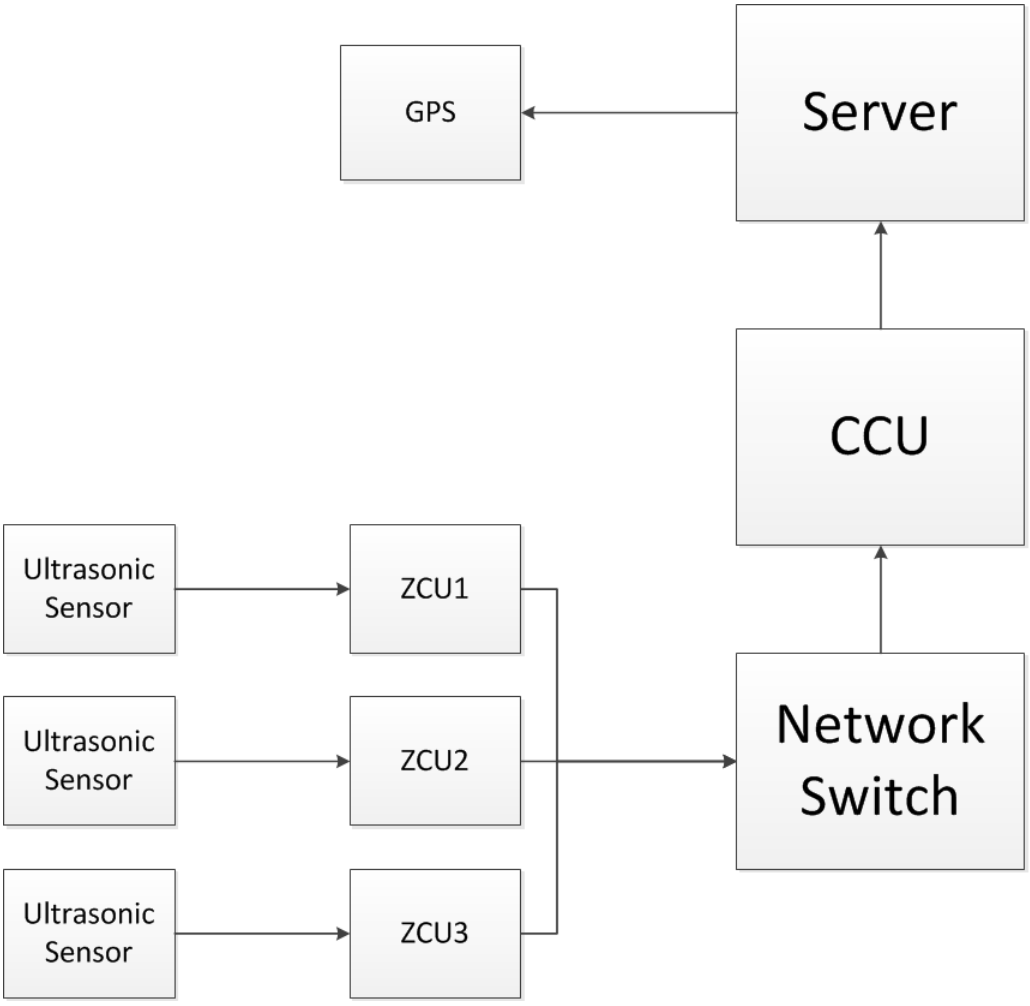
**E 322 DESIGN 6 - SMART PARKING SYSTEM** **HW7**

Group tasks breakdown:

- **Joany Jores** - *1st implementation design.*
- **Muhammad Amir Mohd Azmi** - *2nd implementation design.*
- **Mohd Danial Mohd Razemi** - *Design constraints and possible solutions.*
- **Muhammad Syahir Shahimi** - *Ethical and Professional Responsibilities.*
- **Afiq Izzat Mohamad Fuzi** – *S.W.O.T Analysis*

**Implementation blocks:**

1st alternative



System Components

Main components:

1. **Central Controller Unit (CCU)**

- Central controller of parking guidance system. Main module in the system.
- Responsible for data collecting and data processing.
- Gets information from Zone Controller Unit (ZCU) and sends feedback to peripherals.
- The core of whole system, is mainly responsible for the collection of carport information and data processing of the whole yard, then send feedback of the processing data to the specific PCs or other relevant equipment such as GPS Navigation System.

