A Comparative Analysis of Botball Servo Models

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***Abstract*—The objective of this work is to inform Botball teams about the specific strengths of the servos they are using, while also providing OPEN teams with possible servo alternatives.**

Looking at the different designs, it is clear that certain tasks can be solved better with a different model. An example of this is the weight of the servo, which should be as low as possible for a fast and agile robot.

In this work, four different servos are compared on the basis of various criteria such as price, size, weight, speed and lifting force, all of which are important when choosing a servo.

At the end there is a clear overview of the data of the servos used in this test.

I. Introduction

The objective of this paper is to identify the most suitable servo for specific tasks, such as heavy lifting. A comparison is made between the Absima S90MH servo and the MEX 85MG servo, along with their standard and micro Botball servos. The Absima S90MH and MEX85MG were selected due to their availability from nearby vendors. The comparison is based on factors such as price, size, weight, speed, and lifting force, which are all significant when choosing a servo for a specific objective.

Fig. 1. Servo Model Visualization

II. Literature Review

The cited work [1] offers a fundamental insight into servos, making it particularly useful for newcomers to the field. While the study focuses on the comparative analysis of specific servo models, it also explains more general distinctions, such as the difference between standard hobby servos and continuous rotation servos, or the distinction between micro, standard and giant servos. Additionally, it provides a comprehensive understanding of servo mechanics and their operating principles.

For those OPEN tournament competitors whose requirements extend beyond the four servos analysed in this study, the extensive servo database presented in [2] is a valuable resource. The servos used for comparison in this paper are not included in this database. Despite the potentially overwhelming array of choices, this database serves as a recommended starting point for identifying the most suitable servo for specific applications.

However, regardless of the chosen servo, it is always important to consider its lifespan. This study presents the lifting force of various servos, which is one of the many factors contributing to servo failure. However, other reasons for low servo lifespan and their solutions are presented in reference [3]. This includes selecting the appropriate servo for the intended application.

III. Comparison Details

A. Price

Price is an important consideration when choosing a servo.

The prices were obtained from official websites and converted to the appropriate currency for comparison. The exchange rate used was 1.00 USD to 1.09 EUR on 27th February.

B. Size

Servo dimensions are a critical aspect of robot design, particularly in situations with spatial constraints or specific enclosure requirements. Oversized servos can complicate the design process, while smaller ones may offer greater flexibility. Therefore, selecting the appropriate size is essential for optimizing robot functionality.

To ensure precise measurements, the size of each servo is measured using a caliper. The measurements include length, width, and height, and also take into account the servo head and handles.

C. Weight

Weight is a critical factor in robot design and functionality as it affects stability and agility. The choice of a heavier or lighter servo can significantly impact the robot's overall balance. Heavier servos can provide necessary stability, especially when placed at the robot's center of gravity, while lighter

options are advantageous for applications that require swift movements or strict weight constraints.

Due to the limited availability of specialised measuring instruments, the weight measurements of the servos are conducted using a commercially available scale with a specified accuracy of up to one gram. The servo cable is included in the weight, resulting in a small bias in the measurement.

D. Speed

In robotics, especially in competitive environments, servo speed is crucial. Servos must execute movements quickly to ensure optimal performance in competitions during the given time.

To compare the speed the turning servos is recorded on a 60-Frame-Per-Second camera and analyzed frame by frame. The number of frames required for each servo to turn 60° are counted and used to calculate a value in second/60° for each servo. This test is repeated 6 times and the arithmetic mean is calculated to ensure accuracy. There is a possibility of bias and the values may be slightly higher or lower.

E. Lifting Force

The lifting capacity of a servo is a crucial factor when constructing any lifting mechanism for a Botball tournament. It determines whether the servo will break during testing or, worse, during the tournament. Therefore, it is important to ensure that the weight a servo can lift is sufficient for the task at hand. Many servos have the issue of breaking down so it's important to know their limits. Using a weaker servo can present challenges, but overcoming them can improve the team's mechanical skills and lead to better results, especially when working within limitations. However, a servo with a higher lifting capacity is generally preferable.

The capacity to lift weight is usually measured in kg/cm, although precise measurement can be challenging. In this work, weight is added gradually to the servo until it begins to struggle. The Botball servos had been in use for an extended period, which may have negatively impacted the data.

