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Tunisian Republic



Ministry of Information Technology and Communication Ministry of higher education and scientific research ESPRIT

Graduation project Report

Computer Vision for Elaborated by: Safa chehimi

Work proposed and elaborated within:

DNA Global Analytics



DNA GA Supervisor: Mr. touzi Foued

University Year: 2020-2021



Executive summary

Digital Technology is having an undeniable impact on how we carry out our daily rou- tines, and it has also changed the way we do business. It is a fact that digitization has created new skill sets which most companies need to maintain their competitive edge.

Within DNA Value in DNA Global Analytics Swiss, we have launched a new Intelli- gence solution, where we use machine learning in particular Computer Vision,Nvidia edge device, data aggregation and data visualization to create a customer’s data gathering plat- form. These insights will empower the business to make strategic study on customers and target their advertisement based on the real-time age and gender demographics in the store.Therefore be used to influence buying behavior of consumers which leads to a more profitable business.

The goals of the Competitive Intelligence project is to provide a customer segmentation to evolve the know-how marketing segment. This will provide insights about which DNA GA clients need to know about their clientele to stay ahead in the market strategy. Moving forward we wish to expand the project scope to be able to generate more intelligent features and services to help our clients make the right decision to ensure their business evolution.

Keywords: Computer Vision,people counting,Age and gender classification, FairMOT, CNN, Transfer Learning, Visualization



Dedication



Acknowledgement

I would like to thank everyone who contributed to the success of my internship.

I would show my special and greatest appreciation to DNA Global Analytics for hosting me and for giving me valuable assignments during this internship.

I also thank the entire DNA GA’ team for creating a positive and comfortable work envi- ronment. They were a precious help in the most delicate moments especially my supervisor Foued Touzi. I really appreciated his continuous support, patience, kindness, motivation and immense knowledge. I could not have imagined having a better adviser and mentor.

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Finally, I take this opportunity to acknowledge with much appreciation the jury members who have taken the time to evaluate my work while hoping that they find in this report the qualities of clarity and motivation that they expect.



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Acronyms and Abbreviations

DNA GA Digital Neuro-marketing Algorithm - Global Analytics AI Artificial Intelligence

ML Machine Learning

CV Computer Vision

MOT Multi Object Tracking

YOLO You Only Look Once

PIL Python Imaging Library

VM Virtual Machine

NumPy Number Python

SSH Secure Shell

SSD Single Shot Detector

HOG Histogram of Oriented Gradients

RTSP Real-Time Streaming Protocol

RoI Region of Interest

GPU Graphic Processing Unit

IoU Intersection over Union

AP Average Precision

mAP mean Average Precision

KPI Key Performance Indicator



Introduction

For years, retailers have experimented with various techniques to study customer behav- ior. However, because of a lack of suitable technology and incorrect behavioral models, large amounts of data that can only be considered less than perfect have accumulated with no actual purpose.

thankfully with the rise of Artificial intelligence and Machine learning, retail business are trusting this modern technology to provide a business opportunity to beat the competitors whom are using a more traditional approach.

To gain new customers, maintain client loyalty, and improve customer service, retailers are revamping their business tactics. Knowing the quantity and specificsof visitors depending on gender is one technique to demonstrate a retail shop’s good market performance. Installing CCTV cameras in retail stores allows you to monitor the number of visits. CCTV was only employed for security purposes in the existing store system to monitor activity in the retail business.

But now with the evolution of computer vision we are witnessing a major resurgence of interest in how machines ‘sees’ and how it can be used to build products for consumers and businesses. Few examples of such applications in retail store are: Inventory management, Inventory management, Store layout improvement and Virtual mirrors and recommendation engines.

DNA GA team, within Computer Vision Projects, focus on helping their clients in logterm marketing planning and strategy formulation. Among their top challenges is to help the client take the right decision at the right time to ensure its company’s economic growth. In this study, we attempt to use computer vision to help our client (Cora Supermarket France) identify its target customers by processing their cars’ data and extracting insights from it. Ultimately "Cora" will be offered a custom computer vision solution for intelligent customer behavior analytics with features including real-time people tracking and counting once entering the store beside gender identification and age estimation of their customers.

The remainder of this report will be detailed as follows



The first chapter will contain the overall overview of the project, beginning with present- ing the hosting organism, the market study, then giving the project description. Throughout the second chapter, we represent our work methodology followed by the state-of-art in chap- ter three. In the fourth chapter, we will focus on the design and architecture decisions in this application, both from a general perspective as well as the proposed solution where we will discuss the reasoning behind our approach. The final chapter will focus on the achieved results and the implementation of the solution along with a guide on the various technologies used and the dashboard features.