2. **Zone Controller Unit (ZCU)**

- Zone Control Unit of parking system. The LCD in ZCU is to show the detector's work status.
- One Zone controller can connect to predetermined (40 to 60 ultrasonic detectors.
- Main function is to request information from the UD sensor, and send the data to CCU.
- It gathers and forwards vacancy information from all the UD sensors to the Central Control Unit.
- Forwards commands from the Central Control Unit to the specific PCs or other relevant equipment such as GPS Navigation System.

3. **Ultrasonic Sensors**

- An ultrasonic proximity sensor will be placed on the pavement (for outdoor parking) and on the parking spot (for indoor) for each individual parking space.
- When this sensor is blocked within a particular time limit (15-30 seconds), it will register that a vehicle is parked. The sensor will send this information to the server. The server then change the status of that particular parking space as 'occupied'
- When the sensor is not blocked within a particular time limit (2-3 minutes), it will assume that there is no vehicle in that parking space. This information will be sent to the server and the server will change the status of that parking space to 'available'
- All these information can be viewed via the parking application in the GPS
- This method requires a lot of sensors. It would be quite difficult and costly to set these sensors at every place.

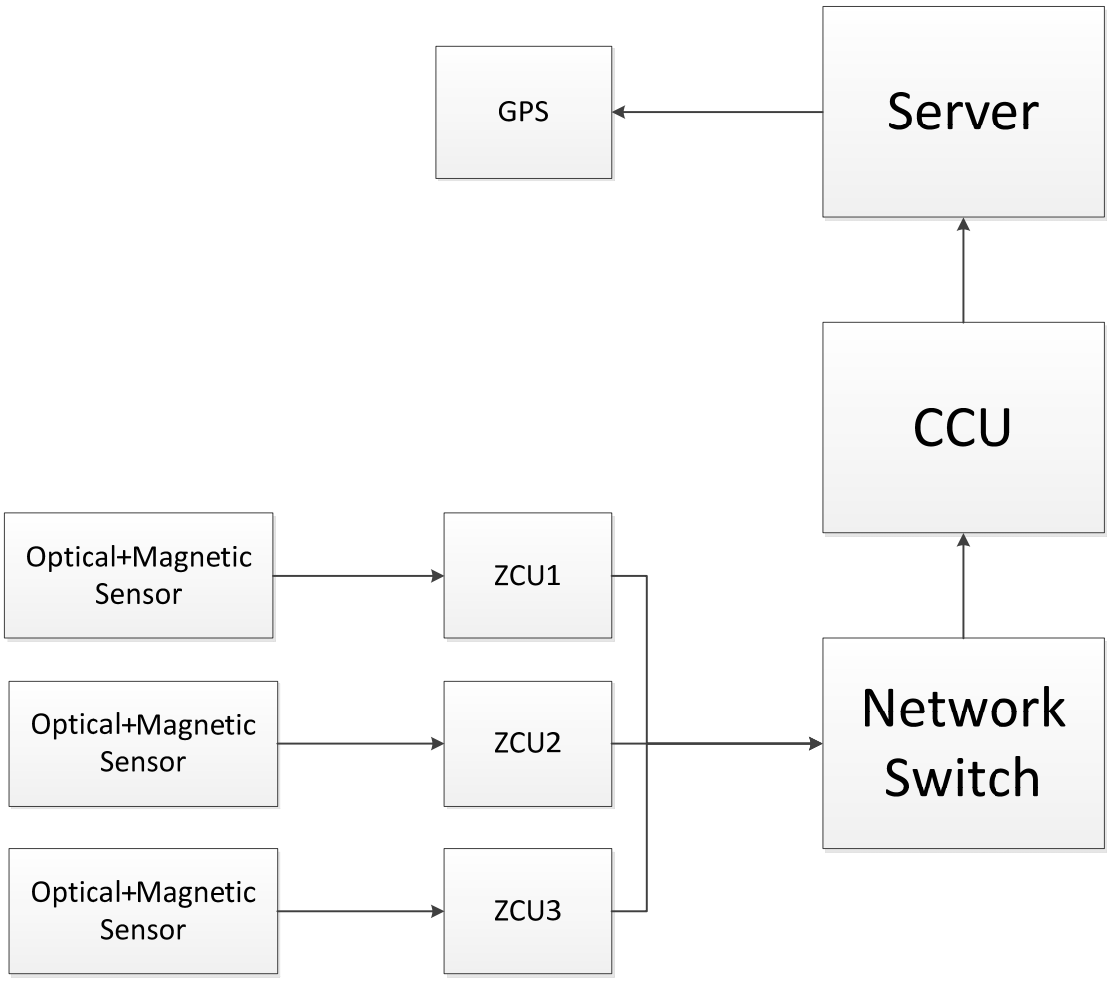
4. **PGS software**

- Monitoring the parking in PC and get the operation data.
- Customizing the ultrasonic sensors.

**5. GPS navigation System**

- Receive the information from the server about the parking availability and the direction.
- Instruct the user to vacant parking space.

2nd alternative:



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3. **Optical & Magnetic Sensors**

- Both the sensors are embedded in the asphalt or on each parking lot (indoors).
- Optical sensors analyze and detect the light intensity above the sensors - when it darkens, that means something (possibly someone is parking) are detected on the parking spot.
- Then, magnetic sensors analyze whether the object (that causes the spot to be darken) is a metal vehicle or other non-metallic object such as shadows or a person.
- These combined information and data are then sent to the ZCU.
- This alternative might increase the cost because the amount of sensors used is doubled as there are two different sensors.

4. **PGS software**

- Monitoring the parking in PC and get the operation data.
- Customizing the optical and magnetic sensors.

5. **GPS navigation System**

- Receive the information from the server about the parking availability and the direction.
- Instruct the user to vacant parking space.

