

## Problem Overview

Inclusion in the world of sports has significantly improved in the last few decades, but there is still a great amount of issues that might discourage people with disabilities from doing sport. Nowadays, there are 285,000,000 visually impaired people, which represent 5% of the population. Out of those, 39,000,000 are blind. When it comes to goalball, orientation is probably the most serious difficulty. Goalball is the only Paralympic sport created specifically

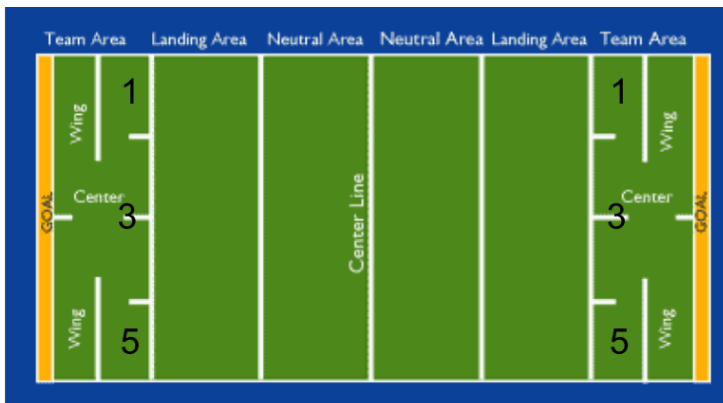


for blind and visually impaired people. It is based mainly on the auditory sense, since it is crucial to detect the trajectory of the ball, which has bells inside. Each player wears an opaque mask to equalize their vision. As it is impossible to orient yourself by sight, it is done by touch. The court is divided into different sections which are divided by lines. These are marked with rope and covered by tape so the players feel them with their feet, as they wear special shoes. However, although they are provided with facilities, orientation is still a problem. The main reason why we chose this problem is

because we believe that by improving the facilities of goalball, more visually impaired people will feel encouraged to start doing sport.

## Detailed description:

The aim of our project is to make orientation easier for goalball players, since it is the most serious problem regarding this sport. As a means of becoming better acquainted with goalball, we contacted Maialen Solaun, a blind Goalball player who shared her experience with us. We explained our proposal and she told us it would be extreme helpful. At the beginning, we did not know in which way we could help players to orient themselves more accurately on the pitch, but she cleared our doubts.



There are two teams in goalball and each one consists of three players. Maialen stated that being in her position during the match was not an easy task at all. Indeed, she told us that if the abovementioned concern was solved, not only would goalball become easier to play, but also more visually

impaired people would be encouraged to play goalball.

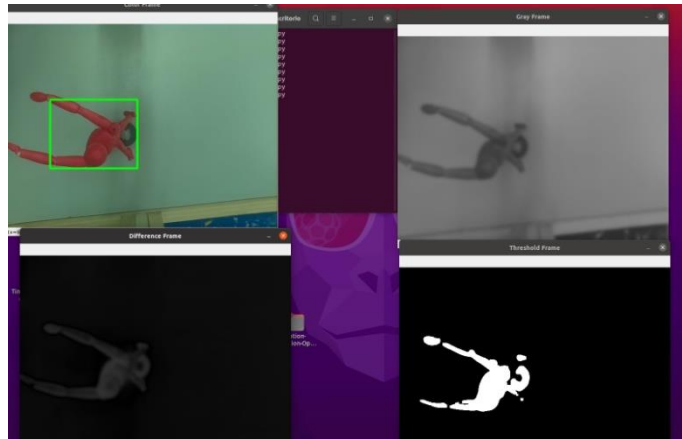
Once having explored all the options, we finally came up with the best one; installing one camera for the position. We contacted an enterprise called Urquizo Ingenieros in order to receive feedback and assistance. Not only did they think it could work in real life, but also they became our project's sponsors. Before installing them in real life, we made the decision of building a mock-up that could be used to test and explain the functioning.

The mock-up consists of a 50x100cm wooden plank which simulates the goalball field. It has two sticks holding a Raspberry Pi micro computer which captures the image and processes it in real time. The camera captures a stick figure which simulates a player. On the top of its structure, two batteries were installed as a means of powering the Raspberry Pi and making it portable. It also has some led stripes which are used to light the field as it would be in real life, as well as to avoid the issues that the shade of the mock-up can produce.

We developed the movement detecting program using Python, which is an interpreted programming language popularly used to detect movement and track objects in real time. This program uses different libraries such as OpenCV, Pandas and Time, whose objective is to calculate the time accurately and make the movement tracking easier.