I

Project Context



I.1 Project Context

In this section, we’re going to present the general context of the project. Then, we will provide a description of the company which proposed and supervised it. During the latter, we will introduce its different center of interests. Then, we will present the market study, the problematic and the work methodology in DNA GA. Finally, we’ll give a brief description of the solution’s overview.

I.1.1 General Context

This project is done as part of my academic process, within the context of graduation internship in order to obtain my national engineering diploma of Telecommunications from the Higher School of Communications of Tunis (ESPRIT). It was done with collaboration of DNA GA Switzerland.

I.1.2 Company description

In this subsection, we will present the company DNA GA and introduce its different work fields.

I.1.2.1 About DNA GA

Founded in 2006, ADN Agency is managed by Bilel Chérif (the current CEO of the group) and accompanies clients in graphic design, consulting and outdoor and digital advertising management. ADN Agency has become DNA Global Analytics to cope with the fusion of the physical and digital worlds. DNA comes from digital neuromarketing algorithms. Its vision is to deal with marketing in a scientific way. DNA Global Analytics (or DNA GA) is the only participant today who can create physical data and merge it with digital data into "phygital" data [ ? ] enabling brands to have a 360-degree consumer vision.

"Today, with our tools, we develop complex mathematical models that simplify marketing decisions" -Nihal Mougamadou, DNA GA CRO-



Figure I.1: DNA logo

I.1.2.2 Centers of interest

DNA GA works across industries at the intersection of emerging technologies with societal trends. Therefore, it has different fields of expertise. Among which, we can cite:

* Blockchain: The transparency created by the fully adopted blockchain can solve the problem of trust, control and arbitrage in media purchasing and placement by tracking the actions and discards of middlemen, who are prone to mistakes and even fraud [ ? ].
* Artificial Intelligence: The goal is to use data to help brands better understand customers and build a bridge between online and offline brand experiences. In order to achieve this ambitious goal, a unique method was constructed by merging online and offline data (such as billboards, advertising screens, navigation bars, surveillance cameras, etc.), and using machine learning algorithms to find patterns through large amounts of data [ ? ].
* Technology: Manufacture smart cameras to analyze customer behavior in real time. The AI team then processes and analyzes the collected data to create a user-friendly dashboard that uses data visualization technology to display key information [ ? ].
* Sport and Entertainment: Today, the sports and entertainment industries are being developed in the direction of complete "phygitalisation". Fans hope that their teams and their favorite players can have a better experience, and the new business model is becoming more and more mature. Industry leaders need to use new technologies to reinvent themselves in order to maintain their position [ ? ].
* University: In addition to technical expertise, DNA also collaborates with several top



universities, renowned professors, researchers and business experts. Indeed, the com- mitment to the development of blockchain and artificial intelligence in multiple fields such as Marketing, Finance, Sports, Security and Safety has led to regular publication of research and participation in the creation of research papers.

* Health and Safety: Organizations must frequently cope with unexpected events such as the COVID-19 pandemic or ever-existing threats like terrorism. These “Black swan” events or perpetual threats to people safety represent new challenges and expectations regarding security as well as business challenges.

I.1.3 Market study

Gathering Data in retail utilizing computer vision is not a novelty.in fact Computer vision is the most technologically mature field in modern artificial intelligence and business skateholders are finding ways to utilize this technology across every sector of the economy, health, manufacturing and retail. One of these business is VisionLabs a dutch company specialized in AI applications mainly in computer vision, a filed that is also shared with our hosting company DNA.

Vision Labs proposes a solution similar to the one we had in mind. they offer products implementing efficient and cost-effective solutions for customer flow analysis in retail facilities of any size. their solution is a mobile or web application that need to be installed by the customer before entering the store. their products can provide this data while detecting:

* Age, gender and emotion classification.
* Visitor groups.
* Dwell and attention time
* Unique and returning visitors

A solution with various features that definitely inspire us in our work, but it lacks even more important features our client is searching for. One being counting people inside the store and two it need to be an end to end solution that uses the installed CCTV camera footage as the data source, a not a mobile application that its use depends on customer.So it now clear to sat that this solution and like many more found on the internet doesn’t not match the clients specific needs.



I.1.4 Problematic

Our client, a French hypermarket, wants to incorporate cutting-edge technology into their daily operations in order to provide outstanding customer service, improve decision-making, and gain a deeper understanding of their customers’ interests. Cora opted for an AI-powered monitoring system to improve their strategy and obtain useful data.

Before us, Cora was adopting a traditional way of storing and processing data. Its main focus was to collect data and ensure clientele understanding through online shopping on the french website. The use of cookies and data collection within the browsers enables the marketing managers to make decisions about upcoming promotions, sales and even enhance their recommendation system.

However in the retail store acquiring the customer’s data is a hard task as loyalty cards are often not used while purchasing, most of the time customers forget to bring it , lose it or just decide not to use it. So the customer’s understanding depends solely on the fact if they have this loyalty card or not.