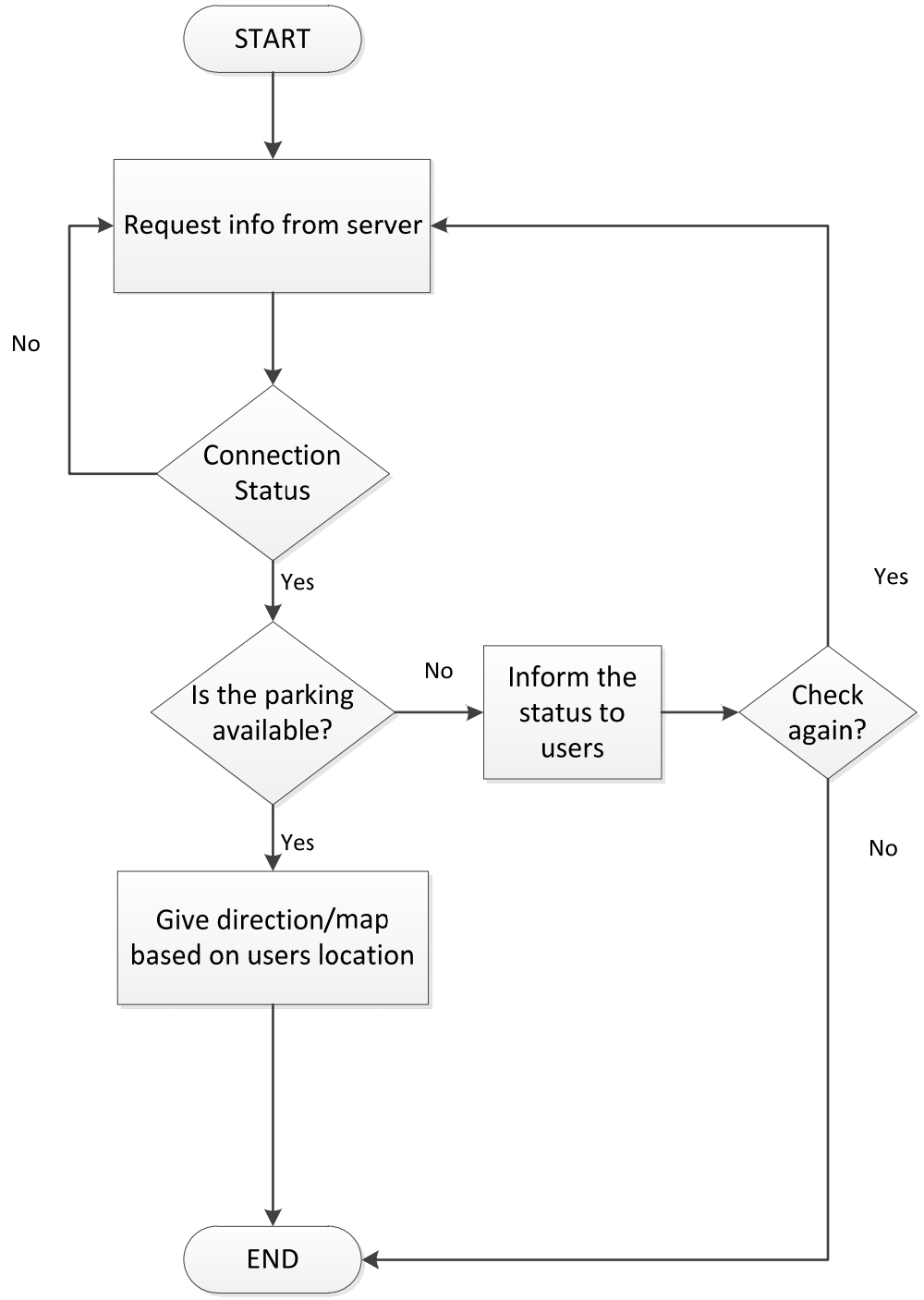
GPS implementation

GPS uses satellites to determine and lock its position. At least four GPS satellites are needed to calculate the position of a certain GPS receiver. The signals from the satellites (moving at the speed of light) are transmitted at the exact same time but may arrive at the receiver at different time, depending on the distance between the satellites and the receiver. This distance is then used by the receiver to calculate its position in three dimensions.

For our project, we have decided to make improvements to enhance the GPS connectivity. The known problem with GPS is that the connection would be lost in indoor places such as in a confined building. To deal with this problem, we have several possible solutions. The first solution is to capture the GPS signal and re-transmit the original signal inside the confined building. Special antenna module will be used to carry out the task. The technique is basically to repeat the signal that is captured outside the building by a special module known as a GPS repeater. This technique should not be a new idea since the availability of such module in the market is well-known. For that reason, we use this availability as our advantage. Moreover, by having this technique, we should be able to re-transmit the captured signal in different spots by using multiple transmitters. Similar techniques but different project objectives are used and explained in the reference work#. More information can be read in this link. Secondly, we also have other alternative to make the GPS works indoors, which is by using an internet connection; either with Wi-Fi or 3G. Basically, the GPS will be assisted (aGPS) by the internet connection in place where there is no satellite coverage. It can supply orbital data for the GPS satellites to the GPS, enabling the GPS receiver to lock to the satellites with more accuracy. In addition, there will be a built-in application in the GPS that contains pre-loaded maps for each outdoor and indoor parking area (for example, Walmart or Best Buy).

Usually indoor parking has several levels. To integrate parking system in GPS by using satellite is quite impossible because it does not know the exact level of the car. To overcome this, the GPS will be installed with Wi-Fi receiver. When the car enters the hotspot location, the GPS will automatically connect to the Wi-Fi. Wi-Fi will locate the location of the car and at the same time provide the local map (map of the parking location) to the GPS so that the GPS will not have to download maps of every building that are using this system.