There are four different tabs which have been programmed using Python on a Raspberry Pi:

- In the first one the real image in which the object in movement is always inside a rectangle.
- In the second and third ones the picture modified by some filters created by the program to make the movement detection easier.
- In the last one, the lack of movement is represented by the color black, whereas the objects in movement are white.



Thanks to our proposal, when the player arrives at their position, they will feel a vibration in their arm. The micro computer would send a message to the bracelet that each player would wear and, thus, the player will know exactly where they are when noticing the vibration.

## **Innovation impact:**

Visually impaired people usually find themselves excluded from the world of sports. The sport we aimed to improve is Goalball, which is one of the two sports practiced by blind people in paralympic games. We thought that inclusion was one of the main objectives to achieve, and we developed the project with the aim of helping goalball players to find the game more comfortable.



The team searched for different solutions, such as the use of lasers or sensors, but finally thought that the more accessible and precise one would be the implementation of a program which detected the movement of the players through a camera.

The innovation of this project is seen in the use of sensors for the orientation. Up to now, there has not been any sport where sensors have been used, this could be due to the lack of interest in improving the world of paralympic sports, but by the introduction of this proposal on the goalball world, the game would improve significantly and the way of playing would become more dynamic and flow better. Even if we thought that it was going to be hard work because we did not have enough knowledge, we had faith in ourselves and started putting the project into practice.

By introducing a camera in goalball, it would be the first sport played in the paralympic games with such technology. Maialen Solaun supported us and she said that it would be magnificent to try our proposal in their training. Furthermore, if this benefited the way they play as well as the players, it could be installed for matches, which is the main objective of this project.

In addition, the innovation of the project would probably attract non-visually impaired people who have never tried this sport. Some people may think that mixing technology and sport could be fun and they would try it. In this way, the popularity of the game would spread faster and as time passed the sport would capture the interest of different sponsors which would make this sport more widely known. If all this happened, the sport would win professional status and even if goalball players would not be able to live off this sport, they could obtain some income from it.

All in all, we could say that the researching team has innovated in an inclusive way for everyone to have the same opportunities on the game. The introduction of the camera has

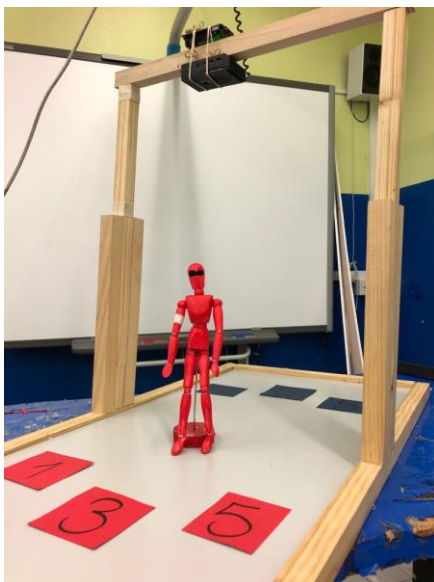
never been tried officially in the paralympic games and this would be the first time. Mixing technology with paralympic sports is the future, since by the implementation of this orientation method this sport will offer a better game experience to players, and it will gradually expand to other sports in order to reach overall inclusion in this hard world.

## Create:

Firstly, we contemplated numerous solutions to solve the assignment First Lego League introduced. We tried to find a way to make people do more sport and we considered several proposals such as making a competition to promote sport and a healthy lifestyle. After some research we realized it was a broad topic, therefore we decided to contact some experts so as to give us their opinion about our problem. All of them told us it would be better to focus on a more specific issue. Among these experts, there was the doctor and professor Jesus Cámara, who guided us in our decision. After his advice, we decided to look for an unusual sport and that is how we found goalball. We realised that this sport was not developed and improving it would be an easier way to make it more reliable. In this way we could encourage more blind people, as well as not disable people, to try this unpopular sport.

Once we knew our problem was going to be about this sport, we decided to contact Maialen Solaun, a goalball player, for further documentation. She told us that one of the main problems they had while playing was the lack of orientation. That is why we reckoned it was a brilliant plan to develop a project in order to solve this difficulty.

We contemplated the best way to achieve this goal was using laser sensors so that the players can know where they are. We first reckoned about giving each player earphones to send a message via sound. Soon after we realized the players had to listen to the bells in the ball, thus we finally made bracelets which vibrate when the Raspberry gives the message.



