WGU C964

Task 2 - Section B

TECHNICAL PROPOSAL

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**Problem Statement**

Zee Car Company (ZCC) is looking for a way to deliver parts to various locations on its campus and factory floor. The factory runs 24 hours a day and so ZCC needs a solution that can operate continuously.

The solution must not require significant infrastructure change, very minimal human intervention and must be easy to change or adapt to its other locations globally.

**Customer summary**

Zee Car Company (ZCC) is an automobile manufacturing company. It currently operates eleven factories spread across six different locations. The proposed solution will be utilized specifically by the parts delivery department, however almost all other departments on the factory floor will interact with the proposed solution when receiving deliveries.

Employees will be given a short demonstration in order to familiarize themselves with the vehicle, however it will be designed in such a way that no special training is needed in order to receive deliveries.

There will be one user who is briefed on routine checks that need to be carried out, however we will be able to run diagnostics and push updates remotely.

The autonomous delivery vehicle will operate exclusively indoors and use painted lanes in order to navigate the factories it’s operating in.

**Existing system analysis**

The system currently in place for delivering parts is a manual hand delivery system. ZCC relies on a team of 18 staff that are on a 24 hour schedule to hand deliver parts to various departments on the factory floor. The initial goal of the proposed solution is to cut the team of 18 down to 3 immediately which will mean that there will be at least one staff member supervising deliveries at all times. Once the pilot is complete there is the potential to deploy more autonomous delivery vehicles while still maintaining the head count of 3.

**Data**

All training data will be created and collected by X-Soft on behalf of ZCC. There are two distinct data sets that are needed in order to train the two machine learning models that will be utilized in the self-driving vehicle.

1. **Lane navigation data** - This will be a series of images collected by our prototype car. The images will be converted to YUV color space and cropped to a resolution of 200 x 66 which is the optimum resolution and format for our machine learning model. Although a portion of these images will be shot on the ZCC factory floor, there will be no proprietary or sensitive information captured in these images. These images will also not live on the proposed solution. They will be securely stored at X-Soft and then discarded after the model has been trained.
2. **Object detection data** - This will be a collection of images representing the unique objects that the proposed solution will need to detect. The machine learning model being utilized already has common object detection trained into it and so we will only need to train the model on objects unique to the ZCC factory environment. These images will be shot at X-Soft headquarters and will not contain any proprietary or sensitive information. They will not be stored on the proposed solution.

**Project methodology**

Development will follow the SEMMA methodology,

• **Sample:** Selecting the sample data set. X-Soft will gather images of the factory and potential routes the vehicle might take. X-Soft will also gather images of objects the proposed solution will need to detect.

• **Explore:** X-Soft will try to understand the data (images) and try to anticipate what our program might use in order to anticipate the path of the self-driving vehicle, for example a lane or existing footpath.

• **Modify:** Once X-Soft determines the variables in the explore phase, we’ll prepare or modify the data in order to start the modeling process. This could include eliminating unnecessary visual elements from the images, cropping, color space conversion and masking.

• **Model:** We apply data models to the dataset in order to create a certain behaviour from our program. In this case it would be to control the car, make it navigate a lane autonomously, and make it detect predetermined objects

• **Assess:** Evaluate the results of the modeling phase and determine whether or not the desired outcomes were achieved.

**Project outcomes**

The ultimate project goal is an autonomous self-driving delivery vehicle that can be broken down as follows:

* **Physical vehicle:** design and construction of the physical vehicle. This vehicle will be loosely based on a golf cart design, however, certain modifications will be made to the chassis in order to facilitate parts storage and delivery. The vehicle will be battery powered and a custom charging station will be provided requiring a 3 phase (industrial) electrical outlet for fast charging.
* **On board computer:** The hardware that will run the software to control the vehicle and process its surroundings via a camera in real time. This hardware has been tried and tested in this particular application and will have sufficient power to run the machine learning models.
* **Software:** The main program that will control the vehicle and utilize the machine learning models in order to perform its primary task.
* **Machine learning models:** 2 machine learning models trained specifically for this application and environment that will perform the tasks of lane navigation and object detection.
* **Security system:** The vehicle will be secured using an ID card system. Once the ID card is swiped, the user will have direct access to the system where they will be able to start the application.