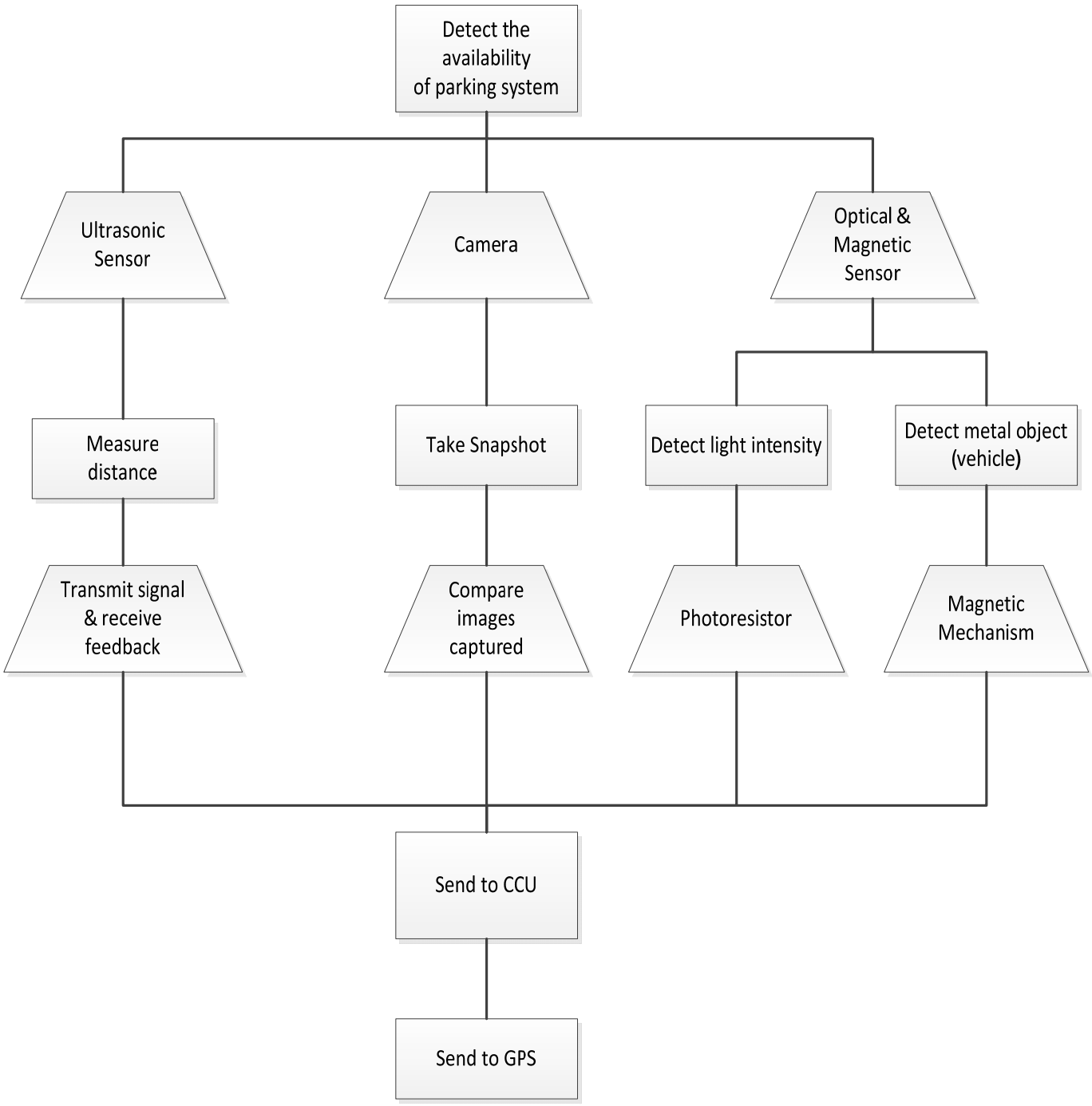
Custom GPS software (Design flowchart)