IV. Results

A. Price

Upon closer inspection of the price data presented in Figure 2, it is clear that the Absima S90MH servo is more expensive than the standard Botball servo. Similarly , a comparison between the micro Botball servo and the MEX 85MG shows a comparable trend, albeit with a smaller price difference. When selecting a servo, it is crucial to consider both the cost and its potential benefits for the robot's design and operation.

The references can be viewed in [4]–[7], while the exchance course can be viewed in [8]

B. Size

The data indicates that the standard Botball servo is larger than the Absima S90MH, while the micro Botball servo is more compact than the MEX 85MG. This comparison of sizes, as shown in Fig. 3, can assist designers in making informed decisions to meet specific spatial requirements in their robotics projects.

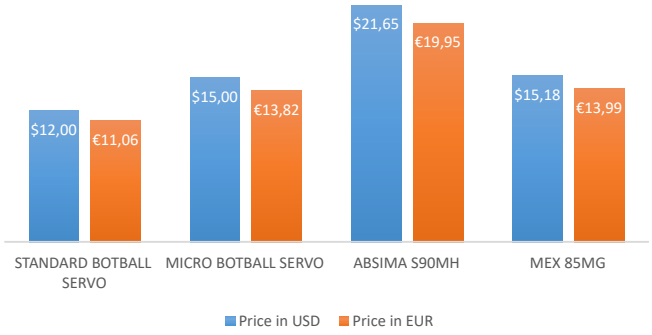

Fig. 2. Comparison of servo prices in EUR and USD

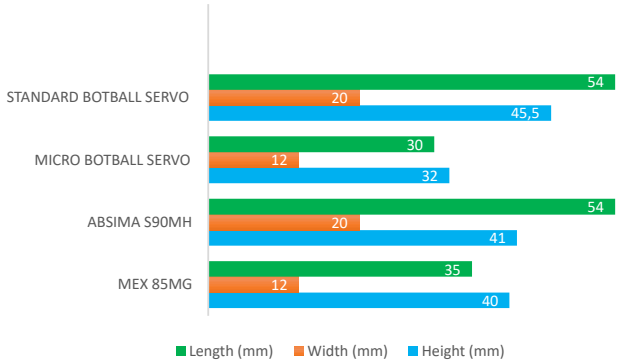

Fig. 3. Comparison of servo dimensions in millimeters

C. Weight

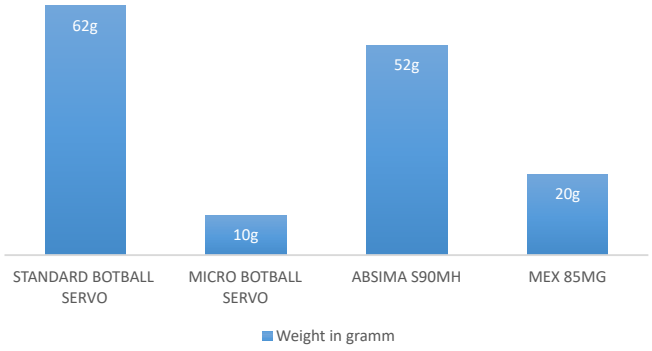

Fig. 4. Comparison of servo weight in gramm

As anticipated, there is a correlation between the size and weight of the servos. The micro Botball servo, being smaller, is also lighter than its counterparts. However, it is important to note the different rotating mechanisms of the

micro Botball servo compared to others, which must be taken into consideration when applying it. Therefore, selecting the appropriate servo requires more than just considering its size and weight. Designers should evaluate each servo's characteristics to ensure they align with the project's specific requirements.

D. Speed

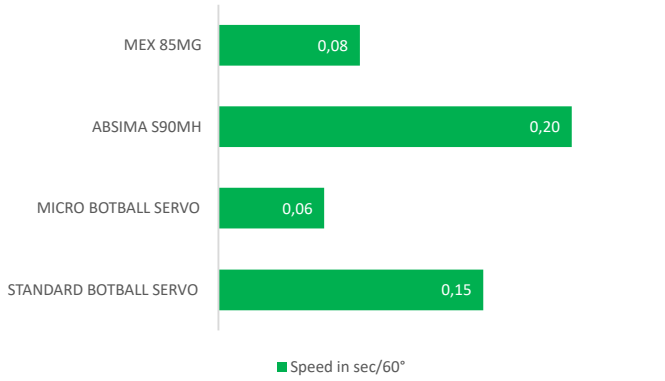

Fig. 5. Comparison of servo speed in sec/60°

Based on the findings, the micro Botball servo has the fastest response time, completing a 60-degree rotation in just 0.06 seconds. It is important to carefully select the servo to meet specific performance criteria, as even slight speed differences can be decisive in competitive robotics.

