapon. In other words, the further away the mass of the weapon is from the central axis, the more MOI it will have
- Shape of the weapon – The shape of the weapon should we such that upon engaging with the opponent, it must have proper "bite" . Having a positive rake angle can maximise the bite.
  Bite is the maximum depth of opponent insertion into the arc of a spinning weapon at a given weapon RPM and forward velocity. You'll get that maximum bite rarely, just like 13 black only comes around rarely on a roulette wheel. Sometimes your luck will be very poor and you'll hit your opponent just as an impactor is facing them and get no bite at all! On average, you'll get half the max bite -- less as your attack speed drops.

7. Build Idea of a Featherweight Combat Robot

For this category , we decided to build a vertical spinner robot. Vertical spinner is a heavy flywheel that spins at high speeds. To cause damage, one or more "teeth" are welded onto or integrated into certain places along the disc's circumference, in order to gouge and tear large sections off of opponent's armour or destroy vital components.They are mounted vertically in the robot.

Advantages:

- Like the horizontal type, vertical flywheels are capable of inflicting substantial amounts of damage to their opponents, tearing into and ripping off sections of armour plating as well as destroying their chassis, wheels and weapons
- It can also flip the opponents into the air or out of the arena.

Disadvantage:

- The gyroscopic forces of a vertical flywheel can adversely affect the robot's manoeuvrability, making it difficult for it to turn when the weapon is spinning. Additionally, they could also lift the robot up onto one side or even cause it to overturn when turning left or right.

Materials

Taking considerations such as availability and cost we decided to use the following materials in our bot:

- Aluminium 6061 T6 - For our robot, we will mainly use Al 6061 in its chasis, weapon mount etc. We selected the alloy keeping in mind it's availability and cost. It also has the perfect weight to hardness ratio.
- S7 Tool Steel – For it's impact toughness and resilience, we will be using s7 tool steel for our vertical weapon disc.
- Titanium – Owing to its high strength and light weight we'll be using titanium in our weapon shaft.

Electronics

We decided to go for a full brushless setup in or bot. Brushless motors are lighter is weight ,provides more power in comparison to their brushed counterparts. Considering the required rpm output and their torque, we decided to go for a 4248 sized motor for the drive and a 5060 sized motor for our weapon turning. The whole system would be powered by Lipo Batteries at 6s ie. 24 volts

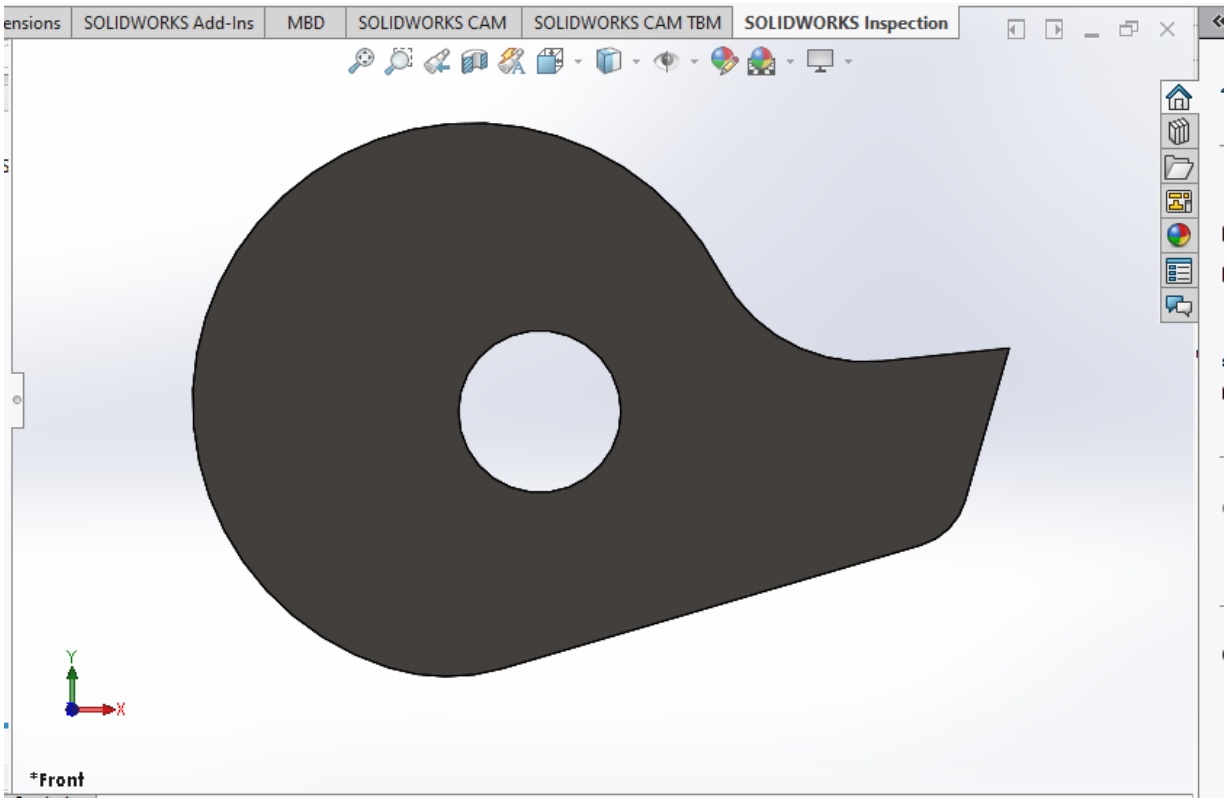
Motor controllers : Motor controllers are the heart of the electronics. For drive we'll be using a 100amp rated esc. 4248 sized motors can withdraw approx 70-80 amps current, So we decided to go to with the 100 amps. Normally the brushless esc moves the motor in single direction only. For bidirectional movement of the motor, we have to reflash the esc with Simon-K firmware.

