

Fabrication of Foot Ball Launcher Machine

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Abstract – A football passing machine is configured to eject a prolate-spheroid-shaped football. The football passing machine includes a frame member, an adjustable launch surface mounted to the frame member, a ball magazine positioned above the adjustable launch surface that is configured to contain a plurality of footballs, a moveable escapement arm that is configured to successively dispense footballs that are contained within the ball magazine onto the launch surface, a moveable ball carriage configured to move a football between a first point on the launch surface that is located directly beneath the ball magazine and a second point on the launch surface that is adjacent a football launch mechanism that is configured to eject a football from the football passing machine. An orientation of the adjustable launch surface is configured to be adjusted to change a launch angle of a football while the frame member and the ball magazine remain stationary. The study of the simple Vapour Compression Refrigeration Cycle is much important in order to understand the overall performance of the system with parameters affecting it. An optimized design is possible through theoretical calculations, however may fail due to the reason that the uncertainty and complexity formulation of pressure drop inside the capillary tubes, heat transfer from the refrigerant inside the condenser tube to the ambient air, and hence done practically. Diameter of Capillary tube plays a very important role on the Performance of the vapour Compression Refrigeration System, The VCR System also depends on the type, quantity of the refrigerant charged. The project consists of an experimental performance on a vapour compression refrigeration system with different capillary tube diameters, with R-134a as refrigerant and hermetic sealed compressor of capacity 0.35 H.P and this study examined the effect of capillary tube diameters on the performance of a vapour compression refrigeration system by applying various amount of Refrigerant Charge. The literature review focuses on the effect that the geometrical parameters of Capillary Tube have on the coefficient of performance of vapour Compression Refrigeration System. All the parameters are to be varied and the performance of the refrigeration system will be evaluated. Further to evaluate the cost, the suitable material may be considered.

Keywords– Vapour Compression Refrigeration System, Coefficient of Performance, Capillary Tube, Global Warming, Refrigerants.

I. INTRODUCTION

Football or soccer is a team sport played with a spherical ball between two teams of 11 players. It is played by approximately 250 million players in over 200 countries and dependencies, making it the world's most popular sport. The game is played on a rectangular field called a pitch with a goal at each end. The object of the game is to score by moving the ball beyond the goal line into the opposing goal.

Football is played in accordance with a set of rules known as the Laws of the Game. The ball is 68–70 cm (27–28 in) in circumference and known as the football. The two teams each compete to get the ball into the other team's goal (between the posts and under the bar), thereby scoring a goal. The team that has scored more goals at the end of the game is the winner; if both teams have scored

an equal number of goals then the game is a draw. Each team is led by a captain who has only one official responsibility as mandated by the Laws of the Game: to represent their team in the coin toss prior to kick-off or penalty kicks. The players keep training to get better in game and try different shoots at positions. A Football Launcher is an innovative piece of training equipment that will change the way your players train and perform.

With a full range of elevation and rotation, football launcher replicates every type of delivery any player or coach could ask for. With different speed ranges, deliveries are not only precise, they are game realistic. And because of the launcher's flexibility, positioning and delivery can be changed in no time at all. Accepting ball sizes 5, 6 and 7 means our machine works with any group, any age, and any level from youngsters at grass roots levels to the seasoned pro looking to stay on top of

their game. With no required battery and the ability to deliver football continuously, crafted with the highest-3 grade materials, the Ball Launcher can keep delivering again and again without injury or fatigue.

Delivering a football accurately and consistently is one of the toughest challenges of coaching. Quite simply misplaced balls, fatigue and lack of quality leads to lost time, frustration and slower development. Ball Launcher can deliver continuously and accurately placed balls every hour without injury, without fatigue and without excuses session after session.

Football launcher was invented by Christian Guttler in Berlin, Germany. The machine is also described as a footonaut. The Footonaut, which costs \$3.5 million, is as large as an apartment with a cube shape and is capable of firing balls from a range of 360 degrees at different speeds and trajectories toward the training players. The players, who are standing inside a circle, must control the ball and pass it through one of 72 gates. Mario Gotze's winning goal of the 2014 FIFA World Cup Final has been credited to his years of practice using Footonaut. The Footonaut is also credited for the success of Borussia Dortmund, who first used the machine. It was reported that the team achieved its highest finish - ninth - in the Bundesliga for five years after using the contraption. There are three clubs currently using Footonaut in their training.

