Feasibility Study of AutoRef

The feasibility study is done with the rules we will implement in mind. The analysis can be different depending on the goal of the project.

Continuation of the study done by the previous batch; they are not included in the document for now.

## Feasibility checks for five CCTV cameras in the arena

Advantages: -

* Cost:
  + Relatively cheap compared to the other cameras and they are built to last. The cost of one camera can be as cheap as €20 to €400, depending on the quality.
* Scalability:
  + The system is scalable since CCTV cameras are easier to plug and play, also, the cost is low.
* Energy Consumption:
  + The cameras are energy efficient since more companies are producing the camera and are widely used in multiple fields.

Disadvantages: -

* Reliability:
  + The reliability will depend on the information of the image and depending on the camera the information can be sparse.
* Speed and Accuracy:
  + Speed will depend on the encoder for the video and the programming software/ language used for analysis. Accuracy will depend on image quality. The expensive cameras will be of a better quality.

Conclusion: The CCTV cameras are cheap and easy to scale. However, the speed of decision-making and accuracy are debatable.

## Feasibility checks of OptiTrack Data

**Advantages: -**

* High Precision:
  + High precision and accuracy in tracking turtle and ball.
* Low Latency and Real-Time Tracking:
  + Minimal delay between the movement of objects and the identification.
* Scalability:
  + The system is highly scalable, so the proof of concept is easy to replicate in the actual field.
* Knowledge:
  + The TechUnited team is already working on it, which means it is easy to get help. Also, the company should be providing some more support if some other problems arise.

**Disadvantages: -**

* Cost:
  + Expensive to set and maintain the system, particularly large-scale systems like MSL field, 22m long. However, TechUnited already has a system setup. So, proof of concept is good to use.
* Complex Setup:
  + Calibration and setting up the cameras to cover the field will be complex and time-consuming, requiring expertise in camera placement, marker configuration, and software calibration. To implement in the tournaments, technical knowledge is important.
* Occlusion:
  + Depending on the number of cameras and camera positions, there can be occlusions.
* Maintenance:
  + Regular maintenance is required to ensure the performance of the system. Including cleaning cameras and markers, updating software, and if required troubleshooting hardware issues.

Conclusion: Since the TechUnited already has a setup it is good to use this system. Data is highly accurate and the system is scalable.

## Feasibility checks for Scaling SSL Vision to MSL:

**Advantages: -**

* Real-Time Tracking and Latency:
  + SSL Vision provides real-time tracking of the robots and the ball during gameplay with minimum latency.
* Precision:
  + The system provides high precision in tracking the position and orientation of the robots and the ball.
* Standardized Output:
  + SSL Vision follows standardized protocols for data output, ensuring compatibility with various software applications and simplifying the development of algorithms and strategies.

**Disadvantages: -**

* Cost:
  + The cost of setting up the camera systems can be high, even though multiple types of cameras can be used with the algorithm.
* Maintenance:
  + Regular maintenance is required to ensure the performance of the system. Including cleaning cameras and markers, updating software, and if required troubleshooting hardware issues.
* Occlusion:
  + Depending on the number of cameras and camera positions, there can be occlusions.
* Complex Setup:
  + Calibration and setting up the cameras to cover the field will be complex and time-consuming, requiring expertise in camera placement, marker configuration, and software calibration. To implement in the tournaments, technical knowledge is important.

Conclusion: SSL Vision and OptiTrack provide similar flexibility and accuracy. If both systems provide similar outputs, then the algorithm that is further developed to referee the match can be easily modified for both systems.

## Feasibility check for MATLAB and Simulink

**Advantages: -**

* Versatility:
  + A wide range of tools and functions are available.
* Integration:
  + Provides seamless integration with other software and hardware components.
* Customization:
  + Allows customization of algorithms to suit the rules and requirements of the MSL.
* Community Support:
  + Support from the TechUnited team, since they predominantly use it. Also large user community exists through which further help is easier to get.

**Disadvantages: -**

* Resource Intensive:
  + Computations can be resource-intensive.
* Real-Time Performance:
  + Achieving real-time performance can be challenging particularly if the tasks are computationally intensive.
* External dependency:
  + The data sources, and sensors, are external dependencies for MATLAB.

Conclusion: Since we have more experience with MATLAB and Simulink than any other programming/scripting languages, it is easier and advisable to use them for the project. Also, we can get help from TechUnited and the community if some roadblocks arise.

## Feasibility check for Python

**Advantages: -**

* Ease of Development:
  + The language is simple and readable. This means that it is easy to read, write, and debug.
* Community Support
  + Large and active community of developers, researchers, and enthusiasts. Also, has many forums, documentation, and tutorials.
* Ecosystem:
  + Python has a vast ecosystem of libraries and frameworks which can be used for implementing any task.
* Integration with ROS:
  + Integrates easily with ROS

**Disadvantages: -**

* Performance:
  + Compared to C++ python can be slower in execution speed and memory usage.
* Resource Efficiency:
  + Dynamic typing and memory management can result in higher resource overhead compared to statically typed languages.
* Dependency Management:
  + When there are more packages, it can be difficult to manage the dependencies.

Conclusion: Python is an easy language to read, write, and debug. There are a lot of communities that exist to get help from with well-explained documents. Integrates easily with ROS. However, the over-dependency on multiple packages can be difficult to manage.

## Feasibility check for C/C++

**Advantages: -**

* C++ has STL which facilitates the use of data structures like vectors, deques and sets.
* There is a computational speed advantage.

**Disadvantages: -**

* There are no predefined regression functions or functions catering to geometry which is one of the basis for what we do.
* For computational speed, there is a need to learn the linear algebra libraries.

**Conclusion:**

We could just use MATLAB and use MEX files to incorporate C++ as and when required. That way we could use the functionalities of MATLAB alongside the data structures of C++.

## Feasibility check for ROS (Robot Operating System)

**Advantages:**

* Middleware:
  + ROS provides a robust middleware infrastructure for building complex robotics systems, including communication between processes, hardware abstraction, and package management.
* Packages:
  + ROS has a lot of packages for various robotics tasks, making development more accessible and efficient
* Language Support:
  + ROS supports multiple programming languages, including C++, Python, and others, allowing developers to choose the language that best fits their needs.

**Disadvantages:**

* Learning curve:
  + ROS has a steep learning curve, especially for beginners, due to its distributed architecture and complex concepts like nodes, topics, and messages.
* Resource-intensive:
  + ROS can be resource-intensive, both in terms of computational resources and memory, which might be a concern for resource-constrained systems.
* Our project involves creating an autonomous referee for soccer robots, focusing primarily on implementing the logic governing the game's laws and rules. Therefore, while ROS is a powerful tool for robot control, it may not be the most suitable choice for our specific needs.