For the weapon esc we decided to go with a generic 200 amps esc since 5060 motors consume 130-140 amps approximately.

For the radio we went with a generic 2.4ghz 6 channel transmitter receiver.

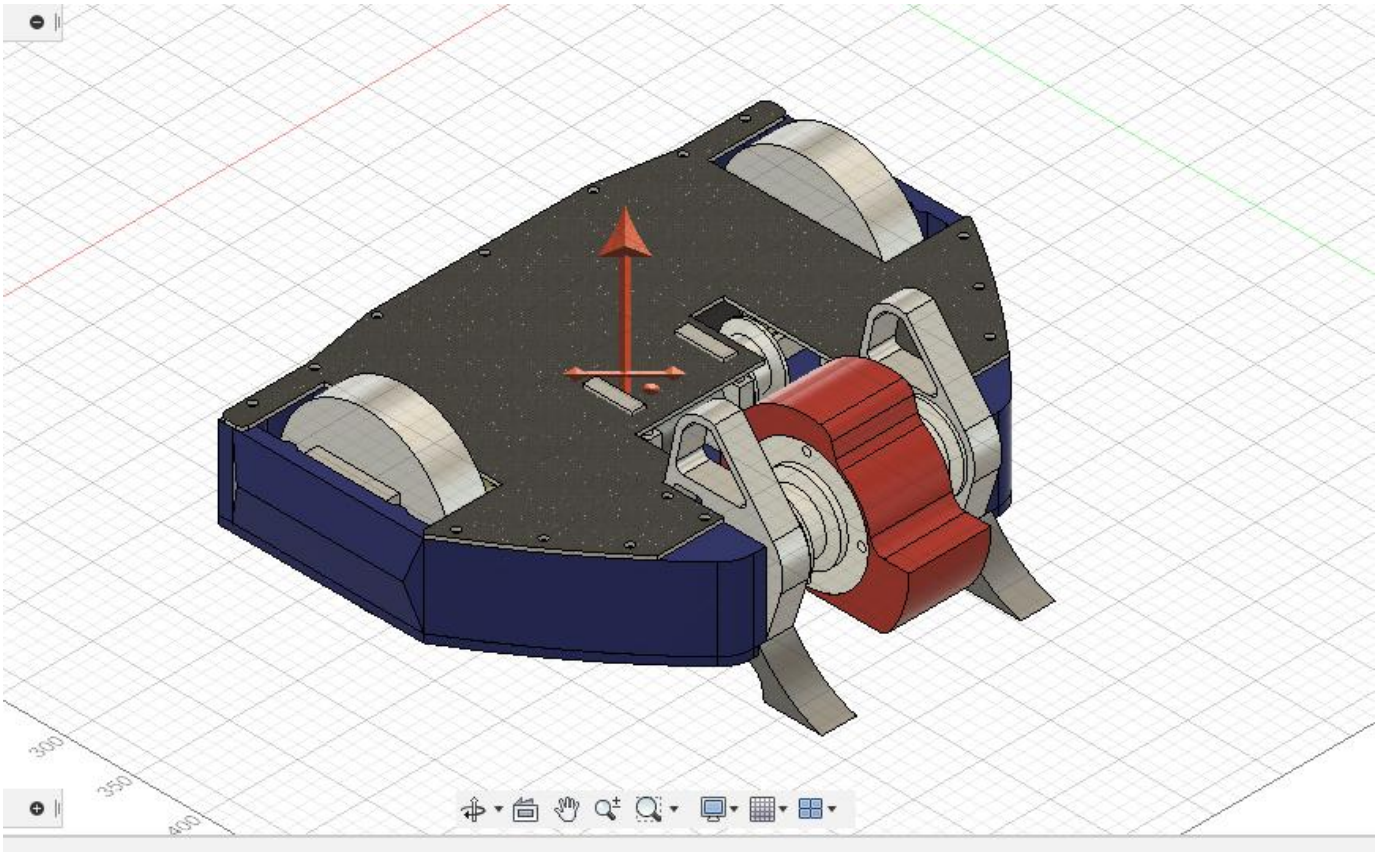
Designs

Weapon design :



The design of the weapon was asymmetrical type. The shape was optimized in a CAD software to ensure maximum energy storage capability and bite.

Chassis Design:



We decided to go with a 2 Wheel drive design in a triangular type design. Triangular design was selected to minimise the frontal area. The shape was optimized not to give any areas so that the opponent can grab the robot and cause damage.

Conclusion

We hope the paper gave a very gainful knowledge as well as information in the field of 'combat robotics', where all the upcoming roboteers and current roboteers can come in this field of work with some specialities. It's not always about winning, but a design challenge for a combat roboteer.

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