II. LITERATURE REVIEW

Innovative technological devices are not well known in sports' audience. However, some European clubs use them to succeed as better results as possible. Not only for injury restoration cases, but also for performance development. Football Launcher is a distinguished example of the technological progress in the 21st century's soccer industry. Football Launcher is a training system invented and designed by Christian Guttler in Berlin, Germany (The Economist, 2015). It is a training machine which boosts player's first touch with the ball and their instant reactions – a 14-meter four-sided robotic cage which is used for improving the passing ability and the spatial awareness of a player.

The player stands in the middle of a circle surrounded by 72 panels – 8 of which spit out balls to various heights, speeds and spins, while the other 64 are grids-targets. The machine is monitored by an application from coach's smart phone or tablet. When the player receives the ball, he has the right to make only one touch either with the foot or with the chest. At the same time, the target is identified by the lighting up of the panel around each grid. The grids are placed in 2 different heights, just like the three kinds of passes (short, long). After the ball touch, the player must aim the right grid directly. The speed of the pass and the time of reaction are also taken into

consideration. One session of the Football Launcher it is equivalent of one week of passing training. The Football Launcher can be filled with up to 200 balls per session. It can change the game perception, the speed of thought and/or the choices of a player in a very effective way.

The training results are calculated on the spot by the application and the coach creates a valuable database in his mobile device which he can incorporate into the training or manage it in countless different ways. Football Launcher was specifically designed for Borussia Dortmund back in 2012. The BVB had already clinched the Bundesliga title in back-to-back seasons, by winning the double for the first time. Nevertheless, the poor performance in the group stage of UEFA Champions League was a shocking experience. The team had not only the worst offense and defense but also was statistically the worst team in passes in its group. The players had tried the fewest passes (1,527) with the worst accuracy (79 %). It was considered as the 'long-ball' team of the group, because the long passes constituted the 12% of the overall passes. The 1,527 passes were less than half of Barcelona's total passes. (Daily Mail, 2012).

The use of Football Launcher is thought as one of the major factors for which the club, from the last place in the group stage, reached the UEFA Champions League final a year later by having one of the lowest budgets in the competition. It may have not won the trophy or the Bundesliga since then, but it is almost every year the runner-up in Germany and ranked 9th in UEFA's Club Ranking with 85.000 points (UEFA, 2017).

Since 2014, TSG Hoffenheim has become the 2nd club that have been introduced to this innovative technology. The results are irrefutable. From the 16th place and the relegation play-offs, in 2013, Hoffenheim managed to be qualified for the Champions League by finishing in the 4th place, in 2017, for its first participation ever in a European Competition. Right now, it is ranked in the 125th place of UEFA's Club Ranking with 12.685 points, the highest in its history (UEFA, 2017).

At this point, it is essential to mention that, in the 2014 World Cup final, the winning goal of Germany came from a simulation of Football Launcher. The scorer, Mario Gotze, controlled a cross with his chest and volleyed the ball into the net with an exact replica of the training the machine provided.

1. Problem Statement

The design idea with all the objective characteristics presents a challenging project to the team. This project features different technologies that will mesh in a cross-functional manner to provide features that will exceed the experience provided by previous systems. Therefore, the main priorities in the project's progress are to identify the type of shots that can be generated in a real- life game

environment and design a mechanism capable of reproducing them while maintaining a relatively low cost. Furthermore, player tracking and prediction will also be of great importance for Skill Court integration. Lastly, the automation and reloading capabilities of the system need to be enhanced to deliver a smooth system work that will impress and be the main features of the design.

2. Project Objectives

To conceive an automatic ball launcher machine for Skill Court training integration and automatic user interactions is the main goal. The system would allow for maximum user customization for improving one's skills while minimizing need for player adjustment. Additionally, the ball launcher will propel balls at different angles and spins using two friction wheels and a three degree-of-freedom platform. The ball launcher will be able to identify and estimate the location and distance of a player, track the player's movement using Open CV. Next, the mechanism will include a device for automatic loading in a training session. Overall, the whole system must fall under the design specifications set by the team to be relevant in the market. Ultimately, this project serves to understand the mechanical engineering design process of a device consisting of multiple components. The end goal is to provide students a challenging and thorough project building experience similar to industry standards.