Furthermore, due to covid-19 restrictions, to minimize the number of people, Cora closes its store doors whenever the security agent feels like the store is a bit crowded, the decision is based on the man’s perspective and not backed by real statistics which can be damaging both for people health if the number of people was higher than the one perceived to be and can be damaging to Cora business if security agent was letting less people than the maximum required .

Through our meeting with cora we noted it’s business needs and functional requirements, they wanted to capture variable data on consumer behavior, people leaving and entering the store, the number of visitors for every minute, their demographic as in age and gender precisely, and it would be integrated with a camera system. A solution like this would provide our client with a broad perspective of their data, allowing them to make data-driven decisions, by combining all of these elements.

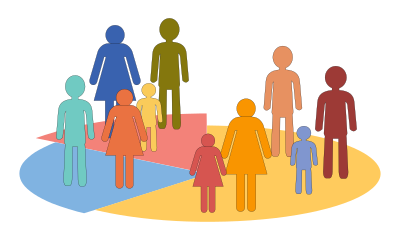


Figure I.2: Customers segments

I.1.5 Solution

On one hand The number of individuals that visit a store or a shopping complex provides important information about how well retail functions. This data can be used to estimate the number of visits, as well as the busiest days and hours. Furthermore, the data can be used to determine how shopper count patterns change over time, as well as the impact of promotions, advertising, competition, weather, school holidays, road closures, and other factors on visitor counts. It can also be used to assess the impact of relocating merchandise and concessions.

on the other hand One of the major aspects that can influence a customer’s decision is gender. women and men approach shopping with different perspectives and considera- tions, women shop out of boredom and fun In contrast to men who shop out of necessity, women go on shopping to purchase both essential and non essential goods, to socialize and be stress free. In addition, female are easily attracted by advertisements compared to male. Therefore, gender identification is one of marketing techniques that can be used to influence buying behavior of consumers.

By combining the two major elements we can leverage data collection in retail though AI to ensure Cora’s business growth and to adjust the company’s marketing strategy.

To answer to the requirements of our client we had to:

* Decide on the most fitting hardware suited for all the technical requirements;



* Collect and analyze in-store CCTV camera footage , to classify the customers into their appropriate age and gender groups.
* Ensure accurate maximum people allowed in the store to answer to human COVID-19 preventive measures.
* the AI solution is real-time with minimal latency.
* Deploy the solution within a short time frame.

finally,We collaborated closely with the client’s team to ensure that the solution was im- plemented smoothly and in accordance with the defined goals. From the initial environment evaluation to system configuration and data science model training.

I.1.5.1 Project Time Management

A project management methodology is a set of principles and practices that guide you in organizing your projects to ensure their optimum performance one of the six major functions is Time management which is the management of the time spent, and progress made, on project tasks and activities. Excellent time management requires the planning, scheduling, monitoring, and controlling of all project activities. As in all software projects , one is advised to choose the project management methodology that is best suited for the project. the methodology was chosen according to:

* Flexibility: outset what the solution will look like, project is prone to change, not sure how the solution outset will look like
* Timeline: client wants to be involved in the process and see results and progress , so work needs to be quick and efficient.

Our projects require extreme flexibility and speed. It is also iterative and incremental. It is best suited to the agile project management method because team members can rapidly adjust tasks as needed to ensure that the customer or business is always satisfied and is provided with outcomes that result in benefits.

Through this method, the project is broken down into “sprints” that are our three busi- ness questions.



Our Agile working process can be broken down into six steps.

1. The first step is to identify the project vision. It defines what the project is, how it will support the business strategy, who will benefit from it and how that will happen.
2. The second step is to build the project road-map where the requirements are set.
3. The third step is to create a release plan that consists in fixing the sprint’s time-frame.
4. The fourth step is to plan and execute each sprint. The fifth step is to hold weekly meetings. These meetings should discuss what was done the previous week and what will be done that week.
5. The sixth step is to hold sprint reviews. These occur at the end of each sprint and consist of presenting the output to the data science team for feedback.

Within the project there is a cycle that will be repeated and only end when the project is deemed finished.

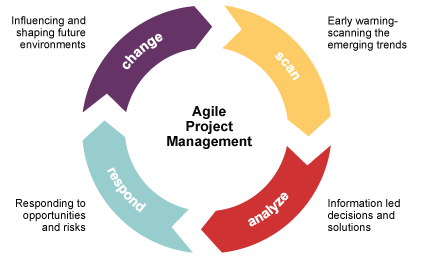


Figure I.3: Agile working cycle

I.1.5.2 Project Management Method

Since time is an important factor in the project, this work should involve precise project time management. To have an overview of the time taken for each phase, Figure below shows how time is partitioned.



**This document was truncated here because it was created in the Evaluation Mode.**