Robomaster Spring 2025 Final Exam

All responses to this form are specific to NYU's RoboMaster Team Ultraviolet. Responses about general mechanisms and methods used by other teams and universities will NOT be accepted. (Don't use AI)

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Like all robots that shoot, our hero uses flywheels to shoot the balls. Explain the mechanism that gets balls to the flywheels this is specific and unique to our team. * 2 points

The expected answer includes detailed descriptions of the function of the motor and servo along the ball path prior to the flywheels.

In our Hero robot, the mechanism responsible for feeding balls into the flywheels is a precisely controlled system that uses both a servo motor and brushless motors, coordinated through CAN bus and serial communication protocols. Balls are initially guided toward the chamber area by a mechanical or passive feed system. Before entering the flywheels, each ball must be properly positioned and released, which is accomplished using a servo-based gate mechanism. This gate is actuated by a high-speed servo connected to an Arduino microcontroller, which receives commands over the CAN bus. Specifically, the servo receives messages with ID 0x400, where the first byte identifies the servo (e.g., 1 or 2), and the second byte dictates the target angle. By adjusting the servo arm to the desired position, the system can reliably allow a single ball to pass into the firing chamber. This method ensures tight control over ball flow, avoiding misfires or double feeds.

Once a ball is chambered, it is immediately pushed into the gap between two flywheels. These flywheels are powered by brushless motors connected to electronic speed controllers (ESCs), which are in turn managed by a Teensy microcontroller. The Teensy listens for serial commands from the Raspberry Pi; when it receives a specific character such as '4', it sends a PWM signal to the ESCs to spin up the flywheels to firing speed (1400 μs pulse width). Conversely, a '3' command stops the flywheels by dropping the signal to 800 μs. This dual-microcontroller architecture—using CAN for servo actuation and serial for motor control—ensures accurate timing and separation of critical subsystems. The servo and motor work in tandem to ensure each ball is released and fired in a controlled, consistent, and high-speed manner, tailored specifically to match the demands of RoboMaster competition.

If you look at the standard and the sentry, they feed balls to the flywheels in a very different manner. Describe how the standard and sentry feed their balls and explain why the hero benefits from this different mechanism. * 2 points

Hint: overheating

In our RoboMaster codebase, the Standard and Sentry robots use a continuous motor-driven feeding system to push balls into the flywheels. This mechanism, while effective for rapid-fire scenarios, involves motors that run for extended periods, creating significant and constant power draw. Specifically, in the double_barrel.ino file used by the Sentry, the flywheels are controlled by PWM signals from a Teensy microcontroller and are kept spinning through serial commands from the Raspberry Pi. There is no gating or servo-based control—meaning the balls are likely fed directly into the spinning wheels via a roller or auger, which keeps running during operation. This leads to continuous motor usage and sustained current through the ESCs, making these systems prone to overheating during prolonged matches or high-frequency shooting.

In contrast, the Hero robot avoids this problem by using a CAN-controlled servo mechanism found in servo.ino. Instead of continuously driving a feed motor, the Hero only actuates the servo to release a ball when a shot is needed. This approach significantly reduces the duty cycle of the feed system, as the servo remains idle most of the time and only moves for brief moments to chamber a single ball. Additionally, the flywheels—controlled using the same double_barrel.ino—are only spun up on command, not kept running continuously. This results in dramatically lower thermal load on both the motor drivers and the servo system. By combining on-demand servo actuation with selective flywheel engagement, the Hero's system minimizes overheating risk, making it more reliable in sustained gameplay conditions. This is a direct architectural advantage over the Standard and Sentry designs, and it's evident from the intentional separation of servo and flywheel control logic in your code.

This year, the sentry is installing a component which DECREASES its pitching range. Explain what this component is and its role on the robot, why the sentry team decided to include it, and why it limits the pitch of the robot. * 2 points

The component mentioned is NOT the mechanical pitch limits on the outer side of the sentry gimbal. Ask your leads if you are unsure of what I mean by the mechanical pitch limits.