We decided to create a replica of a goalball pitch. We did not know where to place the sensors; as a result, we finally decided that it was better to set the Raspberry on top of the sports centre to have a whole view of the field. In this way people would have a clear idea of how this would work in a real situation, as well as how the camera would capture the teammates. On the other hand, we have also added a wooden figure which represents the players. We realized it was easier for the camera to capture bright colors, as the contrast between the figure and the floor was more significant. This is the reason why we painted it with red paint.

Firstly, we only programmed the Raspberry to capture the movements, and after plenty of research, we managed to make the raspberry make a noise when the wooden figure was detected on the camera. This was a fairly difficult task since programming with Python required knowledge that we lacked. At last, we contemplated the possibility of adding some lights in the corners of the mockup to avoid shades.

## Implementation:

As far as the cost is concerned, using a Raspberry Pi would be without a doubt the most affordable and practical option for our idea. Furthermore, this item comes in a fairly convenient size and it could be found easily. With all the components required (a camera and extremely durable batteries) and the programming process cost included, the total price of each micro computer is €150 (\$179, 64). One camera will be approximately needed for each side of the pitch. Therefore, a total of 2 cameras will be installed ( $2 \times €150 = €300$ ) or ( $2 \times \$179, 64 = \$359, 68$ ). Even if the price seems slightly high, it must be taken into account that once this is installed, no more investments would be needed. In addition, it is worth bearing in mind that the project has been developed in a cost-effective way. Although there are cheaper options to develop the project, if all the requirements are wanted this equipment is the most accurate by far. In order to receive the precise position of the players, the programming is completed in the most beneficial possible way.



The bracelet would cost approximately €20 (\$23, 95). Each player will need a bracelet thus the estimated price of all 6 bracelets would be €120 (\$143, 69). The bracelet must be worn in the arm since the rules and regulations do not allow wrist bracelets, watches or any kind of wrist accessories. In a real match, the players would feel a long vibration (1.5 seconds) when they arrived at their position and a short one (0.5 seconds) when they stepped out of it.

Goalball is played indoors; consequently, meteorological events will not affect the cameras in any way. Furthermore, as goalball pitches have spotlights to illuminate the field, there will not be any shades so the camera's functioning will not be altered. On the other hand, the attachment of the Raspberries would be quick, easy and inexpensive, as anyone could install it. Just like in the mock up, the cameras will be placed on the roof so that they can capture the players in a "satellite view". Due to the fact that energy is needed for the micro computers to function, the wiring would need to be installed in the roof. In order to avoid a new electrical installation, the already existing lighting system will be used. To ensure proper functioning of the Raspberries, it would be recommendable to send someone once in a while to check on them, even though it is fairly improvable for them to malfunction.

When the team contacted Maialen Solaun, she told us that it would be prudent to test it in the training sessions before implementing it on real matches. Not with standing, she noted



that if our proposal was successful, it could be used for matches, which would completely revolutionize the way goalball is played.

## Team description:

Goalvolution is one of the two teams Begoñazpi Ikastola presented to First Lego League this school year and it is made up of nine teenagers between the ages of 15 and 16. Since the beginning of the project our values were clear and firmly stated. Working all together, listening to all the members of the team and helping each other were the main basis for the group to work correctly.

During the process of developing the proposal, different problems had to be faced. Firstly, we did not know how to conduct the project as it was difficult to focus the main aim and we spent about two months thinking about it. In spite of all the difficulties we had to cope with, we finally came up with the definitive proposal and the manner of working changed drastically.



Due to all the time we have spent working as a team, we have learned from each other and our capacities and skills have improved in different fields. All the team members have grown personally as well as intellectually.

Obviously, not all of us have the same abilities in every aspect. However, we have tried to work as much as possible as a team and we have learned about those aspects which, we lacked enough knowledge at the beginning.

## **Public Innovative Solution Description**

Inclusion in the world of sports has undergone radical change in the last few decades, but there is still a great amount of issues that might discourage people with disabilities from doing sport. When it comes to goalball, orientation is probably the most serious difficulty. Goalball is the only Paralympic sport created specifically for visually impaired people. It is based mainly on the auditory sense, since it is crucial to detect the trajectory of the ball (with bells inside). The court is divided into different sections, divided by lines. These are marked with rope and covered by tape so the players feel them with their feet. Although they are provided with facilities, orientation is still a problem. Our team has created a movement detecting program using Python to calculate the time accurately and make movement tracking easier. Each player wears a bracelet that vibrates when they arrive at their position.

## **Description of Innovative Solution**

Improving goalball by positioning bracelets