III. METHODOLOGY

As technology continues to advance in different fields, and innovative technology look for ways to improve the quality of life, different devices have made their way into sport sciences. In recent years, many professional sport teams have considered different devices that can improve player's performance on and off the field. In soccer, wearable's, data acquisition, and analysis systems have become quite popular since the 2014 World Cup. One example of this was the use of analytics used by the coach of Germany to make a subsection; said substitution proceeded to win Germany its fourth world cup [46].

Additionally, in after match interviews the substitute Mario Gotze, credited its victory to countless hours of practice using the Footbonaut, a practice system used by German teams (see Targets for Practice in section 1.4). Therefore, there is a great importance to the implementation of technology in multiple sports such as soccer.

When it comes to different types of sport devices, ball machines are one of the most used Ball machines have been widely used to a great effect in multiple sports due to their consistency. Just like in many different sports, muscle memory is very important and given the multiple shots and actions that can be done with a soccer ball, consistency is a key factor to perfect a drill. Therefore, a

system capable of providing in game experience and consistency will be greatly considered by instructors in the soccer training industry.

Skill-Court's ball launcher accompanied with the training methodologies being developed is looking to target both interests mentioned before. With the capability of consistently recreating different types of shots, Skill-Court's ball launcher will provide multiple training sessions. Also, the reloading mechanism will greatly improve the training experience by implementing a new step to a drill. Lastly, the motion tracking and feedback systems that will be implemented to the system will provide with the right amount of data acquisition and player unique development needed. In other words, the system developed will be capable of providing an overall greater experience to different levels of soccer play for an affordable price.

1. Design Specifications Cost

The proposed design should incorporate the client's specific needs. Primarily, the product should be marketable to the demographic of soccer teams and organizations, to achieve this a relatively affordable price tag of under 30,000 rupees must be adhered to. This target range will keep the Skill-Court Ball Launcher competitive with other companies such as First Pitch, and the Sidekick.

2. Mobility and Tracking

The Skill-Court Ball Launcher will also require goal specifications to maintain the overall objective. The chief focus of the product is its ability to track a player and deliver the ball as the player chooses; the machine will be capable of understanding player Distance and predict position based off the player's movement while delivering an accurate pass. For the launcher to be able to deliver a wide range of specified shots, it must also have mobile capabilities. The Launcher's rotational capabilities must range in terms of roll, pitch and yaw. For yaw, the plane of the launcher must be able to move 120 degrees 15 horizontally. As for roll and pitch, the goal is to have a 45-degree tilt in either direction along the relative x and y axe. Along with this mobility, there must also be a self-locking mechanism. This will allow for the aimed target of 5 different types of soccer shots and passes for a variance in play.

3. Further Specifications

The Ball Launcher will also be able to provide a ball output velocity varying from 20-70 mph. The entire machine will be ideally less than 100 lbs. in weight, while battery life of the system should be in the range of 3-5 hours with an equal amount of time for recharge. In addition, the device will be very transportable; capable of fitting in the average truck or car.

4. Reloading

Finally, the Ball Collection and reloading of the Ball Launcher will be capable of storing up to 5 size No.5 soccer balls at a given time. This area of storage will then transfer the balls into the shooting segment to automatically deliver a ball. The Ball Launcher will ultimately fire a shot every 7 seconds to maintain a lively workout.

5. Skill-Court Integration

Skill-Court is the main software and company that we will be working with to accompany the ball launcher. Skill-Court provides a user feedback and timing system that encourages the trainer to improve reaction times and practice their soccer capabilities with automatic computer integration. Passing and soccer drills can be used to incorporate both the launcher, reloading and collection system, and finally Skill-Court to time and test players. The Skill court application will allow the user to communicate with the launcher to begin a drill, and the collection device to complete the drill, while providing various stats such as ball velocity and time of completion.

6. Addressing Global Design:

The team chose to participate as a member of Skill Court LLC and chose the mechanized ball feeder as our senior project; this entails primarily the sport of soccer but can be applied to many others. Our project is aimed to improve and enhance soccer practices across the globe with the various features. The intention being that the device will be built upon improving the skills of players from all regions of the world with varying styles of play. Although we would like to appeal to levels of soccer, cost aspects must be taken into account.

Soccer is an international sport and so we must allow the system and software to be available to as many users as possible. To adhere to this need, the system will be made as affordable as possible while maintaining structural capabilities. Likewise, the software and user customization will be available in multiple languages, of which will be chosen based on the major soccer playing countries and future academy use. At a minimum, user manuals and programs will be in English and Spanish, as well as possibilities of German and French.