Our group chose the first alternative as the best design. It is based on the fact that it uses ultrasonic sensor which is cheaper in term of price than the optical and magnetic sensor combined. In term of detection range, optical and magnetic sensors have the farthest detection range which means that they are as good as their price. However, we are sure that we do not need such distant detection range for the system since the purpose is to detect cars in fairly short distant. Therefore, we could limit the project budget. In term of efficiency, both sensors are equally good. Ultrasonic sensor uses less power as compared to optical/magnetic sensor. It relies on the capability of the ultrasonic sensor to generate ultrasonic pulse which consumed less power than to maintain magnetic inductance in a magnetic sensor. Moreover, by using ultrasonic sensor additional processor/software is not needed. For optical sensor, we need external processor to process the image before the software on the computer make any decision. Image processing is far more complex than simple analog to digital converter. Besides that, by using simple yet sufficient sensor as the ultrasonic sensor, simple maintenance could easily be done. Any problem in the sensor arrays can be spotted easily and the faulty sensor could be replaced in no time. The impacts; it consumed less time for maintenance which means less time for system suspension and less cost for maintenance procedures.

Despite of all these, we would be using the second implementation if we stumbled any problems during the installation of the system. Since both sensors having almost similar characteristics, we would be able to switch them at any instant. Price is the only matter we would have to consider.

Function-means tree diagram



Design constraints and possible solutions:

**Realistic Constraints**

**a) Economic**

- Total cost of project and available budget
- High maintenance cost
- Time taken to finish the product may affect the total cost of budget.

Solution(s):

- Manage budget efficiently.
- Supervise project development to meet project deadlines.
- Use good quality components (with reasonable price).

**b) Environmental**

- Consumes an amount of power to operate.
- Wastes such as plastics, default chips, circuits and wires produced during the implementation phase and during maintenance.

Solution(s):

- Preferably use high efficient product. eg: for power supply, wire connections, circuitry and processor unit. (with reasonable price).
- Implementing the efficient work management to reduce consumption of power.
- Follow regulations guidelines stated by Environmental Protection Agency (EPA) when using different materials during the installation or during daily operation.
- Get permission from the state authority and abide their specific state's regulation.

**c) Health and Safety**

- Workers safety during the implementation of the whole system in a specified building or space.
- Public safety when using the implemented system. It also includes the navigation device such as the GPS receiver.

Solution(s):

- Provide a safe working environment for the workers
- Supervise workers so that they will always follow all the rules in the working environment

**d) Manufacturability**

- The availability of the materials and components required.
- Purchase of the components requires supplier quality and reliability**.**

Solution(s):

- Make research to find reliable component suppliers.
- Compare products from different companies.

**e) Sustainability.**

- The overall system may require system maintenance.
- The life span for every part of the system may vary.
- Reliability and durability of the system and its components.

Solution(s):

- Establish a special unit to do maintenance job.
- Provide efficient and user-friendly customer support to ensure the sustainability

Professional and Ethical Responsibility with possible solutions:

1. Avoid from using registered patents without permission

   **Solution(s):**
   - Request permission from patents' owner if there is any registered patents applied/used in the project

2. The product should not be used as threat to other users' privacy.

   **Solution(s):**
   - The service does not collect or send data from the user without their permission.
   - If it does, the service should prompt the users or notify them about the background services.
   - The service is limited to one user at a time. Other user could not interfere with other users' services in any way.

3. The safety of workers and consumers should be considered.

   **Solution(s):**
   - Minimize/avoid from using toxic materials
   - Provide a safe working environment with strict regulation
   - The project development should be monitored and supervised.

4. The system does not bring any harm to the environment.

   **Solution(s):**
   - Practice green technology

5. The project design should abide the state's law for public safety or Federal Communications Commission (FCC) or Environmental Protection Agency (EPA).

