Design and Development - target: 2000

The project design is a key element of a project and without it, there would be no foundations for the project development process. Neglecting the project design phase can lead to disaster with little hope of discovery. The importance of the project design stems from it’s ability to outline the different factors related to a project. These factors and criteria are what needs to be discussed and tracked by a manager and development team.

A good product design consists of few key entities:

* A thorough description of the knowledge and skillset required to develop the project
* A detailed list of the project requirements and description of the end goal.
* The objectives, milestones, goals, and outcomes related to the project
* Every product, major deliverables, evaluation, monitoring guidelines and features of the success criteria
* Lastly, the budget estimation criteria and associated guidelines.

If the project was not an individual assignment, the manager would need to include key stakeholders, upper-management and any team members involved in the project, in the project design creation. This would help avoid obstacles in the project development process in the future as well as reduce any confusion in understanding the project vision for everyone involved In the project.

The first step of the Project design phase was defining the vision.

The vision statement outlined the different entities that had to be worked on in the future in order to achieve the key objectives such as:

* Implementation of face detection algorithms
* Implementation of face recognition algorithms
* Implementation of automation for the drone
* Lastly, defining how the drone responds to recognised and unrecognised faces.(autonomous tracking)
* Fail safe remote access to drone at all times to override automation during emergencies.

These key objectives also define the problems that will be solved using the project.

When these key objectives have been successfully achieved the end product will be capable of being applied to a wide range of objectives made possible by the different disciplines that have been implemented such as machine learning and computer vision techniques. These features on an autonomous drone would enable the creation of a companion tool unlike any other existing tool. The drone would not only be able to achieve simple tasks such as picture taking and video recording from a range of angles and distances,making it applicable as an excellent photography tool available to professionals but also the average user, with additional effort the drone would be capable of more complex actions such as patrolling an environment and reporting when something defined as an object of interest has been detected. Furthermore, the drone could also be used for vlogging in a multitude of locations where a conventional camera might not be an option, such as when climbing a mountain or during extreme sports. In a sense, the drone would also be usable in conjunction with existing cameras in order to provide a different perspective. The idea being that the project will simply provide a template for which they can be many overlapping applications due to the nature of what is trainable by machine learning and computer vision techniques.

The reason why face recognition is of paramount importance to this project would be because face recognition is the most adaptable and applicable method that can be used to distinguish between humans. and since a large amount of applications will see the drone interacting with humans via the camera, its primary method of perceiving the world, face recognition will have to be the most significant aspect of the Human robot interaction. Other forms of biometric data that can be perceived through a camera such as eye, retina data would be unreliable at the distances the drone would need to operate at for safe as well as effective use of the flying capabilities a drone has. Lastly, when the drone is operated at distances much too far to pick up faces, the primary directive would be instead to pick up human structures which can then be approached in order for the drone to get into face recognition distance.

Such features are only possible thanks to the advancements in machine learning and computer vision technology and by applying then on a robot with as much mobility as a drone, we get something that is capable as the limitations of current hardware and software advancements allow it to be.

This vision statement is significant because it can be presented to stakeholders and acts as a selling point for the need of developing the project in the first place.

In addition, the project design also acts as one of many guidelines during the development stages because if a team is not following the designated path, the project design will guide them back onto to the true path.

With the clear definition of a vision statement follows the tracking and understanding on the problems that need to be overcome to make the vision statement successful.

Identifying these problems has been made possible by previous research on autonomous drones with facial recognition. While there are not many such projects that specifically combine facial recognition based, underlining problems that remain the same include: the range at which face recognition Is possible, the legal implications of processing face data in public spaces, people’s mistrust for drones, stemming from their invasive nature and ability to cause damage whether to people or property. The only solution to the latter being the education of people as to the measures that are in place to prevent damage caused by autonomous drone technology and to safeguard the privacy and well-being of any people’s information taken while the autonomous drones are in operation.

The type of information that is necessary for the implementation of autonomous drone technology with facial recognition is purely face data and the only resources required would be access to datasets of faces for training a machine learning model to recognises faces and the ability to compare faces seen in real time with known faces in the dataset via a camera.

Asides from using publicly available datasets, it is also possible to open up the project to public and ask for anonymous donations of photo’s with people’s faces in them. To retain some level of privacy, the images could then be labelled with numbers so there is no link to the people’s original names.

Other important resources include a drone with adequate hardware to achieve autonomous navigation, a safe testing space and existing software libraries such as OpenCV, numpy and math to name a few. These libraries will be necessary for applying mathematical calculations to the image data that is processed by the drone.