Additionally, different mechanisms such as the platform and reloading of the ball launcher must be manufactured. The materials used must be affordable, environmentally friendly and available in most regions of the world. Related items and machines will be explored that could be used in relation for global learning. Lastly, one of the objectives of the system is to provide the user with feedback. Using the Skill-Court mobile application practice feedback, different unit systems must be used. In other words, the user must be able to switch between unit systems (e.g. km/h for SI, and mph for US units) and the ball feeder must be able to provide the desired velocity.

This would then assist users in both their aim and power capabilities.

7. Constraints and Other Considerations:

Materials needed to create the components of the launcher would need to be both affordable and sturdy, being able to endure vigorous periods of use and stress. Likewise, the design for the system must be considered and simplified to ensure manufacturing costs are kept to a low. Additionally, the system used to track a player using cameras already exists in various software, for this launcher Open CV will be considered. The goal to use Open CV to track a player's position, and then be able to predict the future movement and delivering a ball to the player, of which must be developed. The program would plot the player in a 3D space and provide feedback through the Skill-Court application similar to global design, the production costs of the launcher and collection system must be lowered as a main goal. Affordability and market range for the product will be expanded to its limits. By allowing the product to be available across the globe for a reasonable and competitive price, it will reach more academies and users.

8. Working Principle

A football launcher has 2 rotating wheels which are rotated at a high-speed using motors and the ball is projected through the wheels. The ball is gets projected in the required direction and speed due to the torque produced from the motors. We used dc motors of 2700 RPM as more amount of torque can is produced from a dc motor. The motors we used are gearless dc motors. The dc motors used in this project are run using S.M.P.S (S.M.P.S. is used to supply controlled voltage to the motors). The frame on which the motors are mounted is made up off MILD STEEL.

Whereas, for a ball to be launched at an angle the wheels are adjusted accordingly. The wheels used in the project are of plastic material with rubber gripping, dimensions of the wheels are 26 centimeters in diameter and 15 centimeters in width. Speed controllers can be used to decrease or increase the speed of rotation of the wheels. of which must be developed. The program would plot the player in a 3D space and provide feedback through the Skill-Court application similar to global design, the production costs of the launcher and collection system must be lowered as a main goal. Affordability and market range for the product will be expanded to its limits.

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Fig.1. football launching machine

3.9. Working Mechanism

The general mechanism used in a football launcher is rotary motion. By using rotary motion, we can guide the ball in different directions and shoot the ball at desired angles. The frame can be rotated 360 degree's as per requirement. Rotation around a fixed axis or about a fixed axis of revolution or motion with respect to a fixed axis of rotation is a special case of rotational motion. The fixed axis hypothesis excludes the possibility of an axis changing its orientation, and cannot describe such phenomena as wobbling or precession. According to Euler's rotation theorem, simultaneous rotation along a number of stationary axes at the same time is impossible. If two rotations are forced at the same time, a new axis of rotation will appear.

This article assumes that the rotation is also stable, such that no torque is required to keep it going. The kinematics and dynamics of rotation around a fixed axis of a rigid body are mathematically much simpler than those for free rotation of a rigid body; they are entirely analogous to those of linear motion along a single fixed direction, which is not true for free rotation of a rigid body. The expressions for the kinetic energy of the object, and for the forces on the parts of the object, are also simpler for rotation around a fixed axis, than for general rotational motion. For these reasons, rotation around a fixed axis is typically taught in introductory physics courses after students have mastered linear motion; the full generality of rotational motion is not usually taught in introductory physics classes.

IV. RESULTS & DISCUSSION

Ultimately, the original design has evolved in multiple aspects as certain needs have changed, become obsolete, or improved upon. The final results are a platform which achieves the goals of three degree of free movement while remaining under the budget, through a simple means of control and use. Multiple aspects such as standards and the overall design experience were documented accordingly as the prototype require multiple needs and

fields of specialty to succeed and remain acceptable. The first mentioned goals were achieved in nearly all aspects, with the exception of perfect user interface as it will be continually be developed.