   **Solution(s):**
   - Allow the law enforcer to supervise and monitor the project to receive certification of public safety.

Multi-disciplinary Teamwork Planning

There are two different disciplines which are Electrical engineering and Computer engineering primarily working on the project. Different discipline performs different type of tasks.

- Electrical engineering

    a. Dealing with the circuit design and wiring of the whole system
    b. Maintaining the overall system especially the main components (sensors, CCU, ZCU etc.)
    c. Performing detailed calculations to compute and establish manufacturing, construction, and installation standards.
    d. Understanding the specifications for purchase of equipment and materials.
    e. Implementing research and procedures to apply principles of electrical engineering.
    f. Developing wireless communication into the system
    g. Performing design analysis as well as design constraints.

- Computer engineering

    a. operate computer-assisted engineering tasks such as:

        1. Creating software for the system.
        2. Maintaining the server of the system.
        3. Performing the modification of software to correct errors in software system.

    b. Coordinate installation of software system.
    c. Supervise testing and validation procedures of software.

S.W.O.T Analysis:

i. Strength:

The objective of the system is to provide information to drivers about the status of the parking lot. The implementation of such system in a building for example will increase the efficiency of the parking lot by providing information such as the number of free parking spaces, the location of that parking space and the level of that building. Consider a parking complex with several parking floors. Searching for the free space on each floor is time consuming plus inconvenient for some people living on that particular floor. Another impact it has is it reduce traffic congestion. The implementation of the system in a shopping complex or office building will reduce traffic congestion during peak hours. The system will direct the user to the location of the free space including on the floor level more systematically than ever before. By reducing the amount of time spent in traffic congestion, people can save their precious time doing something more important. Besides that, by reducing traffic congestion the emission rate of harmful gas from the vehicle to the atmosphere can also be reduced significantly.

ii. Weaknesses:

The expected weaknesses of the system are misleading information and system lagging. Since the system provides help in navigation, wrong calculation by the system can cause misleading information to the driver. This situation can happen when one of the sensors is malfunction. The whole system contains interlinking modules which include peripheral such as the sensor module. If one of the modules is malfunction, the whole system would crashes. To fix this problem, an amount of time and money will be spent. Misleading information can cause more severe traffic congestion and cost even more time. Furthermore, system lagging can also be one of the problems during peak hours. During peak hours, the system receives more information than ever before. The input output channel will be overloaded. The system might not be able to compute more efficiently and the buffer memory might not be able to contain that information, therefore the system lags. System lag can also cause traffic congestion.

iii. Opportunities:

The implementation of the system publicly provides more benefits to the people. The additional proposal is to extend this information to the user using user-friendly applications. By doing so, GPS software development is forced to work to meet this demand. At last, the evolution of more user-friendly apps would be created. User would find more versions of the apps and this would increase the probability to create a market. Other than that, market opportunity can be established physically in term of the modules used by the system. These modules include the sensor, the processor, the monitoring devices, visual aids and the gps. Since the system is the combination of bunch of modules, custom design might be required depending on environmental parameters and software limitations. In addition to this is the job opportunity. Such intelligent system needs maintenance on a regular basis. Therefore qualified technician is needed that should guarantee the optimum performance of the system for long period of time.

iv. Threats:

One of foreseen threats in the system is privacy. The objective of the system is to provide information to the user. However, the system will also require information to the user. Since the system is interconnected to the user, information leaks will compromise the user privacy such as his current location. Log files may be accessed without permission by an unauthorized person or the connections can be jammed. Either one, the information about the user is made public. Another problem might come when the system malfunction or crashes. During the malfunction period, the system would not be able to provide information anymore. The malfunction system needs an amount of time to be fixed and this will require money and time.

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**Sensors:**
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**Other links:**
ZPU,CCU system:
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http://www.bikudo.com/product_search/details/292037/car_parking_system_led_display.html