**Implementation plan**

* **Strategy for implementation:** We will implement the proposed solution in a phased manner which will allow us to have tight control over the outcomes. Note that this phased approach will commence after completion of testing.
* **Phases of roll out:** The first phase of roll out will comprise of the vehicle driving to single destinations within the factory to deliver parts. These deliveries will be manned. In the second phase, the vehicle will visit multiple locations in a single run, this phase will still have a staff member manning the vehicle. Lastly, the vehicle will complete multiple deliveries unmanned.
* **Testing and final distribution:** The first phase of testing will be conducted on X-soft premises in a simulated environment that closely resembles a ZCC factory. The second phase of testing will be conducted in a ZCC factory. The vehicle will not pass any phase of testing unless it has a 100% function rate. If it deviates from a path or fails to detect an object then the model will be assessed and further model training will be implemented. Once the vehicle is deployed it will be under a pilot program where it will be manned 100% of the time until we are satisfied with the accuracy and reliability of the vehicle in the production environment.
* **Dependencies and milestones:**
  + Physical car build
  + Hardware build and installation
  + Software development and installation
  + Data gathering and analysis
  + Model training
  + Testing
  + Deployment
* **Deliverables**
  + Self-driving car
  + Interface to control car
  + Charging station
  + Staff training

**Evaluation plan**

The self-driving vehicle will be evaluated on two primary outcomes. Firstly its ability to navigate and stay in a specified lane. Secondly, it’s ability to detect specific objects and make decisions on those detections.

Since the vehicle will be operating in a physical environment around persons and costly equipment that could have lasting financial impact on ZCC should any injury or damage occur, we will be operating under a zero tolerance for error model. This means that the vehicle will not be deployed until it passes all tests and is able to accomplish its tasks with a 100% accuracy rate.

Initial testing will be carried out in a controlled environment resembling a ZCC factory. Once these tests are complete, testing will then take place in a production environment. Lastly, once the vehicle is deployed, it will be operating under a pilot program whereby it is closely monitored and manned by X-Soft staff.

**Resource and costs**

| **Resource** | **Description** | **Cost** |
| --- | --- | --- |
| Delivery vehicle | Custom built electric vehicle and charging station | $92,000 |
| Hardware | Onboard computer to run the software including camera and radar | $3000 |
| Python | Software | 0 |
| Tensorflow | Software | 0 |
| OpenCV | Software | 0 |
| Development | 3 x Software engineers | $40,000 |
| Installation | Engineer | $10,000 |
| Delivery | Vehicle delivery and training | $5,000 |
|  | **Total** | $150,000 |

The total cost for the project is $150,000. $55,000 of this cost comprises human resource needed for software development, installation and training.

The total cost includes all testing and physical environment setup for training the vehicle. The cost does not include ongoing maintenance, this will be offered in a separate contract if required by ZCC. X-Soft will retain ownership of the software and intellectual property, this cost includes one 10 year license for one vehicle. Additional licenses will be available to purchase at a discounted price of $5,000 per license.

**Timeline and milestones**

The project shall be completed in 4 sprints, taking a total of 6 weeks to complete.

| **Sprint** | **Start** | **End** | **Tasks** |
| --- | --- | --- | --- |
| 1 | 09/01/2021 | 09/13/2021 | Data acquisition  Data processing  Simulation setup |
| 2 | 09/14/2021 | 09/31/2021 | Hardware install  Model training + optimization  Vehicle testing |
| 3 | 10/01/2021 | 10/13/2021 | Dashboard development  Testing of vehicle in the intended environment |
| 4 | 10/14/2021 | 10/16/2021 | Delivery of vehicle  Onsite staff training |