In the 2025 RoboMaster season, the Sentry robot includes a component that decreases its pitching range not due to an explicit rule, but as a strategic and engineering-driven decision rooted in real-world constraints. The pitch limitation is implemented to improve shot accuracy and system reliability, especially under dynamic conditions such as high-speed rotation and low-bandwidth motor control. While the Sentry typically uses a 3508 motor for pitch due to cost constraints—avoiding the more capable but expensive 6020—the 3508 lacks the torque and responsiveness needed to stabilize pitch at high angular velocities. This limitation becomes more pronounced when the robot is spinning with a staggered targeting system, as the motor cannot respond quickly enough to keep the aim on target, leading to missed shots. Additionally, advanced armor configurations like “donkers” and “swatters” physically deflect projectiles depending on angle and velocity, making many shots ineffective unless they are fired within very specific pitch and yaw windows. By constraining the pitch range, the Sentry avoids these ineffective angles, ensuring shots are fired only within viable hit zones and minimizing wasted ammo. Mechanically, integrating large motors like the Saturn poses design challenges due to their bulk, often requiring reverse mounting and the use of belts or linkages, which introduce mechanical compliance and further reduce pitch precision. These factors—motor bandwidth, control accuracy, physical deflection geometry, and integration complexity—combine to make pitch limitation not just a safety or rules compliance measure, but a tactical optimization based on real match conditions and hardware realities.

During video assessment, the sentry gimbal was placed on the AI standard chassis. Other than delays in shipping, and delays in production, what are design issues with the current sentry gimbal that prevents it from being mounted onto its chassis? * 1 point

During the video assessment, the primary design issue preventing the Sentry gimbal from being properly mounted onto the AI standard chassis stems from mechanical integration challenges. Specifically, the gimbal's current layout, including the size and placement of components like the pitch motor, conflicts with the spatial constraints of the AI chassis. Larger motors such as the Saturn, if used, protrude significantly and require non-standard mounting solutions like linkages or belt drives to fit within the turret — which complicates alignment and may interfere with surrounding structures. Even with smaller motors like the 3508 or 6020, proper clearance, wire routing, and center-of-mass alignment must be carefully managed, and the existing chassis design may not support this without modification. These design mismatches, rather than software or control issues, are the main factors currently limiting the ability to mount the gimbal effectively onto the Sentry's intended chassis.

If we remove computer vision from our robots, which of the following components are no longer essential for the robot to function in competition? * 1 point

- [ ] PMM
- [ ] MCM
- [x] Realsense
- [ ] VTM
- [x] Jetson
- [x] RPI
- [ ] Devboard C
- [ ] GM6020
- [ ] Light Indicator Module

Explain briefly why the components mentioned above are essential to CV but are not required if CV is removed from the robot. * 1 point

The Realsense camera, Jetson, and Raspberry Pi are essential to the robot only when computer vision is in use. The Realsense provides visual input data such as depth or RGB images for tasks like target detection or localization. The Jetson and Raspberry Pi serve as onboard processing platforms where computer vision algorithms are executed. These devices run models and logic that interpret the camera data and make decisions based on visual input. However, if CV is removed from the robot, none of these components are required. The robot can still operate using basic motor control, sensor feedback, and manual operation via remote control or other non-vision systems — all of which are handled by separate microcontrollers and modules not dependent on visual data

Why does the Controls team require a completely finished robot to tune the drive PID? * 1 point

The Controls team requires a completely finished robot to tune the drive PID because accurate PID tuning depends heavily on the final mechanical and electrical characteristics of the robot. This includes the total mass, inertia, center of gravity, friction, drivetrain configuration, and electrical loading — all of which directly affect how the robot accelerates, decelerates, and responds to control inputs. If the robot is incomplete (e.g., missing armor, battery, or gimbal), these dynamics will differ, leading to tuning values that are inaccurate or unstable once the robot is fully assembled. Additionally, sensor placement, wiring quality, and motor responsiveness can only be verified once the full system is operational. Without a complete robot, the Controls team cannot properly evaluate closed-loop feedback or ensure that the tuned PID parameters will be valid in competition conditions

Which of the following components are in the chassis DEEWS? * 1 point

- [ ] PMM
- [x] PDB
- [ ] MCM
- [ ] VTM
- [x] M3508
- [ ] SMM
- [x] Slipring Breakout Board
- [x] Centerboard
- [x] Dual PC Step Down

Which of the following components are in the gimbal DEEWS? * 1 point

- [ ] PMM
- [ ] PDB
- [ ] MCM
- [ ] VTM
- [ ] M3508
- [x] SMM
- [x] Slipring Breakout Board
- [ ] Centerboard
- [x] Dual PC Step Down

What is the primary win condition of the 3v3 competition? In other words, what number needs to be higher/lower than the opposing team to win? * 1 point

- ○ Base Health
- ○ Sentry Health
- ○ Capture Point Time
- ○ Points
- ○ Experience
- ○ Gold
- ○ Kills
- ◉ Other: Reaching 200 Victory Points before the 5-minute match ends, or havin

Throughout the semester you should have been maintaining your VIP notebook. For some of you, your entries may have been lacking in quality, depth, or pictures. Go back to one of your favorite entries and polish it up by better explaining the task, your approach to solving the problem, and any problems that arose. Make sure to add pictures. You will be graded on the quality of your submitted entry. * 3 points

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