1. Advantages

1. Coaching: Speeding up the development of individual players or improving as a team in record time are just the start of the story. Coaches can choose to build sessions around the Ball Launcher allowing them to validate the ability or improvement of players without having to make any allowances for inaccurate ball delivery. Ball Launcher can provide an increase of over 200% in training density creating reduced downtime and better performance quicker than any other comparable training method.
2. Easy to Transport: Through direct experience we are acutely aware of the issues that many coaches suffer in getting to and from training venues with all the required equipment.
3. Our compact and lightweight Ball Launcher can fit comfortably into the boot of a small family car. It can also be broken down into four separate parts in seconds if needed for extra space and ease of transportation.
4. Suitable for All: Whether used to provide goalkeeper training, hone first touch skills, finishing or validate a set piece strategy for an entire team, Ball Launcher can easily flex to the training needs of each and every training session.
5. Ball Size: Versatility was an important factor in the design process of the Ball Launcher. Because we know that coaches are sometimes called upon to teach at different levels of ability, it can deliver ball sizes 3, 4 and from speeds between 5-80mph.
6. Football Skills: Using a football launcher complex football skills can be mastered as it can shoot balls at different angles and in different directions. Skills like The Maradona Turn, The Scissor kick, The Rabona, The Bicycle, etc., can be easily mastered

2. Disadvantages

Movement: The main disadvantage of a football launcher is simply that it is not a human. The machine cannot move around and therefore, no machine will ever be as good as training with a training partner.

1. Portable: Not all football launchers are portable. As for a football launcher not being portable requires electricity which is a major setback.
2. Cost: In general, a football launcher is expensive. The cost of a football launcher varies according to the features available.
3. Flaws: Chances of short-circuit are more likely to happen due to the heavy load on the motors or heating up of aurdino.
4. Vibrations: Due to the high r.p.m of motors it leads to high vibrations in the setup which results in the slight deflection of the ball while being shot.

V. CONCLUSION

1. Conclusion and Discussion:

The autonomous ball launcher partially achieved the preface goals of three degrees of motion, player tracking, and autonomous nature through wireless control.

2. Evaluation of Integrated Global Design Aspects:

Prior to the first design and completion of the prototype, global insight was first taken into account as a major need and component that must be considered. This was due to both the commercial need of the product to be used around the globe, and soccer at its core being a global sport. This combination pressed for the need of a cheap and easily distributed machine, of which price was a major need to allow for as many users as possible to be exposed to the product.

Due to the nature of the ball launcher and its features, the interface used to connect one's self to the launcher and thus undertake a drill must be user friendly and available in multiple languages. Though the interface and Skill-Court application is only at its natal stages,⁴⁷ eventually the language barrier would be easily crossed and a wide set of languages could become available for global needs.

3. Evaluation of Intangible Experiences:

When working on any type of project or creating some type of device, there are always obstacles to be met and trials to endure. The process of designing and manufacturing this machine was no different as there were challenges at every aspect and time period of which were used to ensure long term goals are achieved. One of the foremost demands was the present budget presented to the group by the sponsor, with this budget alternate designs were relinquished and manufacturing costs intricately decided.

As a mechanical engineering student, one is not always exposed to the demands of traditional industry and business dealings, there must be compromises and withdrawals for a group to succeed and this was a substantial fact when choosing material and electrical components. Including the selection and restriction phases of the prototype, there were also lessons learned during the manufacturing phase.

As a design is made by an engineer through a CAD there is still numerous challenges and mishaps that can occur when translated to the physical parts. The group learned that an accuracy on the computer may not be possible on a manufactured part, or may require tools that far out of reach of the budget. This would suggest that the gap between design and manufacturing is an important one, and must be considered regardless of the industry. One may produce a magnificent and revolutionary conceptual design on the computer, but for it to translate to

commercial success it must be easily produced and realistic in terms of the manufacturers' perspective.

VI. FUTURE WORK

With any product, there is always room for improvement, whether it's best manufacturing costs or durability of the machine. For this launcher, the areas that can and will be improved in the future include programming, electrical, and material properties. The reason behind most of the components used were of cost and practical use, future work would include using material from a supplier that will come cheaper and just as sufficient or of higher quality with a slightly higher price. Material chosen could also be reclaimed after a substantial duration of use rather than tossed in a landfill.

Likewise, the motors and batteries used may be swapped for those of an eco-friendly nature allowing for recycling of products and being certified for bio friendly uses. Obviously, programming is at the core nature of the prototype, future work will include improving upon the processing power and response time of the Arduinos and Raspberry Pi used in this system and finally the Skill-Court application. The launcher relies on all components to successfully run simultaneously in a smooth operation, this will be a key trait that will need to be continuously monitored, compared, with many continuous trials made.

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