Some tools were used as part of a particular machine learning algorithm, whether to process data or prepare the data for the machine learning algorithms.

Existing research papers on autonomous drones and facial recognition highlighted a number of problems and key issues that were addressed in the past as well as potential application scenarios for drones.

At this stage, the supervisor also acts as the only required personnel that aids in the development process through frequent meetings and discussions of the key objectives of the autonomous drone.

The resource management required would be ensuring access to a non-biased dataset for machine learning training and acquiring an adequate drone to implement autonomous face recognition on. To keep track of task management Weekly meetings and updating of key objective progress would be the most effective method of tracking task management. Along side this, the use of a Gantt chart to access the rate of progress and github to monitor the amount of progress each week have both been effective for planning next stages of the project.

The project development process was completed both remotely as this allowed testing to be possible in a variety of environments.

The project development started in March and ended on the 19th September 2022.

The aforementioned resources are needed to complete the project development process because the project nature is very specific and thus requires specific types of information pertaining to face data. Without this information it would not be possible to achieve the key objectives of this project. Similarly. This project is on drone technology and as such, without a drone, testing would only be possible in simulation. It would be extremely hard to test face recognition on a drone in simulation and this would require more work than is necessary. In addition, testing in simulation would not expose real world weaknesses that autonomous drones suffer from such as power consumption problems, flight height limitations, flying condition limitations such as flying in winds whilst attempting to apply face recognition.

The Milestones for the project were:

The application of face detection on a drone

The implementation of reliable face recognition on the drone

Implementation of remote control for the drone

Face tracking for the drone based on face recognition.

Face based obstacle avoidance to prevent the drone from hitting detected faces while following a recognised face.

Creation of autonomous behaviour for when a face is not detected

Implementation of vision based mapping technology to track the drone location when it is not in view

Utilization of drone status such as battery percentage to enable autonomous actions such as a return to base action when the battery gets below a recommend percentage. Such data can also be used to advise caution during remote control as well as constrain the autonomous drone’s actions, preventing flight above a certain height or speed for safety.

After the project goals were defined via the project development process, it was time to devise the perfect strategy to help achieve the goals.

A strategy is defined as a way to achieve the goals, milestones and outcomes associated with a project.

This meant that strategies, although straightforward, are very project-centric and tailor made to suit the needs of a project.

The beautify of a strategy is that it allows a project manager to keep track of things like schedules, budgets, resources and many other elements associated with a project. Ensuring that a project is completed at an appropriate time and with an agreed-upon budget.

To create a perfect tailor made strategy, there are a couple steps that can be taken to ensure the strategy will achieve the goals that have been outlined by a project management process. The first of which is:

Looking back at the projects that have been developed in the project domain and studying the best strategies that have worked successfully in the path. Past projects act as a sort of template that can be used to achieve different goals and milestones connected to the project.

The second step would be to look for overall successful strategies that have worked in the past outside the project domain as well, as sometimes these can be highly effective across projects.

Following the perfect project strategy, would be the contingency plan

The contingency plan serves as a back up or fall back which will be activated if problems become too much to deal with during the project development stage.

To create a contingency plan it is important to study similar projects that have been developed in the past as the past wisdom will help highlight risks and scope creeps that have been faced in the past as well as how to shield a project from the same risks and bugs.

Risks and scope creeps can be anything from:

* unavailability of resources at crucial moments
* unavoidable loss of time to work on project due to real world problems, resulting in the inability to perform at optimal capacity.
* Lack of productive skills during the development and management stages for similar reasons as the above.
* The lack of a budget or the inability to manage a budget accordingly and not having a contingency plan to cover loses can be crucial to the project.
* Lastly, mismanagement of the schedule pertaining to the delivery of the product

The last aspect of project design that needs addressing is the creating of a proper budget.

Again, studying previous projects that have been developed in the past to find out the best working budget that will lead to achieving goals and milestones is a solid approach. A good budget estimate will need to cover everything from the smaller tasks to the behemoths. Most projects fail in the project management paradigm as a result of more attention being paid to bigger milestones and not enough to the smaller ones.

To structure project design efficiently, task/project management tools such as Gantt charts are very useful for accurately planning projects down to the day. Making it easy to quickly detect when project progress is behind schedule as well as what resources are required for achieving key objectives or how soon milestones are expected to be achieved.

Source: https://www.ntaskmanager.com/blog/project-design-in-project-management/