Final Project Report

SOCCER FREE KICK

by

Raul Pulido

Prince John Okodua-Oboh

Ernst Junior Barbier

DGMD S-14: Wearable Devices and Computer Vision

Summer 2021

**Table of Contents**

1. **Introduction ---------------------------------------------------------------------------------------------- 3**
2. **Project Description-------------------------------------------------------------------------------------** 4
   * *Systems Requirements*
3. **Development Process--------------------------------------------------------------------------------- 5**
   * *Data Collection*
   * *Analysis and Feature Extraction*
   * *Model Creation*
4. **Results and Conclusion------------------------------------------------------------------------------ 6**
   * *Model testing*
   * *Learning outcomes*
5. **Future Work---------------------------------------------------------------------------------------------- 7**
6. **Miscellaneous------------------------------------------------------------------------------------------- 7**
   * *Development tools*
   * *Activities Agenda*
7. **References------------------------------------------------------------------------------------------------ 9**
8. **Introduction**

One of the biggest challenges faced by soccer players is finding consistency in taking free kicks. According to statistical analysis, the average scoring percentage for all free kicks in professional soccer is about 70-75%, while 25-30% of those free kicks do not result in a scoring goal. We want to build a system that allows us to identify when a soccer player performs a free-kick if the taken free-kick qualifies as a ***good*** free-kick and converts into a goal, or if, on the contrary, it is a ***bad*** free kick and will not result into a scoring goal. The Soccer Free-Kick project attempts to demonstrate how Artificial Intelligence (Machine / Deep Learning) can be applied to the determine these two categories of free kicks.

A football player kicking a ball

Description automatically generated with low confidence

1. **Project Description**

* ***Systems Structure***

With the goal of categorizing free kicks into bad or good, our system is implemented with the following structure:

* + The use of a smartphone’s accelerometer to capture data.
    1. The smartphone is attached to the leg of the player performing the free kick
    2. An interval of 5 seconds is defined to record the free kick
  + Collected data are labelled and categorized into 2 classes (BAD KICK and GOOD KICK)
    1. **BAD KICK**: free kick that did not have enough power and/or direction to reach the goal
    2. **GOOD KICK**: free kick with enough power and directed towards the goal
  + Recorded raw data are trained and tested using Edge Impulse Studio

A picture containing tree, outdoor

Description automatically generated

1. **Development Process**

Our project was created by leveraging Edge Impulse Studio features for data collection, analysis and features extraction, model creation and testing.

- *Data Collection*

We created a project in Edge Impulse to sample the data from our smartphone’s accelerometer. Data was recorded for a period of 5 seconds (5000 ms), at a frequency of 62.5Hz, and labelled as GOOD KICK or BAD KICK depending on whether the free kick converted into a scoring goal or not. We obtained a total of 279 samples or raw data across 3 different datasets, which we broke down into training data and test data for a coverage of 80% and 20% respectively.

* + *Analysis and Feature Extraction*

Following the data acquisition process, we trimmed our raw data to a smaller windows size before doing any signal processing. (We experimented with 2- and 4-seconds window). For the digital signal process, we performed some trials with low-pass and high-pass filter but ultimately elected to not apply any filter to our data in order to extract a more meaningful feature.

* + *Model Creation*

Our model creation was accomplished by using the Neural Network classification template based on Keras deep learning API. We opted to set the epoch at 30 and the learning rate to 15 seconds. We accomplished an accuracy 90% in classifying our data into BAD KICK and GOOD kick.

*(Note: the described processes above were performed on each of our dataset separately and combined. An analysis of the results is provided in the “Results and Conclusion” section below)*

1. **Results and Conclusion**
   * *Model testing*

As previously stated, we tried different combinations with the 3 dataset we collected for this project. The results obtained were different with each approach. We were successful in creating a more accurate model with each dataset individually than when combined. We also encountered different results when processing our data with different setting (applying filter, trimming time, etcc.). We our most accurate model, our test data live classification were in most cases successful.

* + *Outcomes*
    1. *Positive*
       1. *When testing on single dataset with uniform raw data, accuracy was high and trained model performed as expected.*
       2. *Classification of Good and Bad Kicks were achieved*
       3. *We were able to apply different filters and analyze the different results*
    2. *Negative*
       1. Different inputs create different variables => different output
       2. Lack of uniformity in raw data lead to bad
       3. Accuracy was lower when combined dataset and Trained model did not produced expected results

1. **Future Work**

In the game of soccer, kicking a ball involves many variables to be analyzed, such as:

* + - The foot used takes the shot (right or left)
    - Part of the foot with which the ball is kicked (inner instep or outer instep)
    - The distance between the goal and the ball
    - The power of the shot made by the player
    - External factors can affect the effectiveness of the charge, such as wind direction.

Our plan involves incorporating these variables in future development and creating more classes to eventually have a more effective system with a better analysis of how a player shoots free kicks and provides a more detailed guide on performing better free kick.

1. **Miscellaneous**
   * *Development tools*
     + Smart Phones (Samsung Galaxy S20 Ultra, Iphone XR, Galaxy S10)
     + Edge Impulse Studio
     + Slack, Microsoft Teams
     + Jupyter Notebook
     + STM32L476 Nucleo-66
     + Sensor Tile Kit
     + GitHub repository: (https://github.com/ernstba24/soccer\_free\_kick.git)
   * *Activities Agenda*

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | | **Agenda** | |
| July 16 | | Project Proposal and Organization of the activities | |
| July 20 | Follow up of Setup of Sensor and begin the collection of data |
| July 23 | Results of Sensor Title Data Collection and Begin Data clean/ Data Classification |
| July 27 | Follow up Data Classification |
| July 30 | Results of Data Cleansing/Classification and Preparation of the Final Project Presentation |
| August 2 | Final meeting to review all results and finalize details of the project presentation |

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Responsible** | **Activity** | **Output** |
| July 11-18 | All | Project Proposal | Project Proposal Google Doc |
| July 19-22 | ALL | Sensor Title Setup and Data Collection | Videos, Pictures, and other documents |
| July 23-28 | All | Data Cleansing and Data Classification | Videos, Pictures, and other documents |
| July 31 | All | Preparation of the final project Presentation | Final Video |
| August 2-4 | All | Project Presentation | Final Video Presentation |

1. **References**
   * STMicroelectronics SensorTile Reference Design: Basketball Free throw Classifier by Machine Learning (<https://sites.google.com/view/ucla-stmicroelectronics-iot/home>)
   * Edge Impulse Documentation (<https://docs.edgeimpulse.com/docs>)
   * Free Kick Statistics

(<https://www.thestatszone.com/archive/statistical-insight-into-penalty-shootouts-where-to-place-your-penalty-13886>)

(https://instatsport.com/football/article/penalty\_research)