E. Lifting Force

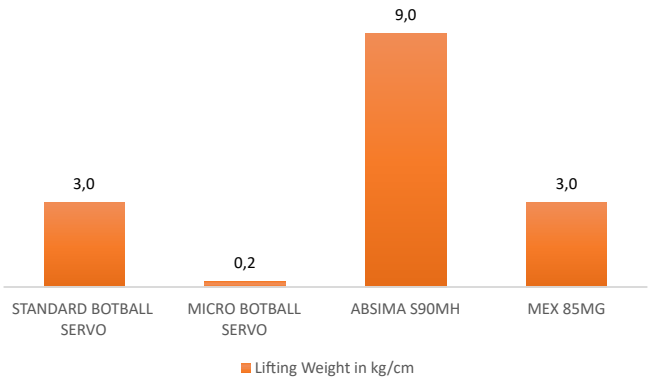

Fig. 6. Comparison of servo lifting weight

Figure 6 demonstrates that the Absima S90MH and the MEX 85MG perform well in this category, while the Botball ones seem to be less impressive.

V. Examples

With all this information in mind, here are some examples of when these different servos and their details come in handy. The price has been omitted as it does not directly affect the competition.

A. Size

The size of a servo comes in handy in many builds for a secondbot. The secondbot usually is very compact and easy to move around. The secondbot normally has a relatively small starting area too so it's highly recommended to keep the bot small if possible. For the mainbot, however, the size doesn't really matter much but it is recommended to use larger ones in most parts. The mainbot has more than enough space and that should be used.

B. Weight

Servo size is important in building secondbots, which are typically compact and have limited space. For mainbots, larger servos are recommended due to the ample space available.

C. Speed

In competitions, servo speed is a crucial factor to consider. However, it is important to note that faster servos can cause shaking and reduce accuracy if the bot or its arm is not built stably enough. To prevent this, the bot's design can be modified, but this may lead to other issues such as increased weight.

D. Lifting Force

In competitions, the lifting force is crucial, much like the speed of a servo. When constructing a robot arm, it is advisable to use a servo with a high lifting capacity at the center to lift the entire arm. If the servo is too weak, counterweights can be added. Weaker servos are better suited for the end of the arm since moving the hand requires less power than lifting the entire arm.

VI. Conclusion

When selecting a servo, it is important to consider its intended application.

For basic mechanisms used in Botball and OPEN tournaments, the Botball servos are sufficient. However, for tasks that require substantial lifting power, the Absima S90MH is recommended as it outperforms the standard Botball servo in capacity, albeit at the expense of reduced speed. Despite its lower weight and compact size, the cost must be justified before considering it as an alternative.

It is worth noting that the MEX 85MG is marginally larger than the micro Botball servo, but surpasses it in velocity. Conversely, the micro Botball servo is recommended for tasks that require high speed and low weight, while the MEX 85MG should be considered when great force and speed are required for a certain task.

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REFERENCES

[1] Basics about servos
https://www.sparkfun.com/servos
(last accessed on February 27, 2024)

[2] Servo database
https://servodatabase.com/servos/all
(last accessed on February 27, 2024)

[3] Servo lifespan and how to increase it
https://www.kebamerica.com/blog/what-determines-the-lifespan-of-a-servo-motor/
last accessed on March 29, 2024

[4] Standard Botball servo
https://botball-swag.myshopify.com/collections/motos-and-servos/products/standard-servo
(last accessed on February 27, 2024)

[5] Micro Botball servo
https://botball-swag.myshopify.com/collections/motos-and-servos/products/micro-servo
(last accessed on February 27, 2024)

[6] MEX 85Mg servo
https://modster.at/komponenten-zubehoer/servos/2263/servo-mex-85mg-modster?c=170
(last accessed on February 27, 2024)

[7] Absima S90MH servo
https://www.absima.shop/pp/absima-S90MH-9kg-servo-25t-metal-gear.htm?shop=absima_en&SessionId=&a=article&ProdNr=2030004&t=19114&c=19129&p=19129
(last accessed on February 27, 2024)

[8] EUR/USD Exchange Rate
https://www.google.com/finance/quote/EUR-USD
(last accessed on